Subject: **Financial Derivatives**	
Course Code: **FM-407**	Author: **Dr. Sanjay Tiwari**
Lesson No.: **1**	Vetter: **Prof. M.S. Turan**
INTRODUCTION TO DERIVATIVE SECURITIES	

Structure

1.0 Objectives

After going through this lesson you will be able to:

- understand meaning and evolution of derivatives

- describe the features and types of financial derivatives
- understand uses and functions of derivative securities
- distinguish between futures and forward contracts

1.1 Introduction

The objective of an investment decision is to get required rate of return with minimum risk. To achieve this objective, various instruments, practices and strategies have been devised and developed in the recent past. With the opening of boundaries for international trade and business, the world trade gained momentum in the last decade, the world has entered into a new phase of global integration and liberalisation. The integration of capital markets world-wide has given rise to increased financial risk with the frequent changes in the interest rates, currency exchange rate and stock prices. To overcome the risk arising out of these fluctuating variables and increased dependence of capital markets of one set of countries to the others, risk management practices have also been reshaped by inventing such instruments as can mitigate the risk element. These new popular instruments are known as financial derivatives which, not only reduce financial risk but also open us new opportunity for high risk takers.

1.2 Defining derivatives

Literal meaning of derivative is that something which is derived. Now question arises as to what is derived? From what it is derived? Simple one line answer is that value/price is derived from any underlying asset. The term 'derivative' indicates that it has no independent value, i.e., its value is entirely derived from the value of the underlying asset. The underlying asset can be securities, commodities, bullion, currency, livestock or anything else. The Securities Contracts (Regulation) Act 1956 defines 'derivative' as under:

'Derivative' includes–

Security derived from a debt instrument, share, loan whether secured or unsecured, risk instrument or contract for differences or any other form of security.

A contract which derives its value from the prices, or index of prices of underlying securities.

There are two types of derivatives. Commodity derivatives and financial derivatives. Firstly derivatives originated as a tool for managing risk in commodities markets. In commodity derivatives, the underlying asset is a commodity. It can be agricultural commodity like wheat, soybeans, rapeseed, cotton etc. or precious metals like gold, silver etc. The term financial derivative denotes a variety of financial instruments including stocks, bonds, treasury bills, interest rate, foreign currencies and other hybrid securities. Financial derivatives include futures, forwards, options, swaps, etc. Futures contracts are the most important form of derivatives, which are in existence long before the term 'derivative' was coined. Financial derivatives can also be derived from a combination of cash market instruments or other financial derivative instruments. In fact, most of the financial derivatives are not new instruments rather they are merely combinations of older generation derivatives and/or standard cash market instruments.

1.3 Evolution of derivatives

It is difficult to trace out origin of futures trading since it is not clearly established as to where and when the first forward market came into existence. Historically, it is evident that futures markets were developed after the development of forward markets. It is believed that the forward trading was in existence during 12^{th} century in England and France. Forward trading in rice was started in 17th century in Japan, known as Cho-at-Mai a kind (rice trade-on-book) concentrated around Dojima in Osaka, later on the trade in rice grew with a high degree of standardization. In 1730, this market got official recognition from the Tokugawa Shogurate. As such, the Dojima rice market became the first futures market in the sense that it was registered on organized exchange with the standardized trading norms.

The butter and eggs dealers of Chicago Produce Exchange joined hands in 1898 to form the Chicago Mercantile Exchange for futures trading. The exchange provided a futures market for many commodities including pork bellies (1961), live cattle (1964), live hogs (1966), and feeder cattle (1971). The International Monetary Market was formed as a division of the Chicago Mercantile Exchange in 1972 for futures trading in foreign currencies. In 1982, it introduced a futures contract on the S&P 500 Stock Index. Many other exchanges throughout the world now trade futures contracts. Among these are the Chicago Rice and Cotton Exchange, the New York Futures Exchange, the London International Financial Futures Exchange, the Toronto Futures Exchange and the Singapore International Monetary Exchange.

During 1980's, markets developed for options in foreign exchange, options on stock indices, and options on futures contracts. The Philadelphia Stock Exchange is the premier exchange for trading foreign exchange options. The Chicago Board Options Exchange trades options on the S&P 100 and the S&P 500 stock indices while the American Stock Exchange trades options on the Major Market Stock Index, and the New York Stock Exchange trades options on the NYSE Index. Most exchanges offering futures contracts now also offer options on these futures contracts. Thus, the Chicago Board of Trades offers options on commodity futures, the Chicago Mercantile Exchange offers options on live cattle futures, the International Monetary Market offers options on foreign currency futures, and so on.

The basic cause of forward trading was to cover the price risk. In earlier years, transporting goods from one market to other markets took many months. For example, in the 1800s, food grains produced in England sent through ships to the United States which normally took few months. Sometimes, during this time, the price trembled due to unfavourable events before the goods reached to the destination. In such cases, the producers had to sell their goods at loss. Therefore, the producers sought to avoid such price risk by selling their goods forward, or on a "to arrive" basis. The basic idea behind this move at that time was simply to cover future price risk. On the opposite side, the speculator or other commercial firms seeking to offset their price risk came forward to go for such trading. In this way, the forward trading in commodities came into existence.

In the beginning, these forward trading agreements were formed to buy and sell food grains in the future for actual delivery at the pre-determined price. Later on these agreements became transferable, and during the American Civil War period, Le., 1860 to 1865, it became common place to sell and resell such agreements where actual delivery of produce was not necessary. Gradually, the traders realized that the agreements were easier to buy and sell if the same were standardized in terms of quantity, quality and place of delivery relating to food grains. In the nineteenth century this activity was centred in Chicago which was the main food grains marketing centre in the United States. In this way, the modern futures contracts first came into existence with the establishment of the Chicago Board of Trade (CBOT) in the year 1848, and today, it is the largest futures market of the world. In 1865, the CBOT framed the general rules for such trading which later on became a trendsetter for so many other markets.

In 1874, the Chicago Produce Exchange was established which provided the market for butter, eggs, poultry, and other perishable agricultural products. In the year 1877, the London Metal Exchange came into existence, and today, it is leading market in metal trading both in spot as well as forward. In the year 1898, the butter and egg dealers withdrew from the Chicago Produce Exchange to form separately the Chicago Butter and Egg Board, and thus, in 1919 this exchange was renamed as the Chicago Mercantile Exchange (CME) and was reorganized for futures trading. Since then, so many other exchanges came into existence throughout the world which trade in futures contracts.

Although financial derivatives have been is operation since long, but they have become a major force in financial markets in the early 1970s. The basic reason behind this development was the failure of Brettonwood System and the fixed exchange rate regime was broken down. As a result, new exchange rate regime, i.e., floating rate (flexible) system based upon market forces came into existence. But due to pressure or demand and supply on different currencies, the exchange rates were constantly changing, and often, substantially. As a result, the business firms faced a new risk, known as currency or foreign exchange risk. Accordingly, a new financial instrument was developed to overcome this risk in the new financial environment.

Another important reason for the instability in the financial market was fluctuation in the short-term interests. This was mainly due to that most of the government at that time tried to manage foreign exchange fluctuations through short-term interest rates and by maintaining money supply targets, but which were contrary to each other. Further, the increased instability of short-term interest rates created adverse impact on long-term interest rates, and hence, instability in bond prices, because they are largely determined by long-term interest rates. The result is that it created another risk, named interest rate risk, for both the issuers and the investors of debt instruments.

Interest rate fluctuations had not only created instability in bond prices, but also in other long-term assets such as, company stocks and shares. Share prices are determined on the basis of expected present values of future dividend payments discounted at the appropriate discount rate. Discount rates are usually based on long-term interest rates in the market. So increased instability in the long-term interest rates caused enhanced fluctuations in the share prices in the stock markets. Further volatility in stock prices is reflected in the volatility in stock market indices which causes systematic risk or market risk.

In the early 1970s, it is witnessed that the financial markets were highly instable, as a result, so many financial derivatives have been emerged as the means to manage the different types of risks stated above, and also for taking advantage of it. Hence, the first financial futures market was the International Monetary Market, established in 1972 by the Chicago Mercantile Exchange which was followed by the London International Financial Futures Exchange in 1982. The Forwards Contracts (Regulation) Act, 1952, regulates the forward/futures contracts in commodities all over India. As per this the Forward Markets Commission (FMC) continues to have jurisdiction over commodity forward/futures contracts. However when derivatives trading in securities was introduced in 2001, the term 'security' in the Securities Contracts (Regulation) Act, 1956 (SCRA), was amended to include derivative contracts in securities. Consequently, regulation of derivatives came under the preview of Securities Exchange Board of India (SEBI). We thus have separate regulatory authorities for securities and commodity derivative markets.

1.4 Features of financial derivatives

It is a contract: Derivative is defined as the future contract between two parties. It means there must be a contract-binding on the underlying parties and the same to be fulfilled in future. The future period may be short or long depending upon the nature of contract, for example, short term interest rate futures and long term interest rate futures contract.

Derives value from underlying asset: Normally, the derivative instruments have the value which is derived from the values of other underlying assets, such as agricultural commodities, metals, financial assets, intangible assets, etc. Value of derivatives depends upon the value of underlying instrument and which changes as per the changes in the underlying assets, and sometimes, it may be nil or zero. Hence, they are closely related.

Specified obligation: In general, the counter parties have specified obligation under the derivative contract. Obviously, the nature of the obligation would be different as per the type of the instrument of a derivative. For example, the obligation of the counter parties, under the different derivatives, such as forward contract, future contract, option contract and swap contract would be different.

Direct or exchange traded: The derivatives contracts can be undertaken directly between the two parties or through the particular exchange like financial futures contracts. The exchange-traded derivatives are quite liquid and have low transaction costs in comparison to tailor-made contracts. Example of ex-change traded derivatives are Dow Jons, S&P 500, Nikki 225, NIFTY option, S&P Junior that are traded on New York Stock Exchange, Tokyo Stock Exchange, National Stock Exchange, Bombay Stock Exchange and so on.

Related to notional amount: In general, the financial derivatives are carried off-balance sheet. The size of the derivative contract depends upon its notional amount. The notional amount is the amount used to calculate the payoff. For instance, in the option contract, the potential loss and potential payoff, both may be different from the value of underlying shares, because the payoff of derivative products differ from the payoff that their notional amount might suggest.

Delivery of underlying asset not involved: Usually, in derivatives trading, the taking or making of delivery of underlying assets is not involved, rather underlying transactions are mostly settled by taking offsetting positions in the derivatives themselves. There is, therefore, no effective limit on the quantity of claims, which can be traded in respect of underlying assets.

May be used as deferred delivery: Derivatives are also known as deferred delivery or deferred payment instrument. It means that it is easier to take short or long position in derivatives in comparison to other assets or securities. Further, it is possible to combine them to match specific, i.e., they are more easily amenable to financial engineering.

Secondary market instruments: Derivatives are mostly secondary market instruments and have little usefulness in mobilizing fresh capital by the corporate world, however, warrants and convertibles are exception in this respect.

Exposure to risk: Although in the market, the standardized, general and exchange-traded derivatives are being increasingly evolved, however, still there are so many privately negotiated customized, over-the-counter (OTC) traded derivatives are in existence. They expose the trading parties to operational risk, counter-party risk and legal risk. Further, there may also be uncertainty about the regulatory status of such derivatives.

Off balance sheet item: Finally, the derivative instruments, sometimes, because of their off-balance sheet nature, can be used to clear up the balance sheet. For example, a fund manager who is restricted from taking particular currency can buy a structured note whose coupon is tied to the performance of a particular currency pair.

1.5 Types of financial derivatives

Derivatives are of two types: financial and commodities.

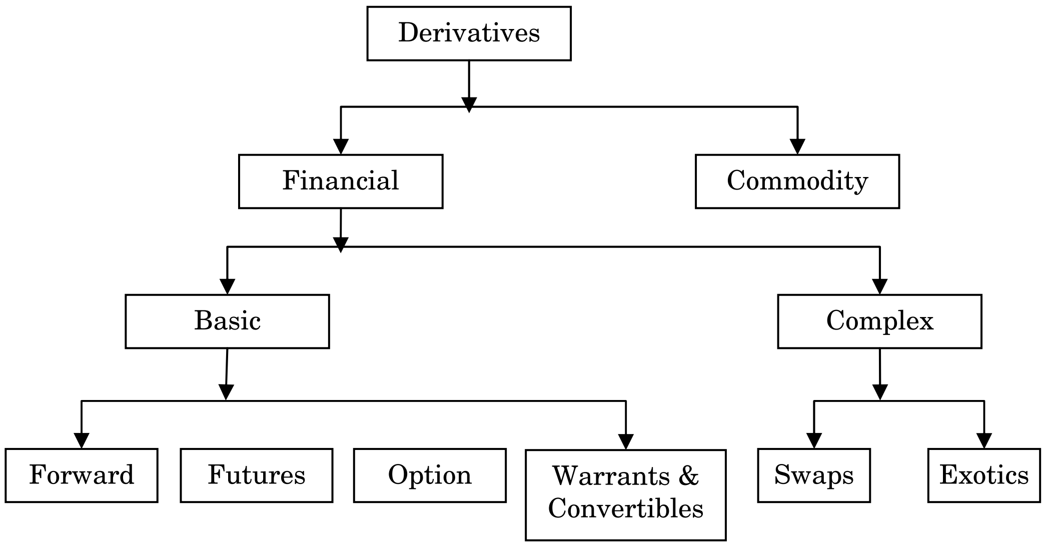

Fig. 1.1: Classification of Derivatives

One form of classification of derivative instruments is between commodity derivatives and financial derivatives. The basic difference between these is the nature of the underlying instrument or asset. In a commodity derivative, the underlying instrument is a commodity which may be wheat, cotton, pepper, sugar, jute, turmeric, corn, soyabeans, crude oil, natural gas, gold, silver, copper and so on. In a financial derivative, the underlying instrument may be treasury bills, stocks, bonds, foreign exchange, stock index, gilt-edged securities, cost of living index, etc. It is to be noted that financial derivative is fairly standard and there are no quality issues whereas in commodity derivative, the quality may be the underlying matter. However, despite the distinction between these two from structure and functioning point of view, both are almost similar in nature.

The most commonly used derivatives contracts are forwards, futures and options.

Forwards: A forward contract is a customised contract between two entities, where settlement takes place on a specific date in the future at today's pre-agreed price. For example, an Indian car manufacturer buys auto parts from a Japanese car maker with payment of one million yen due in 60 days. The importer in India is short of yen and suppose present price of yen is Rs. 68. Over the next 60 days, yen may rise to Rs. 70. The importer can hedge this exchange risk by negotiating a 60 days forward contract with a bank at a price of Rs. 70. According to forward contract, in 60 days the bank will give the importer one million yen and importer will give the banks 70 million rupees to bank.

Futures: A futures contract is an agreement between two parties to buy or sell an asset at a certain time in the future at a certain price. Futures contracts are special types of forward contracts in the sense that the former are standardised exchange-traded contracts. A speculator expects an increase in price of gold from current future prices of Rs. 9000 per 10 gm. The market lot is 1 kg and he buys one lot of future gold (9000 × 100) Rs. 9,00,000. Assuming that there is 10% margin money requirement and 10% increase occur in price of gold. the value of transaction will also increase i.e. Rs. 9900 per 10 gm and total value will be Rs. 9,90,000. In other words, the speculator earns Rs. 90,000.

Options: Options are of two types– calls and puts. Calls give the buyer the right but not the obligation to buy a given quantity of the underlying asset, at a given price on or before a given future date. Puts give the buyer the right, but not the obligation to sell a given quantity of the underlying asset at a given price on or before a given date.

Warrants: Options generally have lives of upto one year, the majority of options traded on options exchanges having maximum maturity of nine months. Longer-dated options are called warrants and are generally traded over-the-counter.

Leaps: The acronym LEAPS means long term equity anticipation securities. These are options having a maturity of upto three years.

Baskets: Basket options are options on portfolios of underlying assets. The index options are a form of basket options.

Swaps: Swaps are private agreements between two parties to exchange cash flows in the future according to a prearranged formula. They can be regarded as portfolios of forward contracts. The two commonly used swaps are:

- *Interest rate swaps*: These entail swapping only the interest related cash flows between the parties in the same currency
- *Currency Swaps*: These entail swapping both principal and interest on different currency than those in the opposite direction.

Swaptions: Swaptions are options to buy or sell a swap that will become operative at the expiry of the options. Thus a swaptions is an option on a forward swap. Rather than have calls and puts, the swaptions market has receiver swaptions and payer swaptions. A receiver swaption is an option to receive fixed and pay floating. A payer swaption is an option to pay fixed and receive floating.

1.6 Uses and functions of derivatives

Generally derivatives are used as risk management tools. Here is the brief description of their uses and functions.

1.6.1 Uses of derivatives

Derivatives are supposed to provide the following services:

Risk aversion tools: One of the most important services provided by the derivatives is to control, avoid, shift and manage efficiently different types of risks through various strategies like hedging, arbitraging, spreading, etc. Derivatives assist the holders to shift or modify suitably the risk characteristics of their portfolios. These are specifically useful in highly volatile financial market conditions like erratic trading, highly flexible interest rates, volatile exchange rates and monetary chaos.

Prediction of future prices: Derivatives serve as barometers of the future trends in prices which result in the discovery of new prices both on the spot and futures markets. Further, they help in disseminating different information regarding the futures markets trading of various commodities and securities to the society which enable to discover or form suitable or correct or true equilibrium prices in the markets. As a result, they assist in appropriate and superior allocation of resources in the society.

Enhance liquidity: As we see that in derivatives trading no immediate full amount of the transaction is required since most of them are based on margin trading. As a result, large number of traders, speculators arbitrageurs operate in such markets. So, derivatives trading enhance liquidity and reduce trans-action costs in the markets for underlying assets.

Assist investors: The derivatives assist the investors, traders and managers of large pools of funds to devise such strategies so that they may make proper asset allocation increase their yields and achieve other investment goals.

Integration of price structure: It has been observed from the derivatives trading in the market that the derivatives have smoothen out price fluctuations, squeeze the price spread, integrate price structure at different points of time and remove gluts and shortages in the markets.

Catalyse growth of financial markets: The derivatives trading encourage the competitive trading in the markets, different risk taking preference of the market operators like speculators, hedgers, traders, arbitrageurs, etc. resulting in increase in trading volume in the country. They also attract young investors, professionals and other experts who will act as catalysts to the growth of financial markets.

Brings perfection in market: Lastly, it is observed that derivatives trading develop the market towards 'complete markets'. Complete market concept refers to that situation where no particular investors can be better off than others, or patterns of returns of all additional securities are spanned by the already existing securities in it, or there is no further scope of additional security.

1.6.2 Functions of derivatives markets

The following functions are performed by derivative markets:

Discovery of price: Prices in an organised derivatives market reflect the perception of market participants about the future and lead the prices of underlying assets to the perceived future level. The prices of derivatives converge with the prices of the underlying at the expiration of the derivative contract. Thus derivatives help in discovery of future as well as current prices.

Risk transfer: The derivatives market helps to transfer risks from those who have them but may not like them to those who have an appetite for them.

Linked to cash markets: Derivatives, due to their inherent nature, are linked to the underlying cash markets. With the introduction of derivatives, the underlying market witnesses higher trading volumes because of participation by more players who would not otherwise participate for lack of an arrangement to transfer risk.

Check on speculation: Speculation traders shift to a more controlled environment of the derivatives market. In the absence of an organised derivatives market, speculators trade in the underlying cash markets. Managing, monitoring and surveillance of the activities of various participants become extremely difficult in these kind of mixed markets.

Encourages entrepreneurship: An important incidental benefit that flows from derivatives trading is that it acts as a catalyst for new entrepreneurial activity. Derivatives have a history of attracting many bright, creative, well-educated people with an entrepreneurial attitude. They often energize others to create new businesses, new products and new employment opportunities, the benefit of which are immense.

Increases savings and investments: Derivatives markets help increase savings and investment in the long run. The transfer of risk enables market participants to expand their volume of activity.

1.7 Futures contracts

Suppose a farmer produces rice and he expects to have an excellent yield on rice; but he is worried about the future price fall of that commodity. How can he protect himself from falling price of rice in future? He may enter into a contract on today with some party who wants to buy rice at a specified future date on a price determined today itself. In the whole process the farmer will deliver rice to the party and receive the agreed price and the other party will take delivery of rice and pay to the farmer. In this illustration, there is no exchange of money and the contract is binding on both the parties. Hence future contracts are forward contracts traded only on organised exchanges and are in standardised contract-size. The farmer has protected himself against the risk by selling rice futures and this action is called short hedge while on the other hand, the other party also protects against-risk by buying rice futures is called long hedge.

1.8 Features of financial futures contract

Financial futures, like commodity futures are contracts to buy or sell, financial aspects at a future date at a specified price. The following features are there for future contracts:

- Future contracts are traded on organised future exchanges. These are forward contracts traded on organised futures exchanges.
- Future contracts are standardised contracts in terms of quantity, quality and amount.
- Margin money is required to be deposited by the buyer or sellers in form of cash or securities. This practice ensures honour of the deal.
- In case of future contracts, there is a dairy of opening and closing of position, known as marked to market. The price differences every day are settled through the exchange clearing house. The clearing house pays to the buyer if the price of a futures contract increases on a particular day and similarly seller pays the money to the clearing house. The reverse may happen in case of decrease in price.

1.9 Types of financial future contracts

Financial futures contracts can be categorised into following types:

Interest rate futures: In this type the futures securities traded are interest bearing instruments like T-bills, bonds, debentures, euro dollar deposits and municipal bonds, notional gilt-contracts, short term deposit futures and treasury note futures.

Stock index futures: Here in this type contracts are based on stock market indices. For example in US, Dow Jones Industrial Average, Standard and poor's 500 New York Stock Exchange Index. Other futures of this type include Japanese Nikkei index, TOPIX etc.

Foreign currency futures: These future contracts trade in foreign currency generating used by exporters, importers, bankers, FIs and large companies.

Bond index futures: These contracts are based on particular bond indices i.e. indices of bond prices. Municipal Bond Index futures based on Municipal Bonds are traded on CBOT (Chicago Board of Trade).

Cost of living index future: These are based on inflation measured by CPI and WPI etc. These can be used to hedge against unanticipated inflationary pressure.

1.10 Forward contract

A forward contract is a simple customized contract between two parties to buy or sell an asset at a certain time in the future for a certain price. Unlike future contracts, they are not traded on an exchange, rather traded in the over-the-counter market, usually between two financial institutions or between a financial institution and one of its client.

In brief, a forward contract is an agreement between the counter parties to buy or sell a specified quantity of an asset at a specified price, with delivery at a specified time (future) and place. These contracts are not standardized, each one is usually customized to its owner's specifications.

1.11 Features of forward contract

The basic features of a forward contract are given in brief here as under:

Bilateral: Forward contracts are bilateral contracts, and hence, they are exposed to counter-party risk.

More risky than futures: There is risk of non-performance of obligation by either of the parties, so these are riskier than futures contracts.

Customised contracts: Each contract is custom designed, and hence, is unique in terms of contract size, expiration date, the asset type, quality, etc.

Long and short positions: In forward contract, one of the parties takes a long position by agreeing to buy the asset at a certain specified future date. The other party assumes a short position by agreeing to sell the same asset at the same date for the same specified price. A party with no obligation offsetting the forward contract is said to have an open position. A party with a closed position is, sometimes, called a hedger.

Delivery price: The specified price in a forward contract is referred to as the delivery price. The forward price for a particular forward contract at a particular time is the delivery price that would apply if the contract were entered into at that time. It is important to differentiate between the forward price and the delivery price. Both are equal at the time the contract is entered into. However, as time passes, the forward price is likely to change whereas the delivery price remains the same.

Synthetic assets: In the forward contract, derivative assets can often be contracted from the combination of under-lying assets, such assets are oftenly known as synthetic assets in the forward market.

The forward contract has to be settled by delivery of the asset on expiration date. In case the party wishes to reverse the contract, it has to compulsorily go to the same counter party, which may dominate and command the price it wants as being in a monopoly situation.

Pricing of arbitrage based forward prices: In the forward contract, covered parity or cost-of-carry relations are relation between the prices of forward and underlying assets. Such relations further assist in determining the arbitrage-based forward asset prices.

Popular in forex market: Forward contracts are very popular in foreign exchange market as well as interest rate bearing instruments. Most of the large and international banks quote the forward rate through their 'forward desk' lying within their foreign exchange trading room. Forward foreign exchange quotes by these banks are displayed with the spot rates.

Different types of forward: As per the Indian Forward Contract Act-1952, different kinds of forward contracts can be done like hedge contracts, transferable specific delivery (TSD) contracts and non-transferable specific delivery (NTSD) contracts. Hedge contracts are freely transferable and do not specify, any particular lot, consignment or variety for delivery. Transferable specific delivery contracts are though freely transferable from one party to another, but are concerned with a specific and predetermined consignment. Delivery is mandatory. Non-transferable specific delivery contracts, as the name indicates, are not transferable at all, and as such, they are highly specific.

1.13 Distinction between futures and forwards contracts

Forward contracts are often confused with futures contracts. The confusion is primarily because both serve essentially the same economic functions of allocating risk in the presence of future price uncertainty. However futures are a significant improvement over the forward contracts as they eliminate counterparty risk and offer more liquidity. Table 1.1 lists the distinction between the two.

TABLE 1.1: DISTINCTION BETWEEN FUTURES AND FORWARDS

Futures	**Forwards**
Trade on an organised exchange	OTC in nature
Standardised contract terms	Customised contract terms
Hence more liquid	Hence less liquid
Requires margin payments	No margin payment
Follows daily settlement	Settlement happens at end of period

1.14 Summary

During the last decade, derivatives have emerged as innovative financial instruments for their risk aversion capabilities. There are two types of derivatives: commodity and financial. Basically derivatives are designed for hedging, speculation or arbitrage purpose. Derivative securities are the outcome of future and forward market, where buying and selling of securities take place in advance but on future dates. This is done to mitigate the risk arising out of the future price movements. Future contracts are standardised having more liquidity and less margin payment requirements while vice-versa is the case of forward contracts. Based on the nature of complexity, these are of two types: basic and complex.

In basic financial derivatives, the focus is only on the simplicity of operation i.e. forward, future, option, warrants and convertibles. A forward contract is an agreement between two parties to buy or sell an asset at a certain time in the future for a certain price, whereas a futures contract is an agreement between two parties to buy or sell a specified quantity of assets at a predetermined price at a specified time and place. Futures contracts are standardised and are traded on an exchange. Option is a contract between two parties which gives the right (not obligations) to buy or sell a particular asset, at a specified price, on or before, a specified date. Option holder is the person who acquires the right to buy (hold), while option seller/writer is the person who confers the right. In a call option, the holder has the right to buy an asset at a specified price and time, while in case of a put option, the holder has the right to sell an asset at specified time and price. The price at which an option is exercised is known as exercise price or strike price and the date is known as expiration date. In case of an American option, option can be exercised on or before the expiration data but European option can be exercised only on date of expiration, warrants are also options which give the holders right to purchase a specified number of shares at a fixed price in a fixed time period. On the other hand, convertibles are hybrid securities which are also called equity derivative securities with features of fixed as well as variable return attributes. Swaps are latest derivatives which can be exchanged for something. There are two types of swaps: interest rate swaps and currency swaps. In interest rate swap, one party agrees to pay the other party interest at a fixed rate on a notional principal amount and in return receives interest as a floating rate on the same principal notional amount for a specified period. Currency swap involves an exchange of cash payment in one currency for cash payments in another currency. Future value of cash flows are required for calculation purposes.

1.15 Key words

Derivatives are the financial instruments whose pay-off is derived from some other underlying asset.

Forward contract is an agreement between two parties to exchange an asset for cash at a predetermined future date for a price specified today.

Future contracts are forward contracts traded on organized exchanges in standardized contract size.

Option is the right (not obligation) to buy or sell an asset on or before a pre-specified date at a predetermined price.

Call option is the option to buy an asset.

Put option is the option to sell an asset.

Exercise price is the price at which an option can be exercised. It is also known as strike price.

European option can be exercised only on the expiration date of option.

American option can be exercised on or before the expiration date of option.

In-the-money: An option is called in-the-money if it benefits the investor when exercised immediately.

Out-of-the money: An option is said to be out-of-the money if it is not advantageous for the investor to exercise it.

At-the-money: When holder of an option neither gains nor looses when the exercises the option.

Option premium is the price that the holder of an option has to pay for obtaining a call or put option.

1.16 Self assessment questions

1. What are derivative securities? Discuss the uses and types of derivatives.
2. Explain different types of financial derivatives along with their features in brief.
3. Distinguish between futures and forward contracts with suitable examples.
4. How can financial derivatives be helpful in hedging, speculation and arbitrage?
5. Explain the terms futures, forward, option and swaps.
6. Throw light on evolution of derivatives?
7. Write a detailed account of functions of derivatives.

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Subject: **Financial Derivatives**	
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Lesson No.: **2**	Vetter: **Prof. B.S. Bodla**
FUTURES AND FORWARDS: TRADING MECHANISM AND PRICING	

Structure

2.0 Objectives

After going through this lesson, the learners will be able to:

- Describe function, evolution and growth of future market
- Identify participants of futures market
- Understand the theoretical framework of futures pricing

- Correlate futures pricing and CAPM

2.1 Introduction

In the previous lesson, you have gained conceptual understanding of derivative securities including futures and forward markets. Here we will discuss the trading mechanism pricing strategies of futures and forwards. To become an efficient investor, one must have the knowledge of functioning and pricing mechanism of the futures market. The future prices are affected by so many factors, which are relevant in pricing of future products. There are various theoretical models to determine the prices of the futures, which are discussed in this lesson.

2.2 Futures markets

Futures markets refer to the relationship among participants and mechanism of trading in futures. The futures may be of commodity or any other underlying assets. Futures contracts are standardised contracts, where only price is negotiated, while in forward contracts all elements are negotiated and they are customised contracts. Since futures market have become an important ingredient of economic activity and the prices of future depend upon so many factors, that is why there is a need to understand the mechanism of futures market and the pricing aspects of the same.

2.2.1 Functions of futures markets

Initially futures were devised as instruments to fight against the risk of future price movements and volatility. Apart from the various features of different futures contracts and trading, futures markets play a significant role in managing the financial risk of the corporate business world. The important functions of futures market are described as follows:

Hedging function: The primary function of the futures market is the hedging function which is also known as price insurance, risk shifting or risk transference function. Futures markets provide a vehicle through which the traders or participants can hedge their risks or protect themselves from the adverse price movements in the underlying assets in which they deal. For example, a farmer bears the risk at the planting time associated with the uncertain harvest price his crop will command. He may use the futures market to hedge this risk by selling a futures contract. For instance, if he is expected to produce 500 tons of cotton in next six months, he could set a price for that quantity (harvest) by selling 5 cotton futures contracts, each being of 100 tons. In this way, by selling these futures contracts, the farmer tends to establish a price today that will be harvested in the futures. Further, the futures transactions will protect the farmer from the fluctuations of the cotton price, which might occur between present and futures period. Here two prices come into picture: future price and spot price. The difference between the two is the profit or loss for the farmer.

Price discovery function: Another important function of futures market is the price discovery which reveals information about futures cash market prices through the futures market. Further, price discovery function of the futures market also leads to the inter temporal inventory allocation function. According to this, the traders can compare the spot and futures prices and will be able to decide the optimum allocation of their quantity of underlying asset between the immediate sale and futures sale. The price discovery function can be explained by an example. Supposing, a copper miner is trying to take a decision whether to reopen a marginally profitable copper mine or not. Assuming that the copper ore in the mine is not of the best quality and so the yield from the mine will be relatively low. The decision will depend upon the cost incurred on mining and refining of copper and the price of the copper to be obtained in futures. Hence, the crucial element in this decision is the futures price of copper. The miner can analyze the copper prices quoted in the futures market today for determining the estimate of the futures price of copper at a specified futures period. In this calculation, the miner has used the futures market as a vehicle of price discovery.

Financing function: Another function of a futures market is to raise finance against the stock of assets or commodities. Since futures contracts are standardized contracts, so, it is easier for the lenders to ensure quantity, quality and liquidity of the underlying asset.

Liquidity function: It is obvious that the main function of the futures market deals with such transactions which are matured on a future date. They are operated on the basis of margins. Under this the buyer and the seller have to deposit only a fraction of the contract value, say 5 percent or 10 percent, known as margins. This practice ensures honouring of the future deals and hence maintain liquidity. When there is a futures contract between two parties, future exchanges required some money to be deposited by these parties called margins. Each futures exchange is responsible for setting minimum initial margin requirements for all futures contracts. The trader has to deposit and maintain this initial margin into an account as trading account.

Price stabilization function: Another function of a futures market is to keep a stabilizing influence on spot prices by reducing the amplitude of short term of fluctuations. In other words, futures market reduces both the heights of the peaks and the depth of the troughs. There is less default risk in case of future contract because the change in the value of a future contract results in a cash flow every day. The daily change in the value of a futures contract must be exchanged, so that if one party (the losing party) defaults, the maximum loss that will be realized is just one day's change in value. Thus the incentive for default in futures is greater than in forwards.

Disseminating information: Aside from the above mentioned functions of the futures markets like risk-transference (hedging), price discovery, price stabilization, liquidity, and financing, this market is very much useful to the economy too. Since in futures market, futures traders' positions are marked to market on daily basis, which is known as daily resettlements. It means that every day the trader's account is added to if (profit occurs) and deducted in case the losses occur. All the profits that increase the margin account balance above the initial balance margin can be withdrawn and vice-versa. If the future price fall, trader account equity rises and vice-versa. Futures markets disseminate information quickly, effectively and inexpensively, and, as a result, reducing the monopolistic tendency in the market. Thus investors are aware of their latest position of equity in transparent and efficient manner.

2.2.2 Evolution of futures market in India

The sequential and chronological detail of futures market development in India is as follows:

- Organized futures market evolved in India by the setting up of Bombay Cotton Trade Association Ltd in 1875. In 1893, a separate association called "The Bombay Cotton Exchange Ltd." was constituted, following conflicts between mill owners and merchants.
- In 1900, futures trading in oilseeds was started with the setting up of Gujarati Vyapari Mandali. In 1913, a future exchange for wheat was set up in Hapur. A second exchange, the Seeds Traders' Association Ltd., trading oilseeds such as castor and groundnuts, was set up in 1926 in Mumbai. Then, many other exchanges trading in jute, pepper, turmeric, potatoes, sugar, and silver, followed.
- Futures market in bullion began at Mumbai, in 1920.

- In 1919, Calcutta Hussien Exchange Ltd., was established for trading in raw jute and jute goods.
- In 1927, East India Jute Association was set up for organised trade in jute.
- In 1940s, trading in forwards and futures was made difficult through price controls till 1952.
- Forward contracts (Regulation) Act was enacted in 1952, while in 1953 Forwards Market Commission (FMC) was established.
- During the 1960s and 70s, the Central Government suspended trading in several commodities like cotton, jute, edible oilseeds, etc. as it was felt that these markets helped increase prices for commodities.
- Two committees that were appointed–Datawala Committee in 1966, and Khusro Committee in 1980, recommended the reintroduction of futures trading in major commodities, but without much result.

Recent development in futures market: One more committee on Forwards market, the Kabra Committee was appointed in 1993, which recommended futures trading in wide range of commodities and also upgradation of futures market. The Kabra Committee recommended the following:

- Strengthening of FMC and Forward Contracts (Regulation) Act, 1952
- Networking of future exchange for better and efficient functioning.
- Stringent vigilance and surveying norms.
- FMC to act as watch dog to monitor the activities of commodity exchanges.

- Some of commodity exchanges need to be upgraded to international levels.

2.2.3 Participants of futures markets

Usually financial derivatives attract three types of traders which are discussed here as under:

Hedgers: Generally there is a tendency to transfer the risk from one party to another in investment decisions. Put differently, a hedge is a position taken in futures or other markets for the purpose of reducing exposure to one or more types of risk. A person who undertakes such position is called as 'hedger'. In other words, a hedger uses futures markets to reduce risk caused by the movements in prices of securities, commodities, exchange rates, interest rates, indices, etc. As such, a hedger will take a position in futures market that is opposite a risk to which he or she is exposed. By taking an opposite position to a perceived risk is called 'hedging strategy in futures markets'. The essence of hedging strategy is the adoption of a futures position that, on average, generates profits when the market value of the commitment is higher than the expected value. For example, a treasurer of a company knows the foreign currency amounts to be received at certain futures time may hedge the foreign exchange risk by taking a short position (selling the foreign currency at a particular rate) in the futures markets. Similarly, he can take a long position (buying the foreign currency at a particular rate) in case of futures foreign exchange payments at a specified futures date.

Hedgers are exposed to risk of a price change. They may be initiating long or short position for a good and would therefore experience losses in case of unfavourable prices. Suppose an oil company in Britain purchases oil to export to India but during transportation period, oil prices fall thereby creating risk of lower prices. To avoid this loss, this firm can sell oil futures contracts to hedge. If the oil price declines, the trading company will lose money on the inventory of oil (spot position) but will make money in the futures contracts that were sold. This is an example of short hedge. Another company may enter into a contract fearing rise in prices which is known as long hedge. Another example of hedging can be illustrated by taking two parties: one is manufacturer of gold ornaments and the other one is retailer. In this case supposing the manufacturer of ornaments signs a deal in June 2006 agreeing to deliver gold ornaments in November 2006 at a fixed price. It is interesting to note that the manufacturer does not have enough store or cash to buy gold today and does not wish to buy gold till Sept. 2006. The manufacturer is exposed to risk that the gold prices will rise between June to Sept. Hence to counter this risk, he should hedge by buying gold futures contracts.

The hedging strategy can be undertaken in all the markets like futures, forwards, options, swap, etc. but their *modus operandi* will be different. Forward agreements are designed to offset risk by fixing the price that the hedger will pay or receive for the underlying asset. In case of option strategy, it provides insurance and protects the investor against adverse price movements. Similarly, in the futures market, the investors may be benefited from favourable price movements.

Speculators: A speculator is a person who is willing to take a risk by taking futures position with the expectation to earn profits. Speculator aims to profit from price fluctuations. The speculator forecasts the future economic conditions and decides which position (long or short) to be taken that will yield a profit if the forecast is realized. For example, suppose a speculator forecasts that price of silver will be Rs 3000 per 100 grams after one month. If the current silver price is Rs 2900 per 100 grams, he can take a long position in silver and expects to make a profit of Rs 100 per 100 grams. This expected profit is associated with risk because the silver price after one month may decrease to Rs 2800 per 100 grams, and may lose Rs 100 per 100 grams.

Speculators usually trade in the futures markets to earn profit on the basis of difference in spot and futures prices of the underlying assets. Hedgers use the futures markets for avoiding exposure to adverse movements in the price of an asset, whereas the speculators wish to take position in the market based upon such expected movements in the price of that asset. It is pertinent to mention here that there is difference in speculating trading between spot market and forward market. In spot market a speculator has to make an initial cash payment equal to the total value of the asset purchased whereas no initial cash payment except the margin money, if any, is made to enter into forward market. Therefore, speculative trading provides the investor with a much higher level of leverage than speculating using spot markets. That is why, futures markets being highly leveraged market, minimums are set to ensure that the speculator can afford any potential losses.

Speculators are of two types: day traders and position traders. Position speculator uses fundamental analysis of economic conditions of the market and is known as fundamental analyst, whereas the one who predicts futures prices on the basis of past movements in the prices of the asset is known as technical analyst. A speculator who owns a seat on a particular exchange and trades in his own name is called a local speculator. These, local speculators can further be classified into three categories, namely, scalpers, pit traders and floor traders. Scalpers usually try to make profits from holding positions for short period of time. They bridge the gap between outside orders by filling orders that come into the brokers in return for slight price concessions. Pit speculators like scalpers take bigger positions and hold them longer. They usually do not move quickly by changing positions overnights. They most likely use outside news. Floor traders usually consider inter commodity price relationship. They are full members and often watch outside news carefully and can hold positions both short and long. Day traders speculate only about price movements during one trading day.

Arbitrageurs: Arbitrageurs are another important group of participants in futures markets. They take advantage of price differential of two markets. An arbitrageur is a trader who attempts to make profits by locking in a riskless trading by simultaneously entering into transactions in two or more markets. In other words, an arbitrageur tries to earn riskless profits from discrepancies between futures and spot prices and among different futures prices. For example, suppose that at the expiration of the gold futures contract, the futures price is Rs 9200 per 10 grams, but the spot price is Rs 9000 per 10 grams. In this situation, an arbitrageur could purchase the gold for Rs 9000 and go short a futures contract that expires immediately, and in this way making a profit of Rs 200 per 10 grams by delivering the gold for Rs 9200 in the absence of transaction costs.

The arbitrage opportunities available in the different markets usually do not last long because of heavy transactions by the arbitrageurs where such opportunity arises. Thus, arbitrage keeps the futures and cash prices in line with one another. This relationship is also expressed by the simple cost of carry pricing which shows that fair futures prices, is the set of buying the cash asset now and financing the same till delivery in futures market. It is generalized that the active trading of arbitrageurs will leave small arbitrage opportunities in the financial markets. In brief, arbitrage trading helps to make market liquid, ensure accurate pricing and enhance price stability.

2.3 Future pricing

There are several theories to explain the relationship between spot and futures prices. Before going through various factors affecting futures prices and spot prices, it is pertinent to note that how futures prices are read from a newspaper. Therefore, let us understand how to read futures prices

The following data has been taken from “The Business Standard” dated 20.09.2006 containing future prices of some underlying assets.

FUTURES TRADING

Rs. lakh, K-in thousand, L-in lakh)

Index futures on NSE		
Instrument, strike price, open, high, low, (close; traded qty, No. of contracts, Notional value)	Open Interest	Expiry Date
Bank Nifty 4928, 4930, 4830, 4862.2 (78 K, 780, 3812.95)	1 L	Sep. 28
Bank Nifty 4900, 4900, 4851, 4851 (400, 4, 19.55)	2 K	Oct 26
Nifty 3490, 3512, 3420, 3440.4 (15 L, 14744, 51312.26)	19 L	Oct 26
Index futures on BSE		
Sensex 12069.65, 12149, 11910, 11963 (12 K, 194, 1466.34)	4 K	Sep 28
Sensex 12159.25, 12159.25, 12055.4, 12055.4 (…)	25	Oct 26
Stock futures on NSE		
ABB 2870, 2892, 2825, 2843.05 (1 L, 1284, 3680.52)	1 L	Sep. 28
Allahabad Bank 80.9, 81.5, 78, 79.35 (7 L, 306, 602.18)	29 L	Sep. 28
Arvind Mills 69.9, 70.65, 66.2, 67.25 (31 L, 1442, 2137.38)	88 L	Sep. 28
Bajaj Auto 2815, 2818, 2735.05, 2758.7 (1 L 1418, 3947.09)	4L	Sep. 28
Bank of India 153, 153.95, 148.2, 150.45 (23 L, 1212, 3483.5)	25 L	Sep. 28
BHEL 2300, 2307.8, 2230.1, 2250.95 (5L, 3623, 12405.44)	14 L	Sep. 28
Cummins (I) 227, 227, 214.9, 216 (55K 29, 122.47)	48K	Oct 26
Escorts 123.65, 124, 117.15, 118.25 (5L 113, 651.07)	2L	Oct 26
Maruti udyog 948, 950.8, 909, 917.7 (23), 5829, 21806.64)	27L	Sep 28

Source: Business Standard, Wednesday, 20, September, 2006.

2.3.1 Features of futures prices

Related to forward prices: Since forward contracts are executed at the time of expiration and are indifferent towards changes in the market and spot prices, hence chances of default may be higher in forward contract than in futures contract. Futures traders are cash settled daily and are cleared through a clearing house. Hence there may be some difference in the prices from daily settlement and margin requirement. This can be further understand with the help of the following example:

Suppose a copper futures and a copper of forward mill expire after one year and further assume that the current price of copper is $ 7000 per tonne. Further suppose that the futures spot price after one year is $ 7000 per tonne. Assuming that there are 250 trading days in a year. There will be no profit or loss on either contract. Now consider two possible situation. In the first condition, let's assume that futures price rose by $ 10 per day for 125 days and then falls by $ 10 per day till expiration. In the second condition, suppose there is a fall of $ 10 per day for 125 days and then enhancement of $ 10 per day for 125 day till maturity. At the end there will be no profit no loss.

It is quite clear that the forward trader is indifferent between two possible price paths because he has no cash flow either at outset or at expiration. The futures traders are affected by daily cash settlement of their futures transactions. The long future trader will prefer price rise in the beginning and investing in the same market and vice-versa. Let us further assume that there is a 10% interest rates on the difference in these two price paths is about Rs. 300 for the future traders.

In case of rise in the price the long futures trader will require payment and invest to earn interest on that amount. In case of falling of price, he will pay the amount. Hence the difference is due to interest gains or losses on the daily settlement basis and the futures trader will be highly affected than the forward trader. It can be concluded that if the interest is positively correlated with the futures price then a long trader will prefer a futures position than a forward position. If the futures price and the interest rates both decline, then the futures trader must make the payment at lower rates of interest.

Future price and the expected future spot prices: Future prices keep on changing continuously. Thus future price can be an estimate of the expected future spot price.

The volatility of futures prices: The futures prices are vulnerable to volatility i.e. there exists a direct relationship between futures trading and the volatility and the patterns in the volatility of futures prices. According to some studies, futures trading increased volatility of cash market. Also, lesser the time to expiration, higher the volatility. Sometimes volatility phenomenon is quite seasonal and at some points in time in particular days. Some other studies reveal a positive correlation between futures trading volume and the volatility of the futures prices. Easy and early accessibility of information make futures price more volatile.

2.3.2 Theories of futures pricing

There are several theories which have made efforts to explain the relationship between spot and futures prices. A few important of them are as follows:

2.3.2.1 The cost-of-carry approach

Some economists like Keynes and Hicks, have argued that futures prices essentially reflect the carrying cost of the underlying assets. In other words, the inter-relationship between spot and futures prices reflect the carrying costs, i.e., the amount to be paid to store the asset from the present time to the futures maturity time (date). For example, foodgrains on hand in June can be carried forward to, or stored until, December. Cost of carry which includes storage cost plus the interest paid to finance the asset less the income earned on assets. For more understanding of the concept, let's take the following cases:

Case 1: For generalization, let us assume a forward contract on an investment asset with price S_0 that provides no income. The following equation gives the price of a forward:

$$F_0 = S_0 e^{rT} \qquad \text{… (2.1)}$$

Where F_0 is forward price.

S_0- Price of an investment asset with no income.

T- Time to maturity

e- Constant

r- Risk free rate of return.

If $F_0 > S_0 e^{rT}$, then the arbitrageurs will buy the asset and short forward contracts on the assets. If $F_0 < S_0 e^{rT}$ they can short the asset and buy forward contracts.

Case II: In case of an asset with income I, the forward price can be calculated as:

$$F_0 = (S_0 - I)\, e^{rT} \qquad \text{… (2.2)}$$

Case III: In case of asset with yield q the forward price is given by:

$$F_0 = S_0 e^{(r-q)T} \qquad \text{… (2.3)}$$

In the similar fashion, the future price of a stock index paying dividend can be calculated as follows:

Since dividend provides a known yield

$F_0 = S_0e^{(r-q)T}$

Illustration 2.1: Suppose a four month forward to buy a zero coupon bond will mature one year hence. The current price of bond is Rs. 930. Assuming risk free rate of return (Compounded) is 6% per annum, the forward price can be calculated as

$F_0 = 930\ e^{0.06 \times 4/12} = \text{Rs. } 948.79$

Where S_0 = Rs. 930, r = 0.06, T = 4/12 = 1/3.

Illustration 2.2: Supposing a three-month Nifty index future contract provides a dividend yield of 1% p.a., current value of stock is Rs. 400 and risk free interest is 6% p.a.

The future price of the index is:

$F_0 = 400\ e^{(0.06-0.01)\times 0.25}$

= Rs. 405.03

If storage cost is also adjusted then the formula for calculating futures prices becomes:

$F_0 = (S_0 + U)\ e^{rT}$.

Where U is the present value of all storage cost incurred during life span of a contract.

Illustration 2.3: Assuming that one year futures contract on gold costs Rs. 2 per 10 gm to store it with payment being made at the end of the year.

Spot price stands at Rs. 450 with risk-free interest rate of 7% p.a.

Here, $U = 2e^{-0.07 \times 1} = 1.865$

Where $S_0 = 450$, $T = 1$, $r = 0.07$

Hence the price of future will be

$F_0 = (450 + 1.865)\, e^{0.07 \times 1} = \text{Rs. } 484.63.$

In case where storage cost are proportional to the price by the commodity, they are known as negative yield and the future price becomes:

$F_0 = S_0 e^{(r+u)T}$

Where u denotes the storage cost p.a. as a proportion of the spot price.

The cost-of-carry model in perfect market: The following formula describes a general cost-of-carry price relationship between the cash (spot) price and futures price of any asset:

Futures price = Cash (spot) price + Carrying cost

Assumptions: The following are the assumptions of this approach:

- There are no information or transaction costs associated with the buying and selling the asset.
- No restriction limit for borrowing and lending.
- Borrowing and lending rates are homogeneous.
- No credit risk associated and margin requirement.
- Goods can be stored indefinitely without loss to the quality of the goods.
- There are no taxes.

In simple terms, the futures prices are influenced to some extent on expectations prevailing at the current time. Under this hypothesis, if markets are operating perfectly then

Current futures price = Expected futures spot price

2.3.2.2 The expectation approach

The advocates of this approach J.M. Keynes, J.R. Hicks and N. Kalidor argued the futures price as the market expectation of the price at the futures date. Many traders and investors, especially those using futures market to hedge, will be interested to study how today's futures prices are related to market expectations about futures prices. For example, there is general expectation that the price of the gold next Oct 1, 2006 will be Rs. 7000 per 10 grams. The futures price today for Jan 1, 2007 must somewhat reflect this expectation. If today's futures price is Rs. 6800 of gold, going long futures will yield an expected profit of

Expected futures profit = Expected futures price–Initial futures price

Rs. 200 = Rs. 7000 – Rs. 6800

Differences of the futures prices from the expected price will be corrected by speculation. Profit seeking speculators will trade as long as the futures price is sufficient far away from the expected futures spot price. This approach may be expressed as follows:

$F_{0,t} = E_0 (S_t)$

Where $F_{0,t}$ is Futures price at time $t = 0$ and $E_0(S_t)$ is the expectation at $t = 0$ of the spot price to prevail at time t.

The above equation states that the futures price approximately equals the spot price currently expected to prevail at the delivery date, and if, this relationship did not hold, there would be attractive speculative opportunity. Future prices are influenced by expectations prevailing currently.

This is also known as hypothesis of unbiased futures pricing because it advocates that the futures price is an unbiased estimate of the futures spot price, and on an average, the futures price will forecast the futures spot price correctly.

2.3.2.3 The theory of normal backwardation

In general, backwardation is the market in which the futures price is less than the cash (spot price). In other words, the basis is positive, i.e., difference between cash price and future price is positive. This situation can occur only if futures prices are determined by considerations other than, or in addition, to cost-of-carry factors. Further, if the futures prices are higher than the cash prices, this condition is usually referred to as a contongo-market market; and the basis is negative. **Normal backwardation** is used to refer to a market where futures prices are below expected futures spot prices.

Second way of describing the cantango and backwardation market is that the former (cantango) is one in which futures prices are reasonably described most of time by cost-of-carry pricing relationship, whereas later (**backwardation**) is one in which futures prices do not fit a full cost-of-carry pricing relationship. Futures prices are lower than those predicted by the cost-of-carry pricing formula.

It has been observed in many futures markets that the trading volume of short hedging (sales) exceeds the volume of long hedging (purchases), resulting in net short position. In such situation, Keynes has argued that, in order to induce long speculators to take up the net-short-hedging volume, the hedgers had to pay a risk premium to the speculators. As a result, the futures price would generally be less than the expected futures spot price, by the amount of risk premium which can be stated in equation as:

$$F = E - r$$

Where, F is futures price for a futures date, E is expected price at that date and r is risk premium.

The theory of normal backwardation states that futures prices should rise overtime because hedgers tend to be net-short and pay speculators to assume risk by holding long positions.

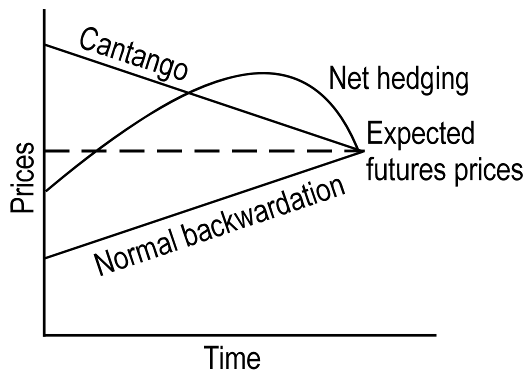

Fig. 2.1: Patterns of futures prices

Figure 2.1 illustrates the price patterns of futures which is expected under different situations. If the traders correctly assess the futures spot price so that the expected futures spot price turns out to be the actual spot price at the maturity. If the futures price equals the expected futures spot price then it will lie on the dotted line. However such situations, sometimes, do not occur, and alternative conceptions exist like normal backwardation and cantango. If speculators are net long then futures prices must rise over the life of the contract if speculators to be compensated for bearing risk. Futures prices then follow the path as labelled normal backwarding in Fig 2.1 It is to be noted that this line will terminate at the expected futures spot price.

2.3.2.4 Future pricing and CAPM

The risk and return relationship can be very well explained by CAPM which suggests that systematic risk is important in return calculations. The

Capital Asset Pricing Model (CAPM) can also be used in determining the prices of the futures.

Sometimes, the futures prices differ from expected future spot prices even after adjusting for systematic risk because of unevenly distributed demand by hedgers for futures positions. For example, if hedgers are dominating in the market through short sales then long hedgers will receive an expected profit in addition to any systematic risk premium. This theory is called hedging pressure explanation. Let us explain the systematic risk explanation by an example.

Suppose the current price of HLL share is Rs. 500 and Treasury Bill rate is 10 per cent per year, assuming that HLL pays no dividend. On the basis of stock index, the arbitrageurs will guarantee that the futures price of HLL share after one year is:

$= F_t,T = S_t (1 + r_{t,T})$

= Rs. 500 (1 + 0.10) = Rs. 550

where S_t is current spot price at time t, $F_{t,T}$ is current futures price at time T and $r_{t,T}$ is rate of return at time T.

If the unbiasedness hypothesis holds, the expected futures spot price should be Rs. 550. It means that HLL share will have a 10 per cent return just like the *T*. Bill despite the fact that the HLL is a riskier stock. So higher risk must be compensated. Assuming HLL share gives expected return of 15 per cent then the expected futures spot price will be

$E_t (S_T) = S_t (1 + r^*_{t,T})$

= Rs. 500 (1 + 0.15) = Rs. 575

where E_t (S_T) is expected futures spot price at time T and $r^*_{t,T}$ is expected rate of return on stock.

Thus, in this illustration, the futures price is less than the expected futures spot price in equilibrium.

Futures price < Expected futures spot price

Or $F_{t,T} < E_t (S_T)$

Rs. 550 < Rs. 575

This implies that, on average, a long futures position will provide a profit equal to Rs. 25 (575-550). In other words, Rs. 25 expected profit on the futures position will compensate the holder for the risk of synthetic stock (synthetic stock = T-bill + Long futures), that is above the risk of T-Bill.

Briefly it can be stated that the difference between the futures price and the expected futures spot price is the same as the difference between the expected profit on riskless securities and that on pure asset with the systematic price risk as the futures contract. Thus, future expected price will be:

$$= \frac{E_t(S_T) - F_{t,T}}{P^*_t}$$

$$= r^*_{t,T} - r_{t.T}$$

where P_t is price of a pure asset with the same price risk as the underlying asset of the futures contract, $r_{t,T}$ is expected rate return on that asset and $r^*_{t,T} - r_{t,T}$ is premium of pure asset with same risk as futures over the riskless rate.

P_t can be easily calculated as present value of the expected futures price of the underlying asset:

$$P_t = \frac{E_t(S_T)}{1 + r^*_{t,T}}$$

Where S_t is price of a pure asset.

If the underlying asset of a futures contract is a pure asset then P^*_t will be equal to P_t and vice-versa. The discount rate $r^*_{t,T}$ can be determined with the CAPM too.

CAPM defines the relationship between risk and return as:

$$r^*_t = r_f + \beta_i (r^*_m - r_f)$$

$$\beta_i = \frac{\rho_{im}\sigma_i}{\sigma_m}$$

Where r^*_i is expected (required) rate of return on a pure asset i, r^*_m is expected rate of return on the market portfolio, r_f is riskless return (essentially equal to r_{tT}), ρ_{im} is correlation between return on individual and market return, σ_i is standard deviation of rate of return on the asset and σ_m is standard deviation of rate of return on market portfolio.

The expected return on each pure asset is earned from the difference between the current spot price and expected futures spot price. The CAPM shows this difference as to be:

$$E_t(S_t) - P^*_t = r^*_i P^*_t + \beta_i (r^*_m - r_f) P^*_t$$

Thus, as stated earlier, the difference between the future price and the expected futures spot price must be equal to this differential. Where β_i is the systematic risk.

$$E_t(S_t) - F_{t,T} = \beta_i(r_m^* - r_f)P_t^*$$

The earlier equation has an important view that futures prices can be unbiased predictor of futures spot price only if the asset has zero systematic risk, i.e., $\beta_i = 0$. In such situation, the investor can diversify away the risk of the futures position. In general, futures prices will reflect an equilibrium bias. If $\beta_i > 0$ (is positive) then, $F_{t,T} < E_t - (S_T)$, and if $B_i < 0$, a long futures position has negative systematic risk, such a position will yield an expected loss, so $F_{t,T} > E_t–(S_T)$. This situation purely reflects the CAPM. In brief, according to CAPM, the expected return on a long futures position depends on the beta of the futures contract if $\beta_i > 0$, the futures price should rise overtime; if $\beta_i = 0$, the futures price should not change, and if $\beta_i < 0$, the futures price should fall over time and vice-versa in the case of short futures.

2.4 Forward markets and trading mechanism

The growth of futures markets followed the growth of forward market. In early years, there was no so much transporting facilities available, and hence, a lot of time was consumed to reach at their destination. Sometimes, it took so much time that the prices drastically changed, and even the producers of the goods had to sell at loss. Producers, therefore, thought to avoid this price risk and they started selling their goods forward even at the prices lower than their expectations. For example, a farmer could sell the produce forward to another party. And by the time the actual goods reached the market, he could have protected himself against the future unfavourable price movements. This is known as short selling. On the other hand, the long position holder agrees to buy the grain at a pre-specified price and at a particular date. For this trading, a middleman is needed who knows the expectations of buyers and sellers and he charges a fees for this purpose known as commission.

Another important point arises, in above said forward arrangements, who would be willing to take the other side of the contract. Who would be the purchaser (or long) be? One such possibility is that the speculator or arbitrageur may come forward and take the short position. Second, a miller, for example, might need to purchase grain in six months to fulfil a future commitment of delivering flour at an already agreed upon price. So to protect his profit margin, the miller could purchase grain forward, booking both the fixed price at some price per quintal, as well as a source of supply. In this way, he could achieve by taking the long side of the producer's forward contract.

2.4.1 Forward prices determination

Forward contracts are very much popular in foreign exchange markets to hedge the foreign currency risks. Most of the large and international banks have a separate 'Forward Desk' within their foreign exchange trading room which are devoted to the trading of forward contracts. Let us take an illustration to explain the forward contract.

As discussed earlier, forward contracts are generally easier to analyze than futures contracts because in forward contracts there are no daily settlement and only a single payment is made at maturity. Both futures prices and forward prices are closely related.

It is important to know about certain terms before going to determine the forward prices such as distinction between investment assets and consumption assets, compounding, short selling, repo rate and so on because these will be frequently used in such computation. We are not discussing these here as under:

An **investment asset** is an asset that is held for investment purposes, such as stocks, shares, bonds, treasury, securities, etc. **Consumption assets** are those assets which are held primarily for consumption, and not usually for investment purposes. There are commodities like copper, oil, foodgrains etc.

Compounding is a quantitative tool which is used to know the lump-sum value of the proceeds received in a particular period. Consider an amount. A invested for *t* years at an interest rate of *r* per annum. If the rate is compounded once per annum, the terminal value of that investment will be

Terminal value = $A (1 + r)^t$,

and if it is compounded *m* times per annum then the terminal value will be

Terminal value = $A (1 + r/m)^{mt}$

Where A is amount for investment, r is rate of return, *t* is period for return and *m* is period of compounding.

Suppose A = Rs. 100, R = 10% per annum, *t* = 1 (one year), and if we compound once per annum (m = 1) then as per this formula, terminal value will be

$100 (1 + 10)^1 = 100 (11)$ = Rs. 110.

If *m* = 2 then

$100 (1 + 0.05)^{2\times1} = 100 \times 1.05 \times 1.05$ = Rs. 110.25

and so on.

Short selling refers to selling securities which are not owned by the investor at the time of sale. It is also called 'shorting', with the intention of buying later. Short selling may not be possible for all investment assets. It yields a profit to the investor when the price of the asset goes down and loss when it goes up. For example, an investor might contract his broker to short 500 State Bank of India shares then the broker will borrow the shares from another client and sell them in the open market. So the investor can maintain the short position provided there are shares available for the broker to borrow. However, if the contract is open, the broker has no shares to borrow, then the investor has to close his position immediate, this is known as **short-squeezed**.

The **repo rate** refers to the risk free rate of interest for many arbitrageurs operating in the future markets. Further, the 'repo' or repurchase agreement refers to that agreement where the owner of the securities agrees to sell them to a financial institution, and buy the same back later (after a particular period). The repurchase price is slightly higher than the price at which they are sold. This difference is usually called interest earned on the loan. Repo rate is usually slightly higher than the treasury bill rate.

The concept of a full-carry-market: The concept of a full-carry-market refers to the degree of restriction relating to the underlying asset. For example, nature of restriction on short-selling, supply of goods, non-seasonal production and consumption, etc. will determine the degree of full-carry-market. So it varies asset to asset and market to near-market. There are five main factors that affect market prices and move them towards or away from full-carry-market. These are short selling conditions, supply condition, seasonality of production, seasonality of consumption and ease of storage.

2.5 Summary

There are various factors affecting pricing of futures. In case of constant risk free interest rates, the forward and future prices are equal. In case of a stock index future, the pricing depends on the nature and type of asset. If the asset is income bearing asset or investment asset, then pricing strategy will be devised keeping in view the yield or regular returns on them. Similarly, in case of consumption asset, the arbitrage opportunity may be used.

Based on some factors, there are different models to determine pricing of futures assets- cost of carry model, expectation model, backwardation model and CAPM. The cost of carry model suggests that futures prices are affected by the cost of carrying these underlying assets such as- storage cost, insurance cost, transportation cost and cost of financing. The interrelationship can be very well explaining in perfect and imperfect capital markets. In backwardation model of futures pricing, the focal point is basis i.e. the difference between cash price and future price. If the basis is positive, then it refers to a market where future price is less than the spot or cash price. In vice-versa case, the situation is known as contango market. Expectation model of future pricing is based on the argument that expected futures profit is equal to expected futures price minus initial futures price. There is also a straight relationship between the capital asset pricing model and prices of future contracts. The anticipated return on asset is earned from the difference between current spot price and expected futures spot price.

2.6 Key words

Delivery price: The specified price in a forward contract will be referred to as the delivery price. This is decided or chosen at the time of entering into forward contract so that the value of the contract to both parties is zero. It means that it costs nothing to take a long or a short position.

Forward price: It refers to the agreed upon price at which both the counter parties will transact when the contract expires.

Future spot price: The spot price of the underlying asset when the contract expires is called the future spot price, since it is market price that will prevail at some futures date.

Long position: The party who agrees to buy in the future is said to hold long position. For example, in the earlier case, the bank has taken a long position agreeing to buy 3-month dollar in futures.

Perfect capital market: Based on assumptions of homogeneous expectations of investors, symmetry of information and no transaction or other costs.

Short position: The party who agrees to sell in the future holds a short position in the contract.

Spot-price: This refers to the purchase of the underlying asset for immediate delivery. In other words, it is the quoted price for buying and selling of an asset at the spot or immediate delivery.

Systematic risk: The risk which cannot be diversified generally denoted by β (Beta).

Underlying asset: It means any asset in the form of commodity, security or currency that will be bought and sold when the contract expires.

2.7 Self assessment questions

1. What do you understand by future market? What are the functions of futures markets? Explain.

2. Describe some important features of futures market with suitable examples.

3. Explain the role of various participants of futures market.

4. How do you determine futures prices? Explain by giving suitable examples.

5. Describe the relationship between the expected futures spot price and futures prices with suitable examples.

6. Explain various theories of determining the prices of futures.

7. Write notes on the following:

   a) Cost of carry in perfect market

   b) Expectations approach

   c) CAPM and future prices

8. Suppose 'X' enters into a six-month forward contract on non-dividend paying stock when stock price is Rs. 50 and risk free rate of interest is 14% p.a. Calculate forward price.

9. A one year futures contract on gold with a storage cost of Rs. 15 per 10 gm per year to store gold to be paid after one year. Assume that the spot price of Rs. 9600 per 10 gm and the risk free rate of interest is 6% p.a. for all maturities. Determine the futures price of the metal.

10. Assume that an investor enters into a six-month forward contract on a non-dividend paying stock when the stock price is Rs. 50 and risk free rate of interest is 10% p.a. Compute forward price.

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Subject: **Financial Derivatives**	
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Lesson No.: **3**	Vetter: **Prof. M.S. Turan**
USE OF FUTURES FOR HEDGING	

Structure

3.0 Objectives

After going through this lesson, you will be able to:

- Understand the concept and types of hedging.
- Differentiate between price risk and basis risk.
- Describe hedging strategy and hedge ratio.
- Explain the managing aspect of a hedge.

3.1 Introduction

In the previous lesson you have got an idea to calculate price of future contracts. Now in this lesson there is a detailed discussion on how the futures can be used for hedging, what are the hedging strategies ad how to manage hedge position. Business outcomes are surprising and have risk and uncertainty elements. To avoid the risk arising out of price fluctuations in future, various strategies are devised keeping in view the timing and pricing dimensions of the instruments. Suppose a farmer anticipates fall in prices of his crop three months hence. He will try to cover his future risk by entering into a future contract at a price set on today's date. Similarly suppose a textile manufacturer anticipates future losses due to government policy, he will lock his future position by entering into two simultaneous contracts of buying raw material from one country and to export the finished product to another country. These are examples of hedging where an investor in anticipation of some price change (adverse or favourable) enters into a future contract/s and lock in the position. Before going deep into the strategies involving hedging, it is pertinent to know basic features and types of hedging.

3.2 Concept and types of hedging

The beauty of derivative market lies in the fact that an investor can protect his risk by entering into a contract. In broader sense, a hedging is an act of protecting one from future losses due to some reason. In a future market, the use of future contracts/instrument in such a way that risk is either avoided or minimised is called hedging. The anticipated future losses may occur due to fluctuations in the price, foreign exchange or interest rate. In case of unfavourable price movement the hedgers enter into future contracts at different time periods. This concept considers that hedging activity is based on price risk. Why investors hedge? According to Hollbook Working, hedging has following purposes:

Carrying charge hedging: In this case, if the spread (Difference between futures and spot price) covers the carry cost too, then stocks should be bought.

Operational hedging: According to this approach, future markets are supposed to be more liquid and investors (hedger) use futures as a substitute for cash market.

Selection or discretionary hedging: This hedging is done only on selected occasions or when there may be some adverse price movements in future.

Anticipatory hedging: This is done in anticipation of buying or selling price of an asset in future.

If an investor uses future contract in a fashion that it eliminates the risk completely is known as perfect hedging model. The factors which may affect perfect hedging are:

- Profits are affected by change in commodity, security, interest rate or exchange rate.
- Knowledge of the firm giving the impact of these factors on firm's profit.
- Quantity which affects the firm.

Example: Suppose a firm is interested to sell 100 kg of cotton in the month of October. The current spot price of cotton is Rs. 600 per kg and it is expected that the price of cotton will fall in the period from now to October. To hedge against the possible risk, the firm enters into a futures contract (short sell) 100 kg of cotton at the rate of Rs. 700 per kg.

Further supposing that:

Case I: The spot price rises to Rs. 750 per kg.

Case II: The price falls below to Rs. 580 per kg.

TABLE 3.1 SHOWING COTTON INVENTORY AND SALES REVENUE

Case	Cotton Revenue ($Q_T \times P_T$)	Profit/Loss [Q_T ($F_{tT} - P_T$)]	Net Revenue
I. Rs. 700	Rs. 70,000	100 × (600 – 700) = – Rs. 10,000	Rs. 60000
II. Rs. 580	Rs. 58000	100 (600 – 580) = Rs. 2000	Rs. 56000

In both the cases, the firm locks in today's future price of Rs. 700 and in cases of fall and rise of price, the firm can offset the position.

Let us denote '*t*' as present time, *T* is date in future, Q_T is the quantity to be purchased on '*T*' time period, P_T is the price at time T and $F_{t,T}$ is the future price at time t. $F_{T,T}$ is the future price at time *T*. The Net Cost to the producer is the price of cotton less the profit on the future position.

Net cotton cost = Cotton costs – Futures profit

$Q_T - F_{t,T} = Q_T P_T - Q_T - Q_T (P_T - F_{t,T})$

Types of hedge: There are two categories of hedging- short hedge and long hedge.

Short hedge: Having a short position (selling a futures) in futures is known as a short hedge. It happens when an investor plans to buy or produce a cash commodity sells futures to hedge the cash position. It is appropriate when hedger owns an asset and expects to sell in future on a particular date. Thus selling some asset without having the same is known as short-selling. For example suppose a US exporter expects to receive euros in three months. He will gain if the euro increases in value relative to the US dollar and will sustain loss if the euro decreases in value relative to US dollar. Another illustration can be understood with the help of the following example:

Supposing an oil producer made a contract on 10 Oct, 2006 to sell 1 million barrel crude oil on a market price as on 10 Jan 2007. The oil producer supposing that spot price on 10 Oct, 2006 is \$ 50 per barrel and Jan crude future price on NYMEX is \$ 48.50 per barrel. Each future contract on NYMEX is for delivery of 1,000 barrels. The company can hedge its position by short selling October futures. If the oil borrower closed his position on 10 Jan 2007 the effect of the strategy should be to lock in a price close to \$ 48.50 per barrel. Suppose the spot price on 10 Jan 2007 be \$ 47.50 per barrel. The company realizes the gain:

\$ 48.50 – \$ 47.50 = \$ 1.00

or \$ 1 million in total from the short future position.

Suppose the oil prices go up by \$ 50.50 per barrel. The company realized \$ 0.50 per barrel.

i.e. \$ 50.50 – \$ 50.0 = \$ 0.50

Long hedge: A long hedge is taking long position in futures contract. A long hedge is done in anticipation of future price increases and when the company knows that it will have to buy a certain asset in the future at anticipated higher price and wants to lock in a price now. The objective of a long hedge is to protect the company against a price increase in the underlying asset prior to buy the same either in spot or future market. A net bought position is actually holding an asset which is known as inventory hedge.

Suppose an investment banker anticipates to receive Rs. 1 million on June 20 and intends to buy a portfolio of Indian equities. Assuming that he has a risk factor of increase in the sensex before money is received. He can go in futures and buy today futures contract at 11000 (today's sensex 11000). He can close his position by selling 10 August stock futures.

TABLE 3.1. SHOWING LONG HEDGE

Spot market	Futures market
June 20 Anticipates receipt of Rs. 1 million on July 20 Current future index is at 11000 fears a rise in index	June 20 Buy 10 September 20 Index futures at a price of 11000 thereby commits himself to pay 11000 × 10 = Rs. 110000 stock on future date
July 20 The future index is 12000 Requires additional Rs. 12000 to buy the stock that Rs. 1 million would have been bought on June 20	Close out his position by selling at a price of 1200. He notionally receives Rs. 112000
Loss = Rs. 12000	Profit Rs. 12000 future market

Source: Based on numerical

Cross hedging: A cross hedge is a hedge where characteristics of futures and spot prices do not match perfectly which is known as mismatch, may occur due to following reasons:

- The quantity to be hedged may not be equal to the quantity of futures contract.
- Features of assets to be hedged are different from the future contract asset.
- Same futures period (maturity) on a particular asset is not available.

Suppose a wire manufacturer requires copper in the month of June but in exchange the copper futures trade in long delivery in Jan, March, July, Sept. in this case hedging horizon does not match with the futures delivery date. Suppose that the copper required by the manufacturer is substandard quality but the available trading is of pure 100% copper and in quantity aspect too, copper may be traded in different multiples than required actually. These are examples of cross hedging.

3.3 Basis and price risk

The difference between the spot price and future price is known as basis. Basis is said to be positive if the spot price is higher than the future price and negative in case of reverse.

Basis = Cash (spot price) – Future price

In case of difference in future price and spot price, basis risk is bound to occur.

Strengthening of the basis occurs when change in the spot price is more than the change in the future price. If the change in spot price is less than the change in futures price, the basis is known as weakening of basis.

The following Table 3.1 gives the clear picture of the price changes.

TABLE 3.1: BASIS POSITION OF CRUDE OIL ($ PER BARREL)

Case	Cash price	Future price	Basis
Oct 10, 2006	65	68	-3
Nov. 15, 2006	67	71	-4
Change	+2	+3	-1

Further suppose that S_1 denotes spot price at time t_1, S_2 is spot price at time t_2, F_1 – Futures price at time t, F_2- Futures price at time t_2, b_1 = basis at time t, b_2 = basis at time t_2

$b_1 = S_1 – F_1 = -3$

$b_2 = S_2 – F_2 = -4$

Consider that a hedger takes a short futures position at time k_1 and knows that the asset will be sold at time t_2. The price for the asset will be $F_1 - F_2$

The effective price will be:

$S_2 + (F_1 - F_2) = F_2 + b_1$

Basic risk = Spot price of asset to be hedged – Futures price of contract used.

To illustrate the concept further suppose that a hedge is put in place at time t_1 and closed out at time t_2. Let's assume that the spot price is Rs. 3.50 and future price is Rs. 3.20 at the initiation of the contract and at the time the hedge is close out these are Rs. 3.00 and Rs. 2.90 respectively. Hence in this case

$S_1 = 3.00, F_1 = 3.20, S_2 = 3.00, F_2 = 2.90.$

The basis will be

$b_1 = S_1 - F_1$ $\quad$ $b_1 = 0.30$

$b_2 = S_2 - F_2$ $\quad$ $b_2 = 0.10$

Supposing that a hedger who knows that the asset will be sold at time t_2 and takes a short position at time t_1. The price realized for the aspect is S_2 and the profit on the futures position is $F_2 - F_1$. The effective price for the asset with hedging will be:

$S_2 + F_2 - F_1 = F_1 + b_2$

Consider another case in which a company knows it will buy the asset at time t_2 and initiates a long hedge at time t_1. The price paid for the asset is

S_2 and the loss on the hedge is $F_1 - F_2$. The effective price is paid with hedging will be:

$$S_2 + F_1 - F_2 = F_1 + b_2$$

In both the cases, the value is same.

Choice of asset underlying the futures contract and the choice of the delivery month affect the basis risk. It is necessary to analyse that which of the available futures contracts has future price that are mostly correlated with the price of the asset being hedged. Further, basis risk increases as the time difference between the hedge expiration and the delivery month increases. For example, if the delivery months are March, June, September and December for a particular contract. For hedge expirations in December, January and February, the March contract will be chosen. This practice is adopted in order to meet the hedger's liquidity requirements. Therefore, in practice, short maturity futures contracts have more liquidity.

Illustration 3.1: Suppose today is 1 March. An American company anticipates to receive 50 million Yens at the end of July, Yens futures contract have delivery months of March, June, September and December. One contract is for the delivery of 12.5 million Yens. The company, therefore, shorts four September dollar futures contracts on March 1. When the Yens are received at the end of July, the Company closed out position. Let us assume that futures price on March 1 in cents per Yens is 0.80 and that the spot and futures price when the contract is closed out are 0.7500 and 0.7550 respectively.

The gain on the futures contract is 0.8000-0.7550 = - 0.0450 cents per yen. The basis is 0.7500 – 0.7550 = -0.005 cents per yen when the contract is closed out.

The effective price obtained in cents per yen is the final spot price plus the gain on the futures.

0.7500 + 0.005 = 0.7550.

This can also be written as the initial futures price plus the final basis

0.8000 – 0.0050 = 0.7950

The total amount received by the company for the 50 million yens is 50 × 0.00795 million dollars or $ 397500.

Illustration 3.2: Today is June 10. Suppose a company needs 10,000 kg of soyabean in the month of either October or November. The soya future contracts are currently traded for delivery every month on NCDEX and the contract size is 100 kg. The company decides to use the December contract for hedging and takes a long position in 20 December contracts. The futures price on June 10 is Rs. 50 per kg. The company is ready to purchase soya on November 20. It, therefore, closes out its future contract on that date. Suppose the spot price and futures price on November 20 are Rs. 55 per kg and Rs. 53.50 per kg.

Solution: The gain on the future contract is 53.50 – 50.00 = Rs. 3.50 per kg. The basis at the closing out of the contract is 55 – 53.50 = Rs. 2.50 per kg. The effective price paid (in Rs. per kg) is the final spot price less the gain on the futures, or 55 – 3.50 = Rs. 52.50 per kg.

If we take the difference between the initial future price plus the final basis, this effective price can also be calculated 50 + 2.50 = Rs. 52.50.

Therefore, total price received = 52.50 × 10000 = Rs. 5,25,000.

3.4 Hedging strategies using futures

When is a short futures position appropriate? When is a long futures position appropriate? Which futures contract should be used? What is the optimal size of the futures position for reducing risk? At this stage, we restrict our attention to what might be termed hedge-and-forget strategies. The objective is usually to take a position that neutralizes the risk as far as possible. Consider a company that known it will gain $ 10,000 for each 1 cent increase in the price of a commodity over the next three months and lose $ 10,000 for each 1 cent decrease in the price during the same period. To hedge, the company's treasurer should take a short futures position that is designed to offset this risk. The futures position should lead to a loss of $ 10,000 for each 1 cent increase in the price of the commodity over the three months and a gain of $ 10,000 for each 1 cent decrease in the price during this period. If the price of the commodity goes down, the gain on the futures position offsets the loss on the rest of the company's business. If the price of the commodity goes up, the loss on the futures position is offset by the gain on the rest of the company's business.

Illustration 3.3: Suppose an oil importer knows in advance on July 10, that it will need to buy 30,000 barrels of crude oil at some time in October or November and the contract size is 1000 barrel. The company therefore decides to use December futures contract for hedging and takes a long position in 15 December contracts. The future price on July 10 is $ 50 per barrel. The company finds itself in a position to purchase crude oil on November 12 closes its futures position on that date. The spot price on November 12 are $ 52 per barrel and $ 51.20 per barrel.

The gain on the future contract is 51.20 – 50 = $ 1.20 per barrel. The basis on the date when the contract is closed is 52.00 – 51.20 = $ 0.80 per barrel. The effective price is the final spot price less the gain on the futures or

52.00 – 1.20 = 50.80

This can also be calculated as the initial futures price plus the final basis.

50.00 + 0.80 = 50.80

The total price received is 50.80 × 30000 = $ 1,52,4000

3.5 Proof of the minimum variance hedge ratio formula

Hedging is basically a tool to minimize risk by taking a short (long) position in one futures contract w.r.t. spot position. The hedge ratio is the size of the position taken in futures contracts to the size of the exposure.

To derive the minimum variance hedge ratio formula, let's define-

δS: change in spot price, S, during a period of time equal to the life of the hedge.

δF: change in futures price. F, during a period of time equal to the life of the hedge

σ_S: standard deviation of δS

σ_F: standard deviation of δF

ρ: coefficient of correlation between δS and δF

h: hedge ratio

When the hedger is long the asset and short futures, the change in the value of the position during the life of the hedge is

$\delta S – h\delta F$

for each unit of the asset held. For a long hedge the change is

$h\delta F - \delta S$

In either case the variance, r, of the change in value of the hedged position is given by

$$v = \sigma_s^2 + h^2\sigma_F^2 - 2h\rho\sigma_s\sigma_F$$

so that

$$\frac{\partial v}{\partial h} = 2h\sigma_F^2 - 2\rho\sigma_s\sigma_F$$

Setting this equal to zero, and noting that $\partial^2 v/\partial h^2$ we see that the value minimizes the variance is

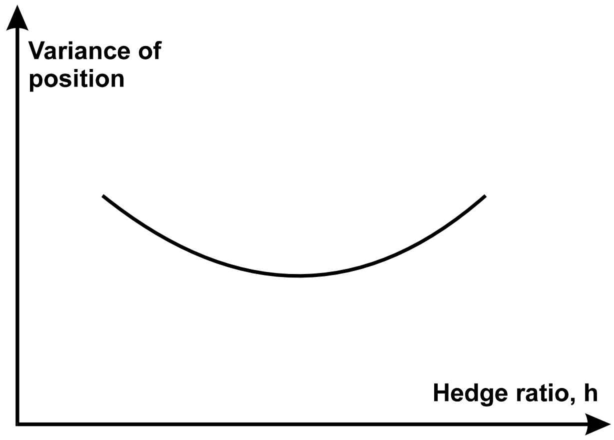
$$h = \rho\frac{\sigma_s}{\sigma_F}$$

The optimal hedge ratio is the product of the coefficient of correlation between δS and δF and the ratio of the standard deviation of δS to the standard deviation of δF. Figure 4.2 shows how the variance of the value of the hedger's position depends on the hedge ratio chosen.

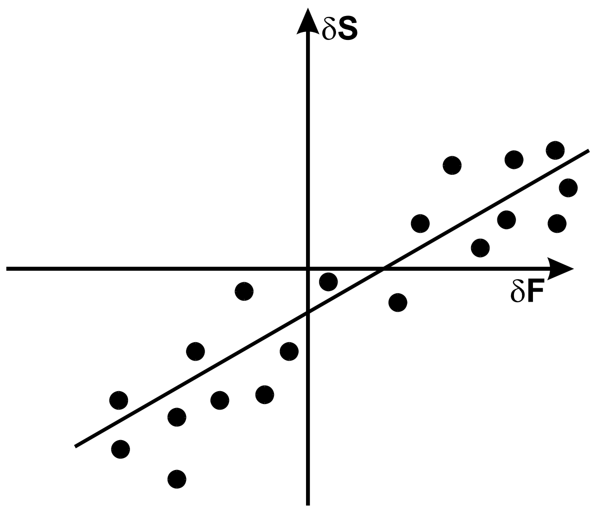
If $\rho=1$ and $\sigma_F = \sigma_S$, the hedge ratio, h*, is 1.0. This result is to be expected, because in this case the futures price mirrors the spot price perfectly. If $\rho = 1$ and $\sigma_F = 2\sigma_S$, the hedge ratio h* is 0.5. This result is also as expected, because in this case the futures price always changes by twice as such as the spot price.

The optimal hedge ratio, h*, is the slope of the best fit line when δS is regressed against δF, as indicated in Figure 4.3. This is intuitive reasonable, because we require h* to correspond to the ratio of changes in δS to change in δF. The hedge effectiveness can be defined as the proportion of the variance that is eliminated by hedging. This is ρ^2, or

$$h^{*2}\frac{\sigma_F^2}{\sigma_S^2}$$



The parameters ro, sigma$_F$, and sigma$_s$ in equation (4.1) are usually estimated from historical data on δS and δF. (The implicit assumption is that the future will in some sense be like the past.) A number of equal nonoverlapping time intervals are chosen, and the values of δS and δF for each of the intervals are observed. Ideally, the length of each time interval is the same as the length of the time interval for which the hedge is in effect. In practice, this sometimes severely limits the number of observations that are available, and a shorter time interval is used.



Optimal number of contracts

Define variables as follows:

N_A: Size of position being hedged (units)

Q_F: Size of one futures contract (units)

N*: Optimal number of futures contracts for hedging

The futures contracts used should have a face value of h^*N_A. The number of futures contracts required is therefore given by

$$N^* = \frac{h^* N_A}{Q_F}$$

3.6 Management of hedge position

Hedging requires regular monitoring and frequent adjustments to bring effectiveness. The evaluation of the hedge is quite necessary to identify the reasons for non-conformity of results. How hedge can be effectively managed? Let's discuss the following steps:

3.6.1 Monitoring of hedge

To monitor the hedge on a continuous basis the following information should be looked for:

Cash/spot position: The hedger should have an idea of the current position in cash/spot and the relevant changes in the same. The gains/losses with reasons of deviation should also be considered.

Future position: Information regarding futures price, size, volume of trading, profits and losses should also be taken care of to bring effectiveness.

Margins: Margin requirements, availability of funds and funding to meet margin can should be furnished.

Fluctuation in basis: The information regarding upward or downward movements of basis should also be considered by hedgers to know the reasons of difference and timing of the same.

Information of events: This type of information is necessary because any event can influence the position of spot or futures and thereby the strategy is to be made.

3.6.2 Adjustments of hedge position

Due to changing environment and impact of relevant information on hedge, the hedger has to adjust his position. The following points are helpful under this heading:

Changing hedge ratio: Due to varying risk profiles of the hedgers, the adjustment is required in the hedge ratio.

Changing goals of hedge: Any new information can lead to change in the hedger goals and hence strategy should be changed/adjusted accordingly.

Change in risk exposure: Frequent changes in risk exposure invite changes in cash position which thereby initiate changes in volume of futures position.

Rolling the hedge: Due to changes in market development, sometimes it becomes necessary to change hedging strategies. Sometimes, the expiration date of the hedge is later than the delivery dates of all the futures contracts. Then in this situation the hedger rolls the hedge forward by closing out one futures contract and taking same position in a future contract with a later delivery date.

To have more understanding of rolling let us consider an example that in May 2007 a company realizes that it will have 10,000 kg of soya to sell in July 2008 and decides to hedge its risk with a hedge ratio of 1.0. The current spot price being Rs. 50 per kg. Also supposing that only first six delivery months have sufficient liquidity to meet company's demand. The company therefore shorts 100 November, 2007 contracts. In October 2007, it rolls the hedge forward into April 2008 contracts. In March 2008, it rolls the hedge forward again upto August 2008 contract. Supposing that the price of the soya oil falls from Rs. 50 kg to Rs. 45 per kg between May 2007 to July 2008 and also supposing that November 2007 futures contract is spot sold as Rs. 48.50 per kg and closed out at 47.00 per kg for a profit of Rs. 1.50 per kg; the April 2008 contract is shorted at Rs. 49 per kg and closed out as Rs. 44.50 per kg with profit of Rs. 5.50 per kg. The August 2008 closed out at Rs. 44.70 per kg for a profit of Rs. 0.80 per kg. In this case the futures contract provide a total of Rs. 7.80 per kg. Compensation for Rs. 5 per kg decline in soya prices.

3.6.3 Evaluating a hedge

To evaluate the performance of a hedge, there should be comparison between earlier hedge effectiveness and the anticipated hedging strategy. While evaluating a hedge, cost-effectiveness should also be considered e.g.

brokerage, fees, translation and management costs etc. For this purpose ex-post measure of effectiveness should be calculated with the help of deviation or significant difference between the anticipated and ex-post hedged strategy.

3.7 Summary

Hedging is an activity of protecting oneself from future losses due to some reason. The concepts of hedging include carrying charge hedging, operational hedging and anticipatory hedging. Here the hedger in interested in knowing price spread between spot and futures prices and is the spread that covers the carrying cost, then the hedger will buy the stock. In operational hedging, the hedger uses the futures market for their operation while in anticipatory hedging, the hedger decides short or long position based on expectation of price fluctuation in future. A cross hedging is the hedging where there is a mismatch between future and spot prices, quantity and time, A short hedge is a hedge involving short position in futures while a long hedge involves long (buy) future position. Basis risk is defined as the risk arising of the difference between cash price and futures price and is important parameter to decide hedging strategy. Hedge ratio is the quantity of stock which should be exchanged for one call or put to minimise the risk in variability of the value of total (hedged) position. It also denotes the ratio between futures position and cash market position. Management of hedging involves three things— monitoring, adjustment and evaluation of a hedging strategy.

3.8 Keywords

Basis is the difference between cash/spot price and future price.

Hedging is an activity of protecting oneself from future losses.

Hedge ratio is the ratio of futures position to cash market position.

3.9 Self assessment questions

1. What do you understand by hedging? Explain the concept with suitable illustrations.

2. Discuss various concepts of hedging with suitable illustrations.

3. Hedging prevents the investor from future price fluctuations? Do you agree with this statement? Elaborate.

4. What do you understand by a hedging strategy? As an investor how will you devise hedging strategy?

5. What is a hedge ratio? Describe the importance of hedge ratio in designing hedge strategy?

6. Give a detailed derivation of minimum variance hedge ratio formula?

7. Differentiate between basis risk and price risk? Also critically examine the relationship between the two.

8. What are the steps involved in management of a hedge? Discuss the measure of effectiveness of a hedging strategy.

9. On June 10, a silver dealer requires 100 kg of silver on September 20 to meet a certain contract of the spot price of silver is Rs. 9000 per 100 gm and futures price is Rs. 8500 per 100 gm. Each contract which is traded on NCDEX is of 10 kg. What type of position should the silver dealer take in futures market? Also calculate the net change in wealth.

10. A short cash position of 200 shares of ABCL Ltd. is hedged by buying stocks of SRKL Ltd. Assume that there is a Rs. 10 change

in ABCL Ltd. Share price for every Rs. 20 change in SRKL Ltd. Determine the amount of contract required to minimise risk.

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Subject: **Financial Derivatives**	
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INTEREST RATE FUTURES	

Structure

4.0 Objectives

After going through this lesson you will be able to:

- Understand the concept of interest rate futures.
- Describe the functioning of short-term and long term interest rate futures market.
- Know the types of interest rate futures like T-bills, T-bonds, municipal bonds and euro-dollar futures.
- Understand the calculation of T-bond pricing.
- Evaluate hedging by interest futures.

4.1 Introduction

In financial markets, various parties, instruments and methods are applied by investors and general public. When global financial markets have become integrated, there is a need to understand the complication involved in financial transactions of various instruments among different participants. For borrowers and lenders of finance, interest rates play important role. While low interest rate is favoured by borrowers of money, enhanced rates of interest on the other hand are cause of concern for them and the vice-versa in the case with lenders. Interest rate fluctuation causes interest rate risk and default risk. Naturally both parties want to avoid this interest rate risk. Interest rate futures are financial derivatives which reduce the interest risk. There are two types of interest rate risks: short and long-term. In this lesson an attempt has been made to let the learners acquainted with the functioning of interest rare futures market and how these can be used as instruments of hedging. On these interest rate futures, a fixed return (in terms of interest) is paid after some interval (principal) or between regular intervals (interest payments). Interest rate futures contracts are complicated in the sense that they are dependent on level of interest rates and the period of maturity of the same.

4.2 Types of interest rates

There are two types of interest rates: short-term and long-term. In financial markets, short term interest rate futures contracts, are future contracts which have a maturity of one year or less and long term interest rate futures are futures having obligation more than one year or more.

4.2.1 Short term interest rate

US Treasury Bills are examples of money market instruments which are meant for one year. The other quoted interest rate futures are: deposit rates, borrowing rates and mortgage rates.

4.2.2 Treasury rates

Treasury rate is the rate of interest at which the government of any country borrows e.g. US treasury rate is the rate at which US government can borrow in US dollars. The risk-free nature of this interest rate is due to the little chance of default by the governments.

4.2.3 Repo rate

This is also known as “Repurchase Agreement”, which is a contract where the owner of the funds (securities) agrees to sell them to counter parties and buy them back at later stage on a higher interest rate. The difference between the selling price and repurchase price of the security is called interest earned by the counter party and is referred to as ‘Repo Rate’. This rate is slightly higher than the treasury rate. It has very little credit risk. In overnight repo, the agreement is renegotiated.

4.2.4 Zero rate

An n-year zero interest rate is the interest rate on an investment which starts on today's date and last for n-years. In this time period no intermediate payment is made. All the interest and principal payment is realized at the end of n-years. Suppose a five-year treasury zero rate with continuous compounding is quoted as 5% p.a. It means that Rs. 100 invested today will grow to

$$100 \times e^{0.05 \times 5} = \text{Rs. } 128.40$$

If the compounding is annual then the Rs. 100 amount will become

$100 \times (1 + 0.05)^5 =$ Rs. 127.63 after 5-years.

Now, the question arises that how the pricing of bonds is done? The price of the bond can be calculated as the present value of all the cash flows that will be received by the owner of the bond using appropriate zero rates as discount rates.

Illustration 4.1: Suppose that a two year treasury bond with a principal of Rs. 100 provides coupon @ 6% p.a. semi-annually. Hence the first coupon of Rs. 3 is discounted at 5% for six months and at 5.8% for one year and so on as shown in Table 4.1 below:

TABLE 4.1: TREASURY COUPON RATE

Maturity year	Zero rate (%) (Continuously compounding
0.5	5.0
1.0	5.8
1.5	6.4
2.0	6.8

The theoretical price of the bond will be:

$3e^{-0.05\times0.5} + 3e^{-0.058 \times 1.0} + 3e^{-0.0064\times1.5} + 3e^{-0.0068\times2.0}$

= Rs. 98.39

If d is the present rate of Rs. 1 received at the maturing of bond. A is the value of an annuity that pays one rupee on each coupon payment date and m is the number of coupon payments per year, the par yield 'C' must satisfy-

$$100 = A\frac{c}{m} + 100d$$

so that $C = \dfrac{(100 - 100d)m}{A}$

Hence par yield is the coupon rate that equates the bond price and its face value.

4.2.5 LIBOR rate

LIBOR (London Interbank Offer Rate) rate is also short term interest rate at which large international banks are willing to lend money to large another international banks. There is an element of risk in LIBOR, because it is influenced by changing economic conditions, financial flows of funds etc.

4.2.6 Forward rates

These are the rates of interest implied by current zero rates for periods of time in the future. Suppose Table 4.2 shows zero rates which are continuously compounded.

TABLE 4.2: CALCULATION OF FORWARD RATES

Year (m)	Zero rate for an *n*-year investment (% p.a.)	Forward rate for n^{th} year (% p.a.)
1	10.0	-
2	10.5	11.0
3	10.8	11.4
4	11.0	11.6
5	11.1	11.5

Thus a 10% p.a. rate for one year means that in return for an investment of Rs. 100 today, the investor receives 100 $e^{0.10}$ = Rs. 110.52 in one year. The 10.5% p.a. rate for two year means that in return of Rs. 100 invested today, the investor receives Rs. 100 $e^{0.105\times2}$ = Rs. 123.37 in two years and so on so forth.

In general, when interest rates are continuously compounded and rates in successive time periods are combined, the overall equivalent rate is simply the average rate during the whole period (e.g. 10% for first year and 11% for second year average to 10.5% for two years). In general, if R_1 and R_2 are zero rates for maturity T_1 and T_2 respectively and R_F is the forward rate for the period between T_1 and T_2, then

$$R_F = \frac{R_2T_2 - R_1T_1}{T_2 - T_1}$$

Further suppose that a borrower borrows Rs. 100 at 10% for one year and then invests money at 10.5% for two years, the resultant cash flow of 100 $e^{0.10}$ = Rs. 110.52 at the end of year 1 and an inflow of 100 $e^{0.105\times2}$ = Rs. 123.37 at the end of year 2.

Because 123.37 = 110.52 $e^{0.11}$, a return equal to the forward rate (11%) is earned on Rs. 110.52 during the second year.

Supposing that an investor borrows Rs. 100 for four year at 11% and invests it for three years at 10.8%. The resultant cash flow of 100 $e^{0.108\times3}$ = Rs. 138.26 at the end of third year and a cash outflow of 100 $e^{0.11\times4}$ = Rs. 155.27 at the end of the fourth year.

Since 155.27 = 138.26 $e^{0.116}$, money is being borrowed for the fourth year at the forward rate of 11.6%.

The equation can be written as:

$$R_F = R_2 + (R_2 - R_1)\frac{T_1}{T_2 - T_1}$$

If $R_2 > R_1$, then $R_F > R_2$

And if $R_2 < R_1$, then $R_F < R_2$

Taking limits as $T_2 \rightarrow T_1$ and let the common value of the two be denoted by T, then

$$R_F = R + T\frac{\partial R}{\partial T}$$

Where R is the zero rate for a maturity of T. This value of forward rate is applicable to very short future time period which begins at time T.

Forward rate agreement: FRA also called future rate agreements which refer to techniques for locking in future short-term interest rates. It is just like an over-the-counter agreement that a certain interest rate will apply to a certain principal during a specified future time period, FRA serves as an effective risk management tool by entering into a bid-offer spreads which is published in newspapers showing rates of interest for future time periods. If there is any fluctuation (deviation) of interest rates, the customer and the bank may agree to pass compensation between them.

Suppose an FRA in which a financial institution agrees to earn an interest rate of R_k for the period of time between T_1 and T_2 on a principal amount of L.

Let R_F is the forward LIBOR interest rate for the period between T_1 and T_2. R is the actual LIBOR interest rate observed at time T_1 for a maturity T_2.

In practice, an FRA is usually settled in cost at time T_1. The cash settlement is the present value of cash flows or

$$L\frac{1+R_k(T_2-T_1)}{1+R(T_2-T_1)}-L$$

When FRA is firstly initiated, R_k is set equal to R_F. In other words, the financial institution earns the forward rate for the time period between years 2 and 3 by borrowing a certain amount of money for two year and investing it for three years.

To further illustrate the concept, lets consider the illustration 4.2.

Illustration 4.2: Suppose a 3-months LIBOR is 5% and the six-months LIBOR is 5.5% with continuous compounding. Consider an FRA where a financial institution will receive 7% measured with quarterly compounding on a principal of Rs. 1 million between the end of month 3 and end of month 6.

In this case, the forward rate is 6% with continuous compounding or 6.0452% with quarterly compounding.

Hence, applying the formula:

$$V = L\,(R_k - R_F)\,(T_2 - T_1)\;e^{-R_2T_2}$$

$$V = 1,00,000\,(0.07 - 0.060452) \times 0.25 \times e^{-0.055\times 0.5} = \text{Rs. } 2,322.$$

Theories determining term- structure: There are two types of risks associated with interest bearing securities. Interest risk arises due to changing nature of macro-economic variables such as inflation, money supply, growth rates, government policy and expectations of the investors. These factors are beyond the control of the management. On the other hand, default risk is concerned with non-payment or default of interest payment. Since government security is viewed as risk-free because generally governments do not default. The volatility of a debt instrument depends on the time-period of maturity, which is generally called 'term'. And the relationship between yield and maturity is known as 'term structure' of interest rates. The 'yield curve' depicting this relationship is based on some theoretical assumptions. According to expectations theory, the term structure at a given time reflects the market's current expectations. It postulates that long term interest rates should reflect expected future short-term interest rates. In other words, the forward interest rate corresponds to a certain future period is equal to the expected future zero interest rate for that period. Market segmentation theory suggests that there is no relationship between short, medium and long term interest rates and the interest rates are affected by demand and supply forces. Hence, the interest rates of any term is quite unrelated to expectations of future rates. Liquidity preference theory argues that forward rates should be higher than expected future zero interest rates. This is so that investors prefer liquidity and invest funds for short-periods and would like to borrow for longer periods at a fixed rate. For example, FIs (Financial Institutions) finance substantial funds by long-term fixed rate loans and with short-term deposits.

4.3 Long term interest rate futures

The most popular interest rate futures instruments are long-term futures. Generally having large size and heavy amount with risk-free feature, the government treasury bonds have become popular. USA is the first country to initiate trading in long-term interest rate futures with the introduction of *T*-bonds by CBOT in 1977. Other countries like Japan, France and UK have long-term interest future market with almost similar pricing mechanism and same functioning.

4.3.1 T-Bonds and T-notes

The treasury bond market consists of treasury bond and treasury notes which have maturity from 10 years to 30 years. In case of T-notes, the maturity is upto 10 years. Therefore, T-bond and T-notes are same but with different maturity profiles.

4.3.2 Features of T-bond futures contracts in US

The basic features of T-bond are as follows:

- These are issued by the US government.
- A fixed rate of interest (coupon) per period (usually six months) is paid on them.
- These can be definitely redempted after 10, 20 and 30 years.
- The market price of these bonds are generally expressed in dollar denomination as a sum per $ 100 nominal.
- The CBOT (Chicago Board of Trade) futures contract permits the delivery of any US T-bond that are not callable for at least 15 years from the first day of the delivery month or, if not callable, have a maturity of at least 15 years from the first day of the delivery month.
- The seller of the futures contract has the option of choosing any bond to delivery having the same coupon and maturity date.
- The prices of T-bonds and T-notes are quoted on The Wall Street Journal with bid and ask rates and are in percentage and 32^{nd} of

face value. E.g. bid price of $6\frac{3}{8}$% of Dec. 06 T-note is 100 and 4/32% of face value.

- The US government has the option of calling the bonds away from their owners before maturity and are called callable T-bonds. E.g. “12¾% of Nov. 09-13” T bonds are first callable in 2009 or otherwise matures in 2013.
- These bonds can be traded in secondary market by authorized dealers like banks, stock broking firms and institutions etc.
- Over-the-counter quotations are based on transactions of $ 1 million or more and all yields are to maturity and are based on the asked quotes.
- Assuming a semi-annual interest, the following formula for finding the price of a bond:

Current price of bond = PV of coupon annuity + PV of face value

$$P_0 = \sum_{t=1}^{24} \left\{ \frac{C/2}{(1+R/2)^{(t-1)+(t_c/B)}} \right\} + \left\{ \frac{P_t}{(1+R/2)^{(2N-1)+(t_c/B)}} \right\}$$

Where, P_0 = Current quoted price of bond

P_t = Price of bond at the end of t time period.

R = Annual yield to maturity

C= Annual coupon interest (amount)

N= Years to maturity

t = Number of remaining days until the next coupon payment

B= Total number of days in a coupon period

4.3.3 Delivery process for T-bond and T-notes futures contracts

Trading T-bonds and T-notes has a structured process where delivery by seller and buyer is done. The delivery process is a three day long process in which the short (seller) intentions to deliver bonds. The first day is called intention day or position day. On this day the short can notify the exchange for his intention to deliver until 8.00 p.m. Central time on the position day to declare an intention to make delivery is called wild card option. The second day is called notice day and by 8.30 p.m. on notice day the CBOT clearing corporation finds the oldest long position and notifies that person that has been matched to the delivering short. The short has the time upon 2.00 p.m. on the notice day to decide which bond to deliver. The third day is called the delivery day when the short must deliver the T-bonds to the long and the long pays the invoice amount. The invoice amount or invoice price is the amount the short is paid upon delivery of T-bonds, Important to note here is that delivery can take place at any time during the delivery month.

4.3.4 Conversion factors and invoice calculations

Treasury bonds futures contracts allow the short sellers to choose to deliver any bond that has a maturity of more than 15 years and that is not callable within 15 years. When a particular bond is delivered, conversion factor comes into picture. The conversion factor is defined as a price received by the party with short position. In other words, the conversion factors are simply the prices per $ 1 face value computed by discounting the bond's future cash flows by a hypothetical 6% annual yield. When a short decides to make a delivery, the conversion factor system adjusts the invoice amount. The invoice amount for a deliverable T-bond or T-note is computed as follows:

Invoice amount = Contract size × Future contract settlement price × conversion factor + accrued interest

The accrued interest can be calculated as:

Accrued interest = Semi-annual coupon interest on \$ 1,00,000 face value of the bonds that the short delivers × $\frac{\text{No. of days since last coupon}}{\text{No. of days in half year}}$

Illustration 4.3: Suppose a 10% coupon T-bond with 20 years maturity. Assuming that first coupon payment is to be in six month intervals until the end of 20 years, when the principal is paid. The face value is \$ 100 and discount rate is 6% p.a., with semi-annual compounded (i.e. 3% per six months) the value of the bond will be:

$$\sum_{t=1}^{40} \frac{5}{(1+0.03)^t} + \frac{100}{(1+0.03)^{40}} = \$146.23$$

Dividing this value by the face value, the value received is 1.4623 which is conversion factor.

Hence, conversion factor is a function of (a) the bond's time to maturity from the first day of delivery month (b) the actual coupon on the bond. The following steps are involved in calculation of conversion factors:

1. Assume it is the first day of delivery month.

2. Make the maturity period to approximately nearest three-months and round off unsubstantial part of time. e.g. 20 years 5.4 months become 20 years and 3 month. Define these as *y* years and *m* month.

3. If rounded time to maturity is zero, i.e. $m = 0$, the conversion factor (CF) is the price of the bond it pay $2y$ semi-annual coupons. If $m = 6$, then the CF is the price if the bond pays $(2y + 1)$ semi-annual coupons.

4. If m = 3 or 9 months, then the CBOT estimates allowed interest to be c/4 (half a semi-annual coupon). Under these assumptions, the price of the bond if YTM is 3% will be:

$$CF = \frac{C/2 + C/2\left(PVIFA_{3\%,2y+1}\right) + 1\left(PVIF_{8\%,2y+1}\right)}{(1+0.03)^{0.5}} - \frac{C}{4} \qquad \text{if } m = 9.$$

$$CF = \frac{C/2 + C/2\left(PVIFA_{3\%,2y}\right) + 1\left(PVIF_{8\%,2y}\right)}{(1+0.03)^{0.5}} - \frac{C}{4} \qquad \text{if } m = 3$$

In a T-bond or T-note future contract, the underlying asset is the cheapest-to-deliver (CTD) security. The short (seller) will be always interested in delivering such bonds whose invoice amount is greater than the market price by the largest margin. Because the party with short position receives- (Quoted future price × Conversion factor) + Accrued interest and the cost of purchasing a bond is:

Quoted price + Accrued interest

And the cheapest-to-deliver (CTD) bond is one for which

Quoted price – (Quoted future price × Conversion factor)

is minimum or the least.

In other words, CTD is that which maximizes inflows and minimises outflows for the short.

CTD = Max (Cash inflow – Cash outflow)

Or

CTD = Max[Invoice amount – (Spot price + Accrued interest)]

4.3.5 Euro Dollar Futures

Dollars deposited in foreign banks are known as Eurodollars. This practice was started in Europe to gain higher yield available on other instruments in US money market. The foreign banks offer attractive interest on deposits because of less regulation and control. The benchmark interest rate paid by foreign banks on Eurodollar deposits is the LIBOR (London inter Bank Offer Rate). These are short term interest rate future instruments and the first Eurodollar future contract was entered by IMM in Chicago in 1981. These are cash settled with quantity $ 1 million having delivery months of March, June, September and December. The value is calculated by Add-on-yield basis.

$$F = P\left[1+\left(LIBOR\frac{t}{360}\right)\right]$$

where, F = Future value, P = Present Value, t= time to maturity.

$$AOY = LIBOR = \frac{F-P}{P}\frac{360}{t}$$

For Eurodollar future, LIBOR is the future interest rate.

4.4 Duration

Two types of payments are made to a bond holder. Regular yield i.e. interest on fixed intervals and the value as redemption. The duration is the average time period the holder of the bond has to wait before receiving cash payments. In a zero coupon bond having n-years maturity, the duration is n-years because the payment are made after n years. In a coupon-bearing bond maturing in m years has a duration of less than m years, because the holder receives some of the cash payments before m years. The bond's price is influenced by the change in the interest rates. The duration is a measure of price sensitivity w.r.t. interest rate changes. In other words, a high duration bond's price is more sensitive to interest rate changes than the low duration bond. It is also defined as the weighted average as the maturities of the bond's coupon and the principal repayment cash flows.

Suppose a bond provides its holder cash flows c_i at time t_i $(1 \le i \le n)$. If yield (y) is continuously compounded then the price of the bond is given by

$$B = \sum_{i=1}^{n} C_i e^{-yt_i} \qquad \ldots (4.1)$$

The duration D, of the bond will be:

$$D = \frac{\sum_{i=1}^{n} t_i C_i e^{-yt_i}}{B} \qquad \ldots (4.2)$$

The equation (4.2) can be written as:

$$D = \sum_{i=1}^{n} t_i \left[\frac{c_i e^{-yt_i}}{B} \right] \qquad \ldots (4.3)$$

Here the bond price B is the AV of all cash payments. $C_i e^{-yt_i}$ is the *PV* of cash flow at time t_i. Hence duration is the weighted average of the times when payments are made, with the weight applied to time t_i being equal to the proportion of the bond's total present value provided by the cash flow at time t_i.

Now differentiating equation (4.1) w.r.t. y, we get:

$$\frac{\partial B}{\partial y} = -\sum_{i=1}^{n} C_i t_i e^{-yt_i} \qquad \ldots (4.4)$$

or $\frac{\partial B}{\partial y} = -BD$ [putting the value of B and D from equation 4.3]

For infinitesimally change in yield curve (δy) the bond's price will be changed as δB shown by following equation.

$$\frac{\delta B}{\delta y} = -BD \qquad \ldots (4.5)$$

or $$\frac{\delta B}{B} = -D\,\delta y \qquad \ldots (4.6)$$

Hence from relationship expressed by equation (4.6) it is clear that the percentage change in bond price is equal to duration multiplied by the change in yield.

Illustration 4.4: Assuming 8% bond with market price of $ 95 semi-annually payments with YTM 10% and time to maturity 2 years.

The duration D will be calculated as

$$D = \frac{1}{95}\left[\frac{1\times 4}{(1+0.05)^1} + \frac{2\times 4}{(1+0.05)^2} + \frac{3\times 4}{(1+0.05)^3} + \frac{4\times 4}{(1+0.05)^4} + \frac{4\times 100}{(1+0.05)^4}\right]$$

= 3.8282 years

Semi-annual coupon payments account for duration of 4 months and 10% YTM amounts to 5% after every 6 months.

Illustration 4.5: Consider a 3-year coupon bond with face value of $ 100 having yield 12% (Continuously compounding) i.e. y = 0.12. Coupon payments of $ 5 are made semi-annually. Then the following table gives duration of the bond.

TABLE 4.1

Years	**Cash flows ($)**	**PV**	**Weight**	**Time × Weight**
0.5	5	$5\,e^{-0.12\times0.5} = 4.709$	0.050	0.025
1.0	5	$5\,e^{-0.12\times1.0} = 4.435$	0.047	0.047
1.5	5	4.176	0.044	0.066
2.0	5	3.933	0.042	0.083
2.5	5	3.704	0.039	0.098
3.0	105	73.256	0.778	2.333
Total	**130**	**94.213**	**1.000**	**2.653**

Here 94.213 is the *PV* of the bond.

The weight in Col. 4 are derived by dividing 94.213 from each element in Column 3.

2.653 gives the duration of the bond.

Modified Duration: The above two illustrations give idea to calculate duration in annual compounding and continuous compounding.

A bond's modified duration is a measure of percentage change in a price relative to a given percentage change in the yield to maturity.

Suppose the yield in annual compounding then the equation (4.5) becomes:

$$\delta B = \frac{-BD\delta y}{(1+y)}.$$

And if y is expressed with a compounding frequency of t times per year then

$$\delta B = \frac{-BD}{1 + y/7}.$$

$$D_{mod} = \frac{D}{(1+y)} \qquad \ldots (4.7)$$

$$\therefore \ \delta B = -BD_{mod}\delta y \qquad \ldots (4.8)$$

Hence the modified duration is the relative price change with respect to change in yield.

In the above Table 4.1 the price of the bond is 94.213 and duration is 2.653. The view expressed in semi-annual compounding corresponds to 12.3673%. The modified duration will be:

$$D_{mod} = \frac{2.653}{(1+0.123673/2)} = 2.499$$

From equation (4.8)

$\delta B = -\,94.213 \times 2.499\ \delta y$

$\delta B = -\,235.39\ \delta y$.

If the yield increases by 20 basis points i.e. (0.2%), $\delta y = +\ 0.002$. The duration relationship gives

$\delta B = -235.39 \times (0.002) = -\ 0.47078$ such that the bond price goes down to

94.213–0.47078 = 93.7422.

The accuracy can be checked by applying the previous formula for annual compounding. Duration of bond portfolio is defined as a weighted average of the durations of the individual bonds in the portfolio, with the weights proportional to the bond prices.

4.5 Hedging with T-bond futures

Fixed interest bearing securities have risks associated with the volatile interest rate markets. Unfavourable interest rate change may lead to potential capital loss to the investors. Interest rate futures have been devised to offset these interest rate risks. Bond price is generally dependent and related to the bond futures. In case of expected increase in long term interest rate, the bond prices will fall and the holder would like to sell futures contracts to offset that risk. If a loss is inevitable due to declined value of the bonds, the investor gets compensation from the future position because he would be able to buy bond futures at a price lower than he sold. While considering a hedge, the hedge-should regress changes in the yield of the spot instrument being hedged on changes in *(a)* futures yield on T-bills futures *(b)* the futures yield for Eurodollar futures. If an investor holds a spot position that will experience losses if short-term interest rate rises (fall in prices of debt instruments), then this short hedger will sell short term interest rates futures contracts. If an investor holds a cash position that will experiences losses where short term interest rates fall, this long hedger will buy short term interest rate futures contracts.

Illustration 4.6: Suppose on a fund manager expects increase in long term interest rates and he fears that the value of bonds in his portfolio will be reduced. The Indian Government futures contract has a nominal value of Rs. 2,50,000 and price per contract is expressed in Rs. 100 nominal value. At long term interest rate of 6%, the following Table 4.2 gives the hedging profile.

TABLE 4.2: HEDGING WITH INTEREST RATE FUTURES

Cash/Spot market	Futures Market
June 10	June 10
Interest rate is 6% p.a.. The bond	Sells Sept 15, T-bond futures

portfolio of Rs. 1,00000 is vulnerable to increase in long-term interest rate.	contracts. Future price is 1000 reflecting 6% p.a. interest rate.
August 8	August 8
Long term interest rate rises to 71% p.a. The value of bond portfolio falls to Rs. 6500	Closes out by buying 4 futures bond contracts. The price of contra ct has fallen for 82.22 reflecting 7.5% p.a. futures interest rate
There is a loss of (1,00,0000-8,15,000) = Rs. 1,35,000 in the value of bond portfolio	There is a profit of Rs. 1,77,800 from the future position.

Net gain from futures position = (1,77,800 – 1,35,000) = Rs. 42,800.

Hedge Ratio: A good hedge is one in which losses in spot market are made up with gains in futures market. Hedge ratio is defined as the quantity of futures contracts used to be hedged and generating determined by comparing the relative price sensitivity to the future and cash instruments. This is based on the principle of dollar equivalency which dictates that-

$$\Delta V_s = h \Delta V_F \qquad \ldots (4.9)$$

where ΔV_s is change in the spot position or anticipated spot position if interest rates change by one basis point (0.01%).

ΔV_F is cash flow generated by the change in futures price of one future contract if interest rates change by one basis point. This relationship is based on the assumption that there exists a perfect positive correlation between interest rate on spot instrument and the future interest rates. However, it is possible that change in the interest rates on cash instrument being hedged do not correlate perfectly with change in interest rates of the chosen futures contract. The hedge may set up the relationship by regression using historical interest rate changes.

$$\Delta r_s = a + b\Delta r_F. \qquad \ldots (4.10)$$

where Δr_s is historical changes in interest rate of the cash instrument

Δr_F = Historical changes in the futures interest rates.

a, b = Regression coefficients

The hedger will be interested in seeking a relationship between yield changes in the spot and future markets.

Hence a hedge ratio is the ratio of the size of the position taken in futures contracts to the size of the exposure.

4.6 Summary

Fixed interest bearing securities are called bonds. There are two types of payments made to bond holders– the regular yield after a fixed interval in the form of interest and the value of the redemption of the bond. Further interest rates are of two types, long term and short term. Interest rate-futures are financial derivatives written on fixed income securities or instruments. Difference types of short term interest rate include treasury rates. LIBOR rate, repo rate, zero rate and forward rate. The interest rate risk and default risk are two risks related to non-payment of interest or principal amount. Term structure of interest rate are theories depicting volatility of debt instrument price and its maturity. Long term interest rate futures include 10 to 30 years maturity bonds issued by the Government known as T-notes and T-bonds. Bond's price is calculated by summing up the present values of coupon annuity and present value of face value of the same after maturity. The delivery process of T-bonds describes the systematic mechanism of the amount, price and time to deliver the bonds. The hedger use these bonds and take short or long position to compensate the losses arising out of falling bond prices. An important tool in this hedging process is the hedge ratio, which denotes the number of futures contracts made by comparing relative price sensitivities of futures and cash instruments. With the help of duration period and regression method, this hedge ratio can be calculated. Minimum hedge ratio is one that minimizes the variance of gains and losses on the hedged portfolio.

4.7 Keywords

Interest Rate Futures are the financial derivatives where the underlying asset is interest rate bonds.

T-bond Future Contract is a hypothetical treasury bond with 20 years to maturity and a 6% coupon.

T-Note Future is a note with 6½ to 10 years to maturity.

Cheapest to Deliver bond is a bond which the short seller choose to deliver, the futures price will reflect the spot price (s) of the bond that the market expects the short to select.

Duration of a bond is measure of its price sensitivity to interest rate changes.

Eurodollar Futures are the futures contracts with underlying as 'euro-dollars'.

4.8 Self assessment questions

1. Define interest rate futures. Discuss the features and types of short term and long term interest rate futures with suitable example.

2. Discuss various theories of term structure of interest rates with their significance.

3. Elaborate trading mechanism of T-bills futures with examples.

4. What are Eurodollar deposits? Explain the trading mechanism of euro dollar futures with illustration.

5. Explain the following terms in detail:
   a) Treasury rates
   b) Repo rates
   c) T-bonds vs. T-notes
   d) Duration of a bond
   e) Conversion factors
   f) Invoice calculation
   g) Implied repo rate

6. A six months interest rate is 12% p.a. and the three months interest rate is 8% p.a. Calculate the forward interest rate for the three months commencing three months from the presents.

7. Explain the delivery process of T-bond futures.

8. Elaborate the features of T-bond and T-notes futures.

9. How do you describe hedging mechanism with T-bond futures?

4.9 References/suggested readings

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Subject: **Financial Derivatives**	
Course Code: **FM-407**	Author: **Dr. Sanjay Tiwari**
Lesson No.: **5**	Vetter: **Prof. B.S. Bodla**
SWAP MARKETS	

Structure

5.0 Objectives

After going through this lesson you will be able to:

- Understand meaning, nature and types of financial swaps.
- Describe advantages of swaps.
- Identify and hedge risks involved in swap transaction.
- Evaluate the interest rate swaps.

5.1 Introduction

In the recent past, there has been integration of financial markets world-wide which have led to the emergence of some innovative financial instruments. In a complex world of variety of financial transactions being taken place every now and then, there arises a need to understand the risk factors and the mechanism to avoid the risks involved in these financial transactions. The recent trends in financial markets show increased volume and size of swaps markets. Financial swaps are an asset liability management technique which permits a borrower to access one market and then exchange the liability for another type of liability. Thus, investors can exchange one asset to another with some return and risk features in a swap market. In this lesson an attempt has been made to get the students acquainted with the mechanism of swaps markets and the valuation of the swap instruments.

5.2 Meaning of swaps

The dictionary meaning of 'swap' is to exchange something for another. Like other financial derivatives, swap is also agreement between two parties to exchange cash flows. The cash flows may arise due to change in interest rate or currency or equity etc. In other words, swap denotes an agreement to exchange payments of two different kinds in the future. The parties that agree to exchange cash flows are called 'counter parties'. In case of interest rate swap, the exchange may be of cash flows arising from fixed or floating interest rates, equity swaps involve the exchange of cash flows from returns of stocks index portfolio. Currency swaps have basis cash flow exchange of foreign currencies and their fluctuating prices, because of varying rates of interest, pricing of currencies and stock return among different markets of the world.

5.2.1 Features of swaps

The following are features of financial swaps:

Counter parties: Financial swaps involve the agreement between two or more parties to exchange cash flows or the parties interested in exchanging the liabilities.

Facilitators: The amount of cash flow exchange between parties are huge and also the process is complex. Therefore, to facilitate the transaction, an intermediary comes into picture which brings different parties together for big deal. These may be brokers whose objective is to initiate the counter parties to finalize the swap deal. While swap dealers are themselves counter partied who bear risk and provide portfolio management service.

Cashflows: The present values of future cash flows are estimated by the counterparties before entering into a contract. Both the parties want to get assurance of exchanging same financial liabilities before the swap deal.

Less documentation is required in case of swap deals because the deals are based on the needs of parties, therefore, less complex and less risk consuming.

Transaction costs: Generating very less percentage is involved in swap agreement.

Benefit to both parties: The swap agreement will be attractive only when parties get benefits of these agreements.

Default-risk is higher in swaps than the option and futures because the parties may default the payment.

5.2.2 Types of financial swaps

The swaps agreement provide a mechanism to hedge the risk of the counterparties. The risk can be- interest rate, currency or equity etc.

5.2.2.1 Interest rate swaps

It is a financial agreement to exchange interest payments or receipts for a predetermined period of time traded in the OTC market. The swap may be on the basis of fixed interest rate for floating interest rate. This is the most common swap also called 'plain vanilla coupon swap' which is simply in agreement between two parties in which one party payments agrees to the other on a particular date a fixed amount of money in the future till a specified termination date. This is a standard fixed-to-floating interest rate swap in which the party (fixed interest payer) make fixed payments and the other (floating rate payer) will make payments which depend on the future evolution of a specified interest rate index. The fixed payments are expressed as percentage of the notional principal according to which fixed or floating rates are calculated supposing the interest payments on a specified amount borrowed or lent. The principal is notional because the parties do not exchange this amount at any time but is used for computing the sequence of periodic payments. The rate used for computing the size of the fixed payment, which the financial institution or bank are willing to pay if they are fixed rate payers (bid) and interested to receive if they are floating rate payers in a swap (ask) is called fixed rate. A US dollar floating to fixed 9-year swap rate will be quoted as:

8 years Treasury (5.95%) + 55/68.

It means that the dealer is willing to make fixed payments at a rate equal to the current yield on 8-years T-note plus 55 basic points (0.55%) above the current yield on T-note (i.e. 5.95 + 0.45 = 6.40%) and willing to receive fixed rate at 68 basis points above (i.e. 5.95 + 0.68 = 6.63%) the Treasury yield. Another example to understand the concept: Suppose a bank quotes a US dollar floating to a fixed 6-years swap rate as:

Treasury + 30 bp/Treasury + 60 bp vs. six months LIBOR

Here this quote indicates that the bank is willing to pay fixed amount at a rate equal to the current yield on 6-years T-note plus 30 basis point (0.30%) in return for receiving floating payments say at 9 six months LIBOR. The bank has offered to accept at a rate equal to 6-year T-note plus 60 bp (0.60%) in return for payment of six-month LIBOR. Similarly floating rate is one of the market indices such as LIBOR, MIBOR, prime rate, T-bill rate etc. and the maturity of the underlying index equal the time period/interval between payment dates.

The fixed rate payments are normally paid semi-annually or annually e.g. example March 1 and Sept. 1. On trade date the swap deal is concluded and the date from which the first fixed and floating payments start accruing is known as Effective Date. For example, a 5-year swap is traded on Aug 30, 2006, the effective date may be Sept 1, 2006 and ten payments dated from March 2007 to Sept 1, 2011. Floating rate payments in a standard swap are October in advance paid in arrears, i.e. the floating rate applicable to any period is fixed at the start of the period but the payments occur at the end of the period. There are three dates relevant to the swap floating payments. D (s) in the setting date at which the floating rate applicable for the next-payment is set. D (1) is the date from which the next floating payment starts to accrue and D (2) is the date on which payment is due. Fixed and floating rate payments are calculated as:

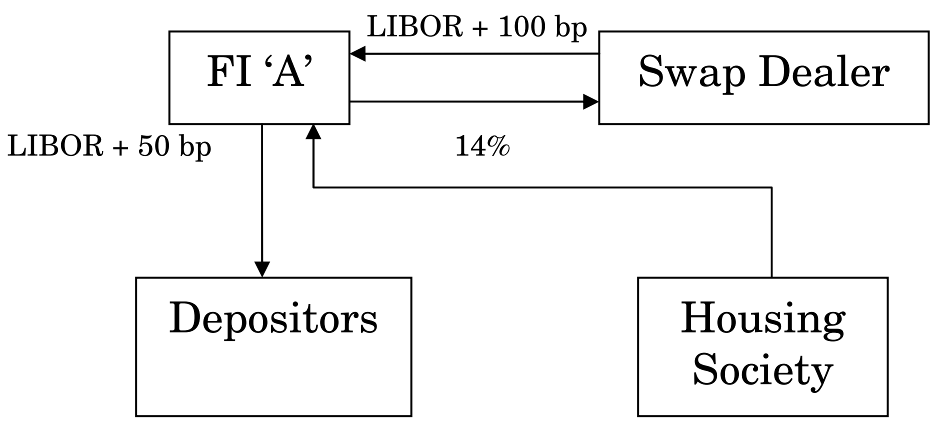
Fixed payment = $P \times R_{fx} \times F_{fx}$

Floating payment = $P \times R_{fl} \times F_{fl}$

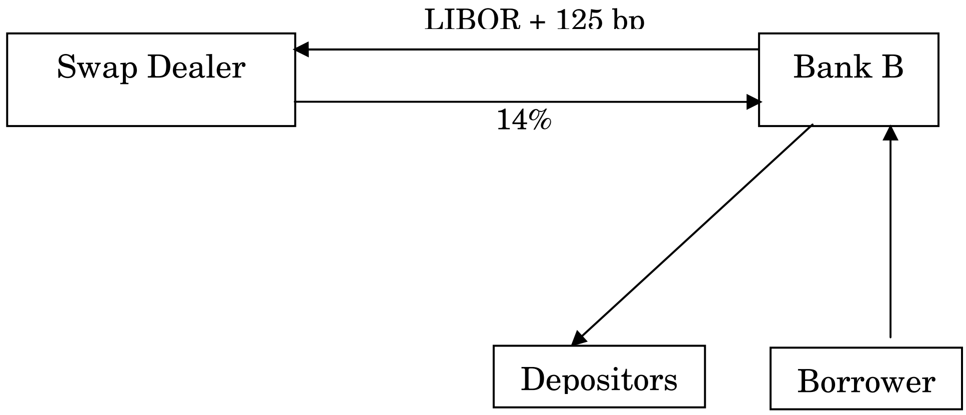
Where P = Notional principal, R_{fx} is the fixed rate R_{fl} is the floating rate set on reset date. F_{fx} is "fixed rate day count fraction" and F_{fl} is "floating rate day count fraction". No calculate interest, the last two time periods are taken. For floating payments in is $(D_2 - D_1)/360$. Hence in a swap only interest payments are exchanged and not the notional principal.

Illustration 5.1: Suppose a financial institution gives 50 bp higher on floating interest rate (LIBOR) on its deposits and pays floating interest rate to housing society at a fixed rate of 14%. To hedge against the risk involved due to non-payment of interest to the depositor, it enters into a swap agreement with a dealer and makes that it will receive from the dealer G floating rate (LIBOR) + 100 bp and will pay 14% fixed interest on the same notional amount. In this process the financial institution gets a profits of (0.5%) on notional amount. The dealer enters into another swap contract with a bank with whom it agrees to pay a (LIBOR + 125 bp) and receives 14% interest on notional principal. In this way, every participant gets profit due to this swap transaction which can be shown by the following diagram:

CASE-I

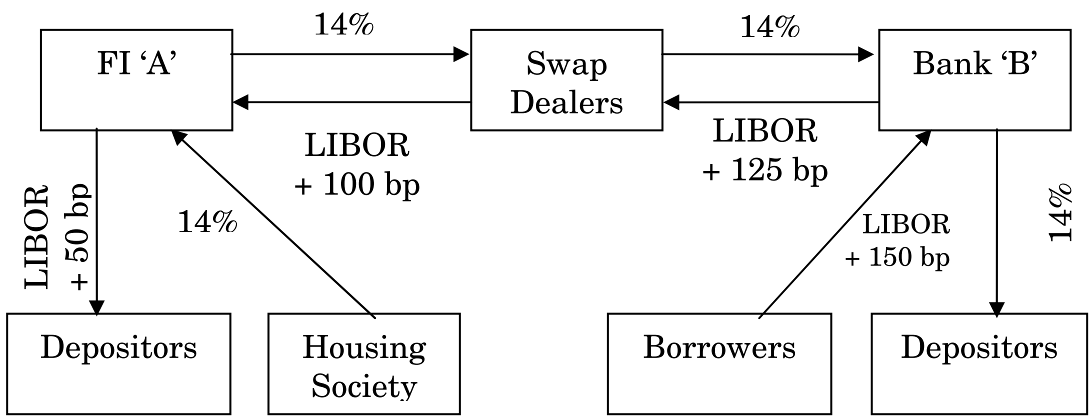


CASE-II



If both the cases are merged in a single case

CASE-III



From the above figure it is clear that the profit to FI 'A' is 50 bp (0.50%), to the bank 'B' is (0.25%) and to the swap dealer it is (1.25%).

There are various types of interest rate swaps. Zero coupon to floating swaps, the fixed rate payer makes a bullet payment at the end and floating rate payer makes periodic payments. Alternative floating rate type swap include alternative floating rates e.g. 3-month LIBOR, 1-month CP, T-Bill rate etc. which are charged to meet the exposure of other party. In a floating to floating swap, one party pays one floating rate and the other pays another floating. Forward swaps include exchange of interest rate payments that do not begin until a predetermined future date in time. In a swaption, the features of swaps and options are combined together. The buyer of a swaption has the right to enter into an interest rate agreement by some specified time period and in case the buyer exercises the option, the writer will become the counterparty. In a swaption agreement it is clearly written that either the buyer should pay fixed rate or floating rate. A call swaption provides the party paying fixed payment the right to terminate the swap to maturity, thereby making the writer fixed payer and floating receiver. In a put swaption, the writer has the right to terminate the swap to the party making floating payments, thereby making the writer of the put swaption as floating rate receiver and fixed rate payer. Equity swap involves the exchange of interest payment linked to the stock index.

Illustration 5.2: Suppose party 'A' enters into a three-year fixed to floating interest rate swap with party 'B' on the following terms:

Notional Principal is $ 3000000. Let's assume that party 'A'; pays on a semi-annual basis at 6% rate of interest and receives from party 'B' LIBOR + 25 basic points. The LIBOR at present is 5.75% p.a.

Amount to be paid as per fixed rate: Since the payment is after every 6 months the interest payment will be:

(Notional principal) (Days in Period/360) (Intt. Rate/100)

$$= \$\ 30{,}00{,}00{,}00\ (182/360)\left(\frac{6.00}{100}\right)$$

= $ 909900

Amount to be paid as floating rate. The interest is

$$30000000 \times \frac{182}{360} \times \frac{5.75}{100} = \frac{0.5055 \times 0.0575}{100000000} = \$\ 769623.75$$

Assuming there are 182 days in a period.

5.3 Currency swaps

In these types of swaps, currencies are exchanged at specific exchange rates and at specified intervals. The two payments streams being exchanged are dominated in two different currencies. There is an exchange of principal amount at the beginning and a re-exchange at termination in a currency swap. Basic purpose of currency swaps is to lock in the rates (exchange rates). As intermediaries large banks agree to take position in currency swap agreements. In a fixed to fixed currency rate, one party raises funds in currency suppose 'pounds' and the other party raises the funds at fixed rate in currency suppose US dollars. The principal amount are equivalent at the spot market exchange rate. In the beginning of the swap contract, the principal amount is exchanged with the first party handing over British Pound to the second, and subsequently receives US dollars as return. The first party pays periodic dollar payment to the second and the interest is calculated on the dollar principal while it receives from the second party payment in pound again computed as interest on the pound principal. At maturity the British pound and dollar principals are re-exchanged on a fixed-to-floating currency swaps or cross-currency-coupon swaps, the following possibilities may occur:

(a) One payment is calculated at a fixed interest rate while the other in floating rate.

(b) Both payments on floating rates but in different currencies.

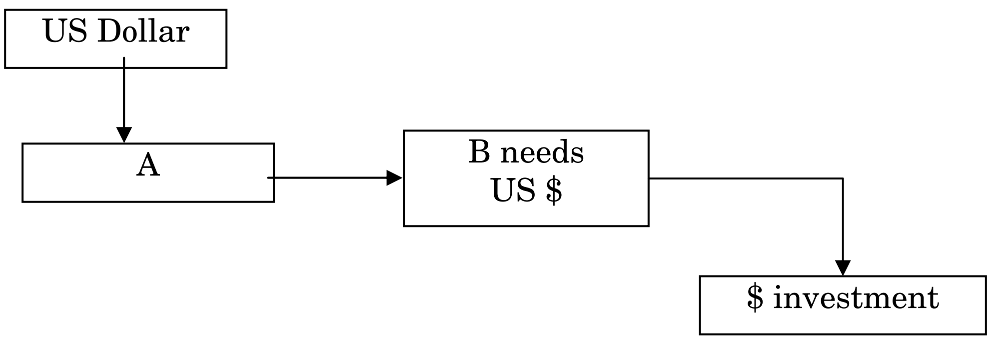
(c) There may be contracts without and with exchange and re-exchange of principals.

The deals of currency swaps are structured by a bank which also routes the payments from one party to another. Currency swaps involve exchange of assets and liabilities. The structure of a currency swap agreement can be understood with the help of the following illustration. Suppose a company 'A' operating in US dollar wants to invest in EUR and the company 'B' operating in EUR wants to invest in US dollars. Since company 'A' having revenue in EUR and both have opposite investment plans. To achieve this objective, both the companies can enter into a currency swap agreement. The following structure describes the investment plans of the company A and B.

FIG. 5.1: SHOWING SWAP REALISATION OF EUR INVESTMENTS

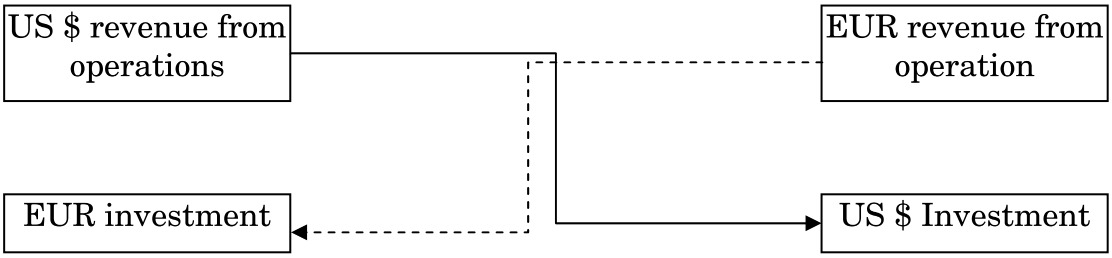
CASE-I

CASE-II



If two cases are joined together, then the swap has the following structure:

CASE-III



Currency swaps can be categorized as follows:

Fixed to fixed currency swaps: In this swap agreement the currencies are exchanged at a fixed rate. A fixed to floating currency swap involves the combinations of a fixed-to-fixed currency swap and floating swap. One party pays to the another at a fixed rate in currency say 'A' and the other party makes the payment at a floating rate in currency say 'B'. In a floating-to-floating swap the counter parties will have payment at floating rate in different currencies.

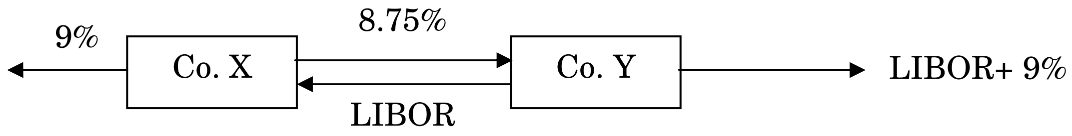
Illustration 5.3: Suppose two companies X and Y want to borrow Rs. 12 crore for 6 years. The company Y wishes to arrange a floating loan. The interest in LIBOR semi-annually paid. The following are terms and conditions:

	Fixed Rate	Floating Rate
Company X	9.00%	Six month LIBOR + 25 bp
Company Y	10.00%	Six month LIBOR + 30 bp

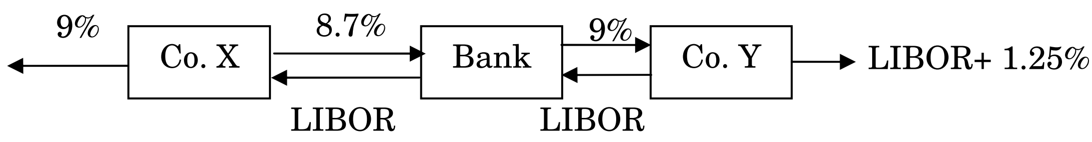
Show these transactions with and without intermediary.

Solution: The company X borrows at fixed rate of 9%, the company Y borrows at floating rate of (LIBOR + 0.25%). They enter into a swap agreement.

Case I: Swap if there is no intermediation.



Case II: Swap with intermediation



5.4 Valuation of swaps

The value of a swap depends upon so many factors such as the nature of swap, interest rate risks, expiry time, value at expiration, fixed and floating rates of interest, the principal amount and many more. Let's discuss the valuation aspect of an interest rate swap.

5.4.1 Valuation of interest rate swap

At the initiation stage the worth of an interest swap is zero or nearly zero. With the passage of time, this value may be positive or negative. The fixed rate interest swap is valued by treating the fixed rate payments as cash flows on a traditional bond and the floating rate swap value is quite equivalent to a floating rate note (FRN). If there is no default risk, the value of an interest swap can be computed either as a long position in one bond combined with a short position in another bond or as a portfolio of forward contracts. Since in a swap agreement the principal is not exchanged. Some financial intermediaries act as market makers and they are ready to quote a bid and an offer for the fixed rate which they will exchange for floating. The bid is the fixed rate in a contract where the market maker will pay fixed and receive floating while the offer rate in a swap the market maker will receive fixed and pay floating. These rates are quoted for the number of maturities and number of different currencies. The following table 5.1 shown an illustration of the quotes where payments are exchanged semi-annually.

TABLE 5.1: BID AND OFFER RATES IN A SWAP MARKET AND SWAP RATE (%AGE PER ANNUAL)

Maturity (No. of years)	**Bid (%)**	**Offer (%)**
2	5.03	5.06
3	5.21	5.24
4	5.35	5.39
5	5.47	6.51
6	5.65	5.68
10	5.83	5.87

Here the bid offer spread is 3-4 basis points. Usually the banks and financial institutions discount the cash flows in the OTC market at LIBOR rate of interest. Hence, the valuation of the interest swap is done by calculating fixed rate payments being equal to cash flows on conventional bond and the floating rate payment as being equivalent to a floating rate note.

The value of the swap can be expressed as the value of fixed rate bond and the value of the floating rate underlying the swap. The value of swap to a company receiving floating and paying fixed.

$$V_{swap} = B_0 - B_1 \qquad (5.1)$$

Where V_{swap} is the value of the swap. B_0 is the value of floating rate underlying and B_1 is the value of the fixed rate bond underlying the swap. Therefore, from equation (5.1) it is obvious that the value of interest rate swap is dependent on the value of fixed interest rate bond and floating interest rate bonds. The discount rate used reflect the riskiness of cash flows. Generally the fixed rate interest cash flows have almost similar risk as the floating rate flows. This is so because in case of one party making default, the other will terminate the contract and will stop the payments. The value of B_0 and B_1 can be calculated as:

$$B_1 = \sum_{i=1}^{n} Ke^{-r_i t_i} + Pe^{-r_n t_n} \qquad (5.2)$$

where e = constant, B_1 = Value of the floating rate bond, t_i is the time until i^{th} $(1 \leq i \leq n)$ payments are exchanged, P is the notional principal in swap contract, r_i is the LIBOR zero rate corresponding to maturity t_i and k is the fixed payment made on each payment date.

Supposing that the floating rate bond immediately after payment date becomes floating rate bond. It follows that B_0 = P immediated after a payment date. Just before the next payment date, B_0 = P + k*, where k* is the floating rate payment (already known) that will be made on next payment date. For time t_1 the value of swap today will be its value just before the next payment date discounted at rate r_1 and for time t_1.

$$B_0 = (P + k^*)e^{-r_1 t_1}$$

Illustration 5.4: Let us assume that a bank agrees to pay six month LIBOR and receives 10% p.a. (with semi-annual compounding) on a notional principal of \$ 100 million. The remaining life of swap is 1.5 years. Fixed rate of interest with continuous compounding for 3 months, 9 months and 15 months maturities are 11%, 11.5% and 12% respectively. The six months LIBOR (9% the last payment date was 10.2% with semi-annual compounding. Also assuming in this example.

k = \$ 5 million, k* = \$ 6 million.

$B_0 = 5e^{-0.11 \times 3/12} + 5e^{-0.75 \times 9/12} + 100\ e^{-1.50 \times 15/12}$

$B_1 = 6e^{-0.11 \times 3/12} + 100e^{-0.11 \times 3/12}$

5.4.2 Valuation of a currency swap

The currency swaps can be valued as the difference between the present values of the conventional bonds. The computation of a currency swap is just equivalent to the valuation of interest rate swaps. Suppose that there is no default risk and S* is the spot exchange rate (expressed as the number of units of domestic currency per unit of a foreign currency), the value of the currency swap will be given by:

$$V_{cusw} = S^*B_f - B_d \qquad \ldots (5.2)$$

Where V_{cusw} is the value of currency swap, B_f is the value of foreign currency bond (foreign currency) and B_d is the value of domestic currency bond underlying the swap.

In this case the valuation of currency swap can be done based on term structure of interest rates in domestic currency, term structure of interest in foreign currency and the spot exchange rate. The value of bond equivalent to the foreign currency interest flows has the value as:

$$B_f = \sum_{i=1}^{n} k_f e^{r_i^f t_i} + Pe^{-r_n^f t_n} \qquad \ldots (5.3)$$

Where k_f is the foreign currency interest flows, r^f is the foreign currency discount rate, t_i is the corresponding time periods to the interest payments and P is the principal sum in foreign currency. Similarly, the bond equivalent to the domestic currency cash flow be determined as follows:

$$B_d = \sum_{i=1}^{n} k_d e^{-r_i^d t_i} + S'Pe^{-r_n^d t_n} \qquad \ldots (5.4)$$

where k_d is the fixed foreign currency interest payments, r_i^d is the discount rate for various periods to cash flow, t_i is the length of those time periods to cash flows, S' is the exchange rate at the time of contract entry and P is the principal expressed in foreign currency converted into equivalent domestic currency principal.

Illustration 5.5: Suppose there is flat term structure in India and US. The US rate is 4% p.a. and Indian rate is 9% p.a. (both with continuous compounding). A financial institution enters into a swap agreement where it receives 8% p.a. on Indian Rupees and 5% p.a. on US dollar annually. The principal sums in Indian and US currencies are Rs. 10 million and $ 1200 million. The spot exchange rate is $ 110 = Rs. 1 with time period of 3 years. Calculate the value of this currency swap:

Solution: Here $B_d = 0.8\, e^{-0.09 \times 1} + 0.8e^{-0.09 \times 2} + 10\, e^{-0.09 \times 3}$ = Rs. 9.64 m

$B_f = 60\, e^{-0.04} + 60\, e^{-0.04 \times 2} + 1260\, e^{-0.04 \times 3}$ = $ 1230.55 m

Hence the value of this currency swap

$V_{cusw} = S^*B_d - B_f$

$$= \frac{1230.55}{110} - \text{Rs. } 9.64 = \text{Rs. } 1.55 \text{ million}$$

In addition to conventional swap, another market of swap has emerged in the recent years i.e. debt-equity swap. In a debt-equity swap agreement one firm purchased a country's debt in the secondary market at a discount and swap into local equity. To have more understanding of this concept suppose an MNC wants to invest in France, will hire a bank to buy French Franc in the secondary market. Again the loan through an intermediary presents the loans suppose denominated in dollars to a local bank, which redeems these for French Franc currency.

5.5 Rationale behind swapping

To avoid risk of fluctuation in forex, interest rates, stock indices investors attitude etc. the swap market has merged now to explain that why firms and people want to enter into swap agreement. The rationale can be explained by the following points:

- Market in perfection and inefficiency
- Different risk preferences
- Government regulation
- Funding at low cost
- Demand supply imbalance
- To improve financial records

Imperfect market: As you know that the swap agreements are meant for transforming financial claims to reduce risk. Since there lie different reasons for the growth in swap market and the most important to the imperfection and inefficiency in the markets. The swap agreements are required in order to investigate market imperfections, difference of attitude of investors, information asymmetry, tax and regulatory structure by the government, various kinds of financial norms and regulations etc. Had there been a uniformity of standards and norms and perfect market conditions, swaps could not have generated much enthusiasm. Hence due to imperfect capital market conditions, swaps give opportunity to the investors for hedging the risk.

Differing risk profiles: The basis of credit rating of bonds by financial institutions, banks and individual investor is quite different. In other words, the computation of risks are different from point of view of individual, institutional and other types of investor, thereby changing the risk profile. Based on this, the investor has to take decision to hedge, speculate or arbitrage opportunity. In some markets, the company can raise funds at lower cost and can swap for a particular market. A low credit rated firm can raise funds from floating rate credit market and enjoy comparative advantage over highly rated company because it pay a smaller risk premium. The differing interest rates in different markets can be arbitraged and disbursed between the counterparties.

Regulation by govt: The regulatory practices of government of different nations can make attractive or unattractive the swap markets. Sometimes the government restricts the funding by foreign companies to protect the interest of the domestic investors. It may also happen that to attract foreign companies the government opens the domestic markets. This phenomenon of the government rule and regulations influence the growth of swap agreements.

Funding at low cost: In some businesses suppose export financing, there exists subsidised funding and currency swap agreements can take advantage of this situation. The company can swap the exchange risk by entering into a favourable currency swap.

Demand and supply forces: Depending on the needs of the country and its development plans, the central bank squeeze the reserve requirements thereby increasing the supply of the funds because of resultant lowering of interest rates. Definitely the borrowers will be interested in those markets where there is a sufficient supply of funds. Thus the borrowers can take arbitrage opportunity in his favour due to different economic conditions prevailing in those countries.

Asset-Liability matches: The counterparties involved in swap sometimes desire to make the match between asset and liability. For this purpose they take the help of swap and funds can be tapped as per the requirements of the companies.

Therefore, differing rates of interests in different markets and overtime changes in the same provide arbitrage opportunities which can be tapped by the currency swap agreements.

5.6 Summary

Swap is an agreement or contract between two parties to exchange cash flows or payments. This is basically a funding technique where the borrower swaps one liability for another liability. Due to differing capital market conditions and differing needs of the companies, the swap market has gained momentum. The features of a swap market include: exchange of periodic payment of cash flows between two parties, arrangement of the swap by an intermediary usually a bank, low transaction cost and termination only by both.

There are two types of swaps: interest rate swaps and currency swap. Interest rate swap agreements are the contracts between two parties to exchange cash flows arising out of payments or receipts of the interest rates in same currency. In notional principal basis of swap there is only the exchange between the interest and no exchange of principal amount. Interest rate swaps can be further classified as: plain vanilla swap, zero coupon to floating, floating to floating, forward swap, swaptions, equity swap etc. On the other hand currency swap has the feature of exchange of cash flows arising out of exchange rate differential between two currencies. There is an exchange of principal amount at maturity at a predetermined rate. This can be of different types like: fixed-to-fixed, floating-to-floating, fixed-to-floating etc. The valuation of interest swaps can be done by taking the difference of the values of fixed rate bond and the value of the floating rate bond underlying the swap. The currency swaps can be valued as the difference between the present values of two conventional bonds. In other words, the currency swap can be valued from the term structure of interest rates in domestic currency and term structure of interest in foreign currency and the spot-exchange rate.

5.7 Keywords

Swap is a financial agreement which exploit arbitrage opportunity between two markets and in which two counterparties agree to exchange stream of cash flows over a time according to a predetermined rule.

Swaption is an option on interest rate swap where buyer of the swaption has a right to enter into an interest rate swap by some specified date in future. The swaption agreement will specify whether the buyer of the swaption will be fixed-rate receiver or a fixed-rate payer.

Interest rate swap is a contract in which two parties agree to swap interest payment for a pre-determined period of time-traded in over the counter market.

Equity swap is the swap in which the exchange of one of the cash streams is derived from equity instrument.

LIBOR refers to London Inter Bank Offer Rate at which a bank is willing to lend to other bank on Euro-currency deposits.

5.8 Self Assessment Questions

1. Define a swap agreement. Also discuss its main features.

2. Discuss various reasons for the growth of financial swaps.

3. What are the types of swaps? Explain the major characteristics of interest rate swaps with suitable illustrations.

4. What are currency swaps? Discuss various features and types of currency swaps with suitable examples.

5. Explain various factors affecting the valuation of swaps. How will you calculate the value of interest rate swap?

6. "The valuation of currency swaps is different from valuation of interest rate swaps". Do you agree? If yes, please explain the reason.

7. Assume that a company in India want to borrow in British pound market at a fixed rate of interest. Another company in Britain wishes to borrow Indian Rupee at a fixed interest rates as follows:

	Pound sterling	Rs.
Company in India	10%	8.50%
Company in Britain	9.5%	7.5%

How will you design a swap agreement; having intermediary as a bank, 10 basis point p.a. which produces a gain of 15 points p.a. for each of two companies.

8. Write notes on the following:
   (a) Putable swap
   (b) Debt-equity swap
   (c) Plain vanilla swap
   (d) Currency swap
   (e) Floating-to-floating swap
   (f) Features of swap agreements

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Subject: **Financial Derivatives**	
Course Code: **FM-407**	Author: **Dr. Sanjay Tiwari**
Lesson No.: **6**	Vetter: **Prof. B.S. Bodla**
OPTION MARKETS	

Structure

6.0 Objectives

After going through this lesson you will be able to:

- Understand the concept of options
- Know the features and types of options
- Differentiate between futures and options
- Know valuing aspect of options
- Understand and calculate the pay-offs from an option
- Explain the features and types of currency option.
- Discuss the factors affecting pricing of currency option.
- Elaborate futures and options trading systems.

6.1 Introduction

The options are important financial derivatives where the instruments have additional features of exercising an option which is a right and not the obligation. Hence, options provide better scope for risk coverage and making profit at any time within the expiration date. The price of the underlying is also derived from the underlying asset. Options are of different types. Some are related to stock index, some with currency and interest rates. During the last three decades the option trading gained momentum though the first option in commodity was launched in 1860 in USA. Based on the sale and purchase there are two types of options: put and call. The exercise-time of an option makes it in American or European. The other category of option includes- over the counter (OTC) or exchange traded. Options can be valued either with the help of intrinsic value or with time value. There are two positions in option trading- long and short position. More detail about the option strategy to go long and short are given in the lesson 8 of the booklet.

The description on pricing aspect of option is available in lesson 7 of this booklet.

6.2 Options: An introduction

Option may be defined as a contract between two parties where one gives the other the right (not the obligation) to buy or sell an underlying asset as a specified price within or on a specific time. The underlying may be commodity, index, currency or any other asset. As an example, suppose that a party has 1000 shares of Satyam Computer whose current price is Rs. 4000 per share and other party agrees to buy these 1000 shares on or before a fixed date (i.e. suppose after 4 month) at a particular price say it is become Rs. 4100 per share. In future within that specific time period he will definitely purchase the shares because by exercising the option, he gets Rs. 100 profit from purchase of a single share. In the reverse case suppose that the price goes below Rs. 4000 and declines to Rs. 3900 per share, he will not exercise at all the option to purchase a share already available at a lower rate. Thus option gives the holder the right to exercise or not to exercise a particular deal. In present time options are of different varieties like- foreign exchange, bank term deposits, treasury securities, stock indices, commodity, metal etc. Similarly the example can be explained in case of selling right of an underlying asset.

6.3 Features of options

The following features are common in all types of options.

- **Contract:** Option is an agreement to buy or sell an asset obligatory on the parties.
- **Premium:** In case of option a premium in cash is to be paid by one party (buyer) to the other party (seller).

- **Pay off:** From an option in case of buyer is the loss in option price and the maximum profit a seller can have in the options price.
- **Holder and writer** Holder of an option is the buyer while the writer is known as seller of the option. The writer grants the holder a right to buy or sell a particular underlying asset in exchange for a certain money for the obligation taken by him in the option contract.
- **Exercise price** There is call strike price or exercise price at which the option holder buys (call) or sells (put) an underlying asset.
- **Variety of underlying asset** The underlying asset traded as option may be variety of instruments such as commodities, metals, stocks, stock indices, currencies etc.
- **Tool for risk management** Options is a versatile and flexible risk management tools which can mitigate the risk arising from interest rate, hedging of commodity price risk. Hence options provide custom-tailored strategies to fight against risks.

6.4 Types of options

There are various types of options depending upon the time, nature and exchange of trading. The following is a brief description of different types of options:

- Put and call option
- American and European option
- Exchange traded and OTC options.

Put option is an option which confers the buyer the right to sell an underlying asset against another underlying at a specified time on or before a predetermined date. The writer of a put must take delivery if this option is exercised. In other words put is an option contract where the buyer has the right to sell the underlying to the writer of the option at a specified time on or before the option's maturity date.

Call option is an option which grants the buyer (holder) the right to buy an underlying asset at a specific date from the writer (seller) a particular quantity of underlying asset on a specified price within a specified expiration/maturity date. The call option holder pays premium to the writer for the right taken in the option.

American option provides the holder or writer to buy or sell an underlying asset, which can be exercised at any time before or on the date of expiry of the option. On the other hand a European option can be exercised only on the date of expiry or maturity.

This is clear that American options are more popular because there is timing flexibility to exercise the same. But in India, European options are prevalent and permitted.

Exchange traded options can be traded on recognized exchanges like the futures contracts. Over the counter options are custom tailored agreement traded directly by the dealer without the involvement of any organized exchange. Generally large commercial bankers and investment banks trade in OTC options. Exchange traded options have specific expiration date, quantity of underlying asset but in OTC traded option trading there is no such specification and terms are subjective and mutually agreed upon by the parties. Hence OTC traded options are not bound by strict expiration date, specific limited strike price and uniform underlying asset. Since exchange traded options are guaranteed by the exchanges, hence they have less risk of default because the deals are cleared by clearing houses. On the other side OTC options have higher risk element of default due to non-involvement of any third party like clearing houses. Offsetting the position by buyer or seller in exchange traded option is quite possible because the buyer sells or the seller buys another option with identical terms and conditions. Hence, the rights are transferred to another option holder. But due to unstandardized nature of OTC traded options the OTC options cannot be offset. Margin money is required by the writer of option but there is no such requirement for margin funds in OTC optioning. In exchange traded option contracts, there is low cost of transactions because the creditworthiness of the buyer of options is influencing factor in OTC-traded options.

6.5 Distinction between futures and options

Though both futures and options are contracts or agreements between two parties, yet there lies some point of difference between the two. Futures contracts are obligatory in nature where both parties have to oblige the performance of the contracts, but in options, the parties have the right and not the obligation to perform the contract. In option one party has to pay a cash premium (option price) to the other party (seller) and this amount is not returned to the buyer whether no insists for actual performance of the contract or not. In future contract no such cash premium is transferred by either of the two parties. In futures contract the buyer of contract realizes the gains/profit if price increases and incurs losses if the price falls and the opposite in case of vice-versa. But the risk/rewards relationship in options are different. Option price (premium) is the maximum price that seller of an option realizes. There is a process of closing out a position causing ceasation of contracts but the option contract may be any number in existence.

6.6 Valuing an option

The value of option can be determined by taking the difference between two or if it is not exercised then the value is zero. The valuation of option contract has two components: intrinsic value and time value of options.

6.6.1 Intrinsic value of option

Let's understand the cases when to exercise an option and when not exercise it. In case of a call option the buyer of call will exercise the option if the strike/exercise price (x) is less than the current market (spot price) while a seller will do differently. Similar case is with writer of an option. The seller (writer) will exercise the option if the strike price (X) is higher than the current (spot) price. The following Table 6.1 show these cases. Suppose X is exercise price and S is spot current market price.

TABLE 6.1

Call option	Exercise/not exercise	Put option	Exercise/not exercise
If X > S	Not exercise	If X > S	Exercise
If X < S	Exercise the option	If X < S	Not exercise the option

The intrinsic value of an option is called fundamental or underlying value. It is the difference between the market/spot/current price and the strike price of the underlying asset. For a call option, it can be calculated as follows:

Max [(S-X), 0] where S is the current/spot price and X is the exercise/strike price of the underlying asset and as clear from the above Table 6.1, the option holder will exercise the option if the exercise price is less than the current market price i.e. if $S > X$ or $X < S$. The difference between S and X will be positive and this is known a positive intrinsic value and in case if $s = X$ then the intrinsic value is zero. In any case it cannot be negative because then the holder will not exercise the option.

Similarly the intrinsic value of a put option is the difference as shown:

Max [(X-S), 0] If $X > S$ or $S > X$ then the writer will exercise the option. In case of equal values of X and S the intrinsic value will be zero. There is no negative value of a put because the writer will not exercise his right to sell an underlying if the exercise price is less than the market price.

Further an option is said to be in-the-money if the holder (writer) gets the profit if the option is immediately exercised. The option is said to be out of the money if it gives loss when exercised immediately. If the current/spot price is equal to the strike price the option becomes at-the-money.

6.6.2 Time value of an option

As you know that an American option can be exercised any time before the expiration date, there lies a probability that the stock price will fluctuate during this period. It is the time at which the option holder should exercise the option.

Suppose an option holder wants to exercise his option right at a particular time t, because at that time he thinks that it is profitable to exercise the option. Hence, the difference between the value of option at time suppose 't' and the intrinsic value of the option is known as time value of the option. Now there are various factors which affect the time value as follows:

- Stock price volatility
- The time remaining to the expiration date
- The degree to which the option is in-the-money or out of the money.

In other words, the time value of an option is the difference between its premium and its intrinsic value. The maximum time value exists when the option is At the Money (ATM). The longer the time to expiry, the greater is an option's time value. At expiration date of an option, it has no (zero) time value.

For better understanding let's assume that X is the exercise price and S is the stock current price. Suppose this is a case of a call, where the holder will exercise only when S > X.

Before expiration, the time value of a call will be

Time value of a call = C_t – {Max [0, S-X]}.

C_t is the premium of a call.

Similarly, for a put the time value will be

Time value of put = P_t – {Max [0, X-S]}

Where P_t is the premium of a put option.

6.7 Pay-off for options

The optionality characteristic of options results in a non-linear payoff for options. In simple words, it means that the losses for the buyer of an option are limited, however the profits are potentially unlimited. The writer of an option gets paid the premium. The payoff from the option writer is exactly opposite to that of the option buyer. His profits are limited to the option premium, however his losses are potentially unlimited. These non-linear payoffs are fascinating as they lend themselves to be used for generating various complex payoffs using combinations of options and the underlying asset. We look here at the four basic payoffs.

6.7.1 Payoff for buyer of call options: Long call

A call option gives the buyer the right to buy the underlying asset at the strike price specified in the option. The profit/loss that the buyer makes on the option depends on the spot price of the underlying. If upon expiration, the spot price exceeds the strike price, he makes a profit. Higher the spot price, more is the profit he makes. If the spot price of the underlying is less than the strike price, he lets his option expire un-exercised. His loss in this case is the premium he paid for buying the option. Figure 6.1 gives the payoff for the buyer of a three month call option on gold (often referred to as long call) with a strike of Rs. 7000 per 10 gms, bought at a premium of Rs. 500.

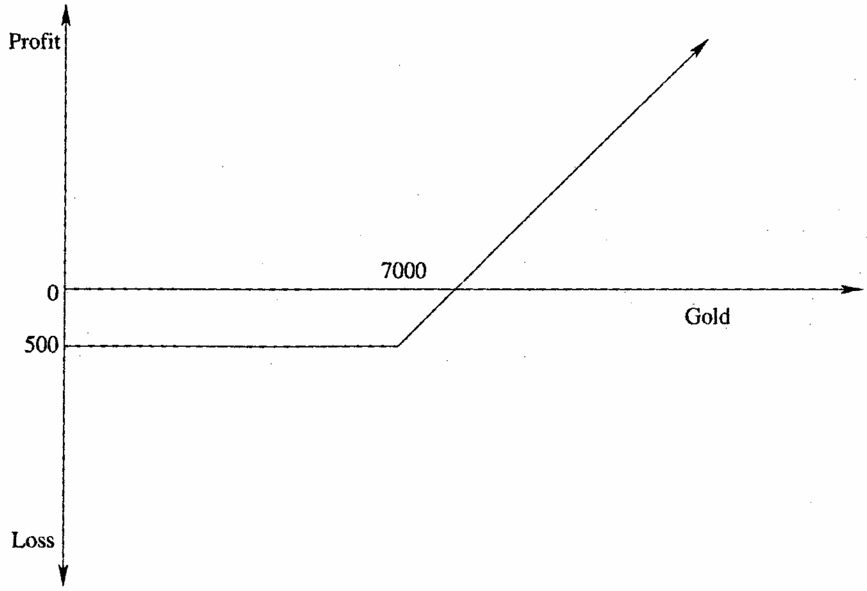

FIGURE 6.1: PAYOFF FOR BUYER OF CALL OPTION ON GOLD

The figure shows the profits/losses for the buyer of a three-month call option on gold at a strike of Rs. 7000 per 10 gms. As can be seen, as the prices of gold rise in the spot market, the call option becomes in-the-money. If upon expiration, gold trades above the strike of Rs. 7000, the buyer would exercise his option and profit to the extent of the difference between the spot gold-close and the strike price. The profits possible on this option are potentially unlimited. However if the price of gold falls below the strike of Rs. 7000, he lets the option expire. His losses are limited to the extent of the premium he paid for buying the option.

6.7.2 Payoff for writer or call options: short call

A call option gives the buyer the right to buy the underlying asset at the strike price specified in the option. For selling the option, the writer of the option charges a premium. The profit/loss that the buyer makes on the option depends on the spot price of the underlying. Whatever is the buyer's profit is the seller's loss. If upon expiration, the spot price exceeds the strike price, the buyer will exercise the option on the writer. Hence as the spot price increases the writer of the option starts making losses. Higher the spot price, more is the loss he makes. If upon expiration the spot price of the underlying is less than the strike price, the buyer lets his option expire un-exercised and the writer gets to keep the premium. Figure 6.2 gives the payoff for the writer of a three month call option on gold (often referred to as short call) with a strike of Rs. 7000 per 10 gms, sold at a premium of Rs. 500.

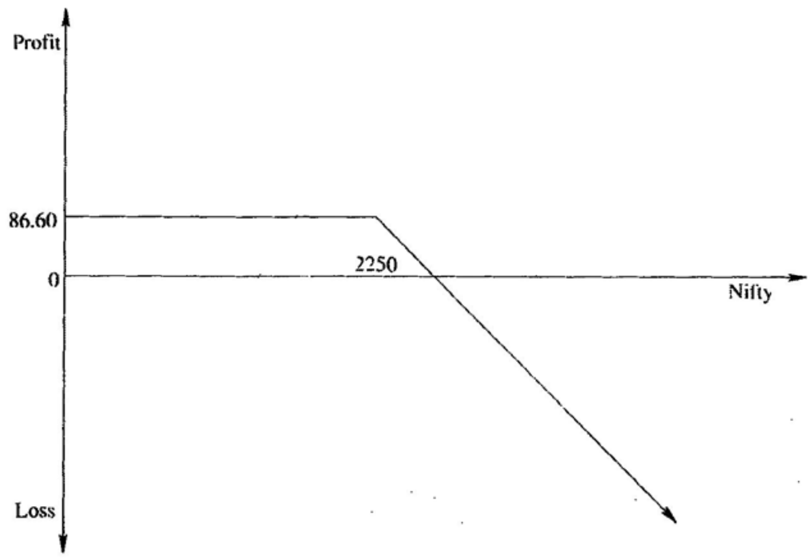

FIG.: PAYOFF FOR WRITER OF CALL OPTION

6.7.3 Payoff for buyer of put options: Long put

A put option gives the buyer the right to sell the underlying asset at the strike price specified in the option. The profit/loss that the buyer makes on the option depends on the spot price of the underlying. If upon expiration, the spot price is below the strike price, he makes a profit. Lower the spot price, more is the profit he makes. If the spot price of the underlying is higher than the strike price, he lets his option expire un-exercised. His loss in this case is the premium he paid for buying the option. Figure 6.3 gives the payoff for the buyer of a three month put option (often referred to as long put) with a strike of 2250 bought at a premium of 61.70.

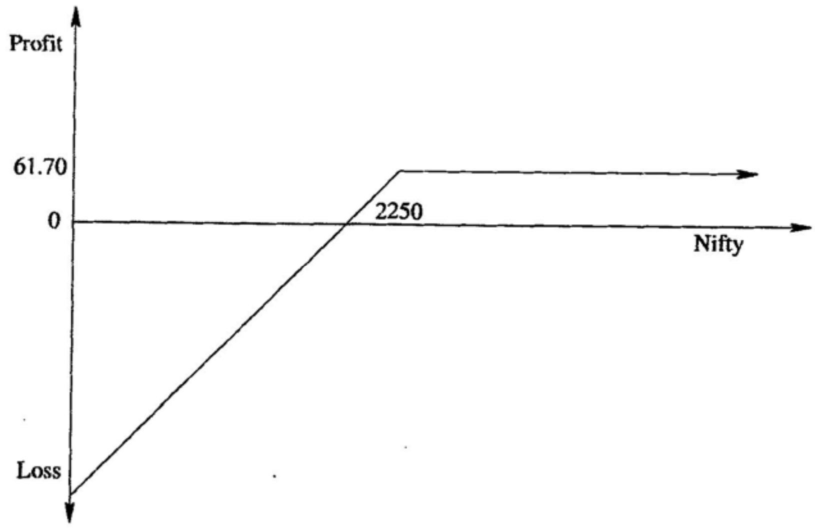

FIG. 6.3: PAYOOF FOR BUYER OF A PUT: LONG PUT

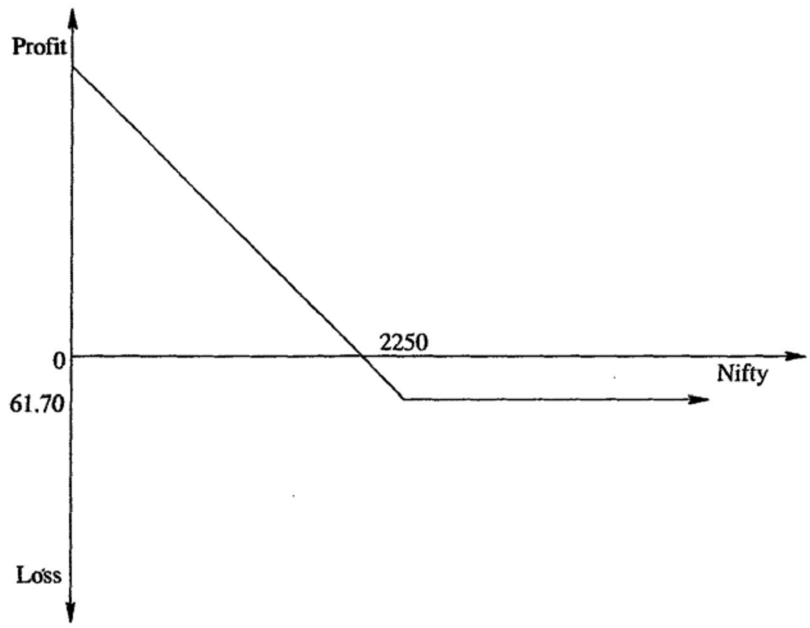

FIG. 6.4: PAYOFF FOR WRITER OF A PUT: SHORT PUT

6.7.4 Payoff profile for writer of put options: Short put

A put option gives the buyer the right to sell the underlying asset at the strike price specified in the option. For selling the option, the writer of the option charges a premium. The profit/loss that the buyer makes on the option depends on the spot price of the underlying. Whatever is the buyer's profit is the seller's loss. If upon expiration, the spot price happens to the below the strike price, the buyer will exercise the option on the writer. If upon expiration the spot price of the underlying is more than the strike price, the buyer lets his option expire un-exercised and the writer gets to keep the premium. Figure 6.4 gives the payoff for the writer of a three month put option (often referred to as short put) with a strike of 2250 sold at a premium of 61.70.

6.8 Currency options

With the opening and integration of capital markets world-wide, the free flow of foreign currency from one country to another has increased at a faster pace. Foreign currency options are used by different market participants e.g. exporters, importers, speculators, arbitrategeurs, bankers, traders and financial institutions. Currency options are devised to protect the investors against unfavourable movements/fluctuations in foreign exchange rates. Like other option instruments, currency options are also financial instruments which give the option holder the right not the obligation to buy or sell a particular currency at a specific exchange rate (price) on or before an expiration date. Here the underlying asset is the foreign currency.

6.8.1 Features of currency options

- *Right not the obligation*: The currency options give the holder to buy or sell a currency right (not obligation at a fixed price (exchange rate) for a specified time period. A call currency option gives the holder to buy a currency at a fixed rate (price at a specified time and a put currency option gives the owner the right to sell a currency at a fixed price (exchange rate) at a specified time. the buyer is known as holder and seller is called writer of currency option. The writer gets the premium from the holder for obligation undertaken in the contract.

- *Two parties*: There are two parties in the contract. The buyer (holder) and the seller (writer). In other words, a yen call option gives the holder the right to buy yen against rupee, is also a rupee put option.
- *The exercise/strike* price is the rate at which the currency is exchanged for another.
- *The premium* is the cost or price or value of the option itself.
- *Spot exchange* rate is the current rate of exchange.
- *Option premium* is paid in advance by the buyer to the seller which lapses irrespective of whether the option is exercised or not. In OTC market the premium is quoted as percentage of the transaction amount, whereas in domestic currency amount per unit of foreign currency in the exchange traded options.
- *The currency options* can be in the money (ITM), out of the money (OTM) or at the money (ATM) as explained in the earlier lessons.
- *Currency options* can be traded on over the counter (OTC) market as well as exchange traded. OTC currency options are customer tailored and have two categories: retailer and wholesale markets. The retail segment of currency option markets are influenced by participants such as- traders, financial institutions and portfolio managers who trade (purchases) from banks. The wholesale currency options market is participated by big commercial banks, financial institutions and investment banking firms for speculation or arbitrage purposes. This market has so many limitations like- relatively lower liquidity due to customer tailored nature; non-standardized, risk of non-performance by the writer (counter

party risk); mispricing due to non-competitiveness; differing exercise prices, expiration date, amount and premium. On the other hand, the currency option can also be traded through recognised exchanges worldwide. The first such exchange to introduce currency options trading is Philadelphia Stock Exchange (PHLX) in 1982. Since then a lot of exchanges have been involved in currency option trading. The exchange traded options are cleared through clearing house, which is the counter party to every option contract and guarantees the fulfilment of the contracts.

6.8.2 Types of currency options

Likewise other forms of options, currency options have also two types of pricing/values. The price/value of a currency option is the premium (amount) which is paid by the holder (buyer) of currency option to writer (seller) of currency option. There are two types of currency option prices; intrinsic value and time value of currency option. The option holder will exercise the right if he finds movement of exchange rate in favourable direction i.e. in case of higher exchange rate than the current rate of exchange, he will exercise the call. Hence intrinsic value of the currency option is the financial gain on in-the-money option. In case of out-of-the-money, the option holder will not exercise the current option and the intrinsic value is zero. For example in a call option in Swiss Francs with a strike price (exchange rate) of $ 0.90 and spot rate of $ 0.94, the gain will be $ 0.04 per Franc. There lies enormous possibilities of price movement between the current date and the expiration date, hence giving option holders the profits/gains. The time value of a currency option is just the expected value which may be incurred during the life of the option. As the option approaches to its expiration, the time value will tend to zero. Consider an example that the value of a call option on French Franc with a strike price of $ 1.5/Franc. The intrinsic value will be zero at the spot exchange rate of $ 1.50/FF but as the spot rate moves, the time value will be positive. Near expiry the time value will be zero. The total value will be equal to time value plus the intrinsic value.

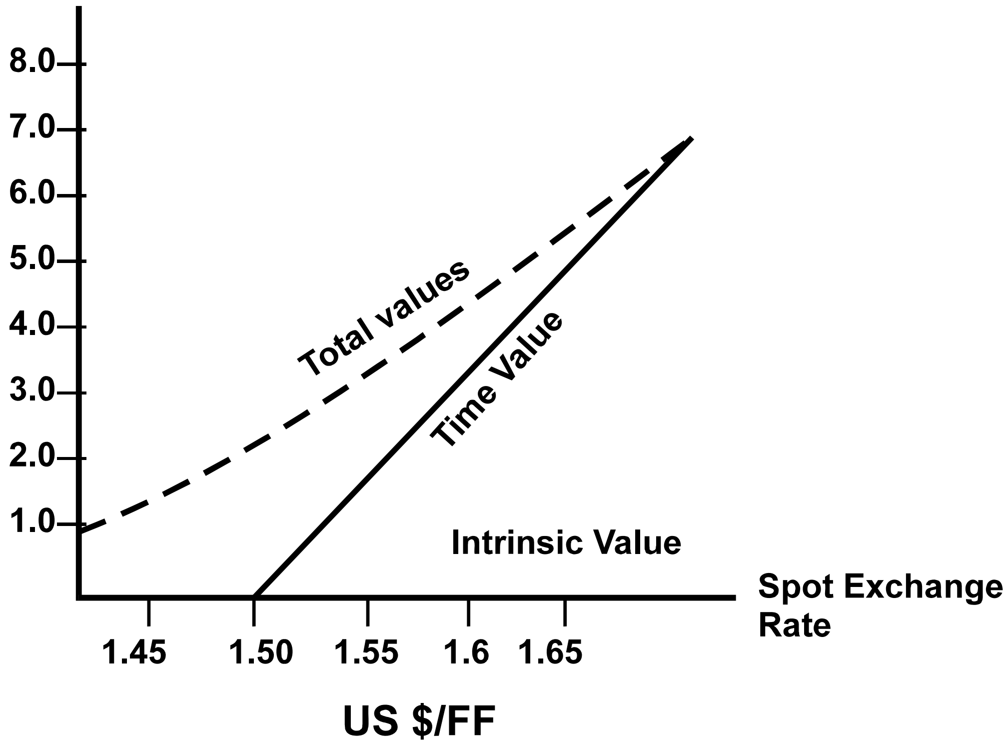

FIG. 6.5: TOTAL VALUE OF A CALL CURRENCY OPTION

6.9 Factors affecting pricing of a currency option

There are so many determinants of the valuation of a currency call option. These are discussed below:

- Fluctuations in exchange forward rate
- Fluctuations in spot exchange rate
- Time to expiration
- Interest rate changes
- Changing volatility
- Alternative option exercise prices

Fluctuations in forward exchange rate: Change in the spot exchange rate has direct impact on the time value of currency option. Past and expected change in the spot exchange rates should be taken care of by the traders of currency options. This sensitivity in known as Delta (Δ) the value of which is given by:

$$\Delta \text{ (Delta)} = \frac{\Delta \text{ Pr emium}}{\Delta \text{ Spot exchange rate}} = \frac{\text{Change in premium}}{\text{Change in stock exchange rate}}$$

Time to expiration: Longer the time to maturity, the higher will be the value of the currency option. This sensitivity is known as theta and is measured by ratio of relative change is premium w.r.t. time.

$$\text{i.e. Theta} = \frac{\Delta \text{ Premium}}{\Delta \text{Time}}.$$

The longer maturity currency options have better value, because with the time period expiring to maturity the time value of currency option deteriorates.

Interest rate changes: The differential in the interest rates have also impact on valuation of currency option. The change may in the interest rate of domestic currency or in the foreign currency.

There are two measures to quantify this sensitivity i.e. Rho and Ph.

Rho is the ratio of change in premium paid in foreign currency option w.r.t. change in the interest rate in domestic currency.

$$\text{Rho } (\rho) = \frac{\Delta \text{Premium in US dollar}}{\Delta \text{Rs. interest rate}}$$

On the other hand ϕ (Phi) is the ratio of changes in premium in domestic currency w.r.t. change in the interest rates.

$$\phi \text{ (phi)} = \frac{\Delta \text{Premium}}{\Delta \text{Foreign interest rate}}$$

When interest rates on foreign currency are higher than the interest rate on domestic currency, the foreign currency sells forward at a discount and vice-versa.

When the domestic interest rate rises, the trader should buy a call option on foreign currency option to avoid loss due to increase in the value of the option.

Illustration 6.1: Assume that call currency option enable to buy of dollar for Rs. 50.00 while it is quoted at Rs. 50.70 in the spot market, and premium paid for call currency option is Rs. 1.00. Calculate the intrinsic value of the call?

Sol: Spot rate (Rs./$) = 50.70

Strike rate (Rs/$) = 50.00

Intrinsic value = 50.70 – 50.00 = Rs. 0.70.

Time value of the currency call = 1.00 – 0.70 = Rs. 0.30.

Strategies in currency option: The strategies for the options trading have been discussed in lesson 8. To give a small view of the strategies in a currency options, the following strategies can be used:

The currency option trader definitely looks for the maximum trade off (pay off) from exercising the option. If an investor buys a call, then he will buy in anticipation of rise in exchange rate of that currency in future. Suppose an Indian foreign exchange dealer anticipates rise in the exchange rate from Rs. 52/$ then he will get a profit as shown in Fig. 6.6.

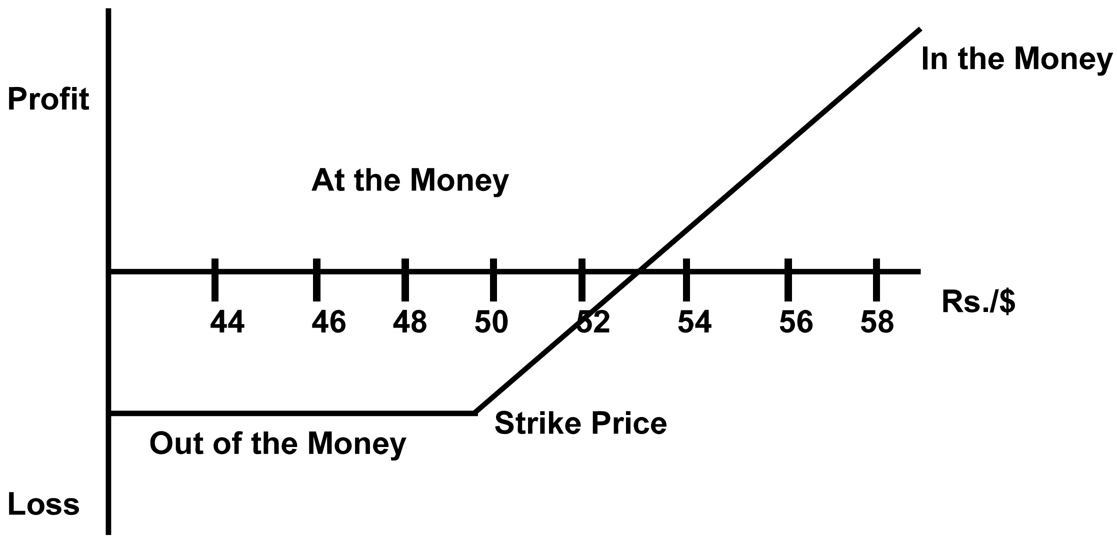

FIG. 6.6: SHOWING PROFIT/LOSS OF BUYER OF
A CALL CURRENCY OPTION

Profit = Spot exchange rate – (Strike price + Premium)

If there is an expected fall in the spot rate of the currency option than the strike rate for a seller (writer) he will not exercise the option.

The profit = Premium – (spot rate – Strike rate).

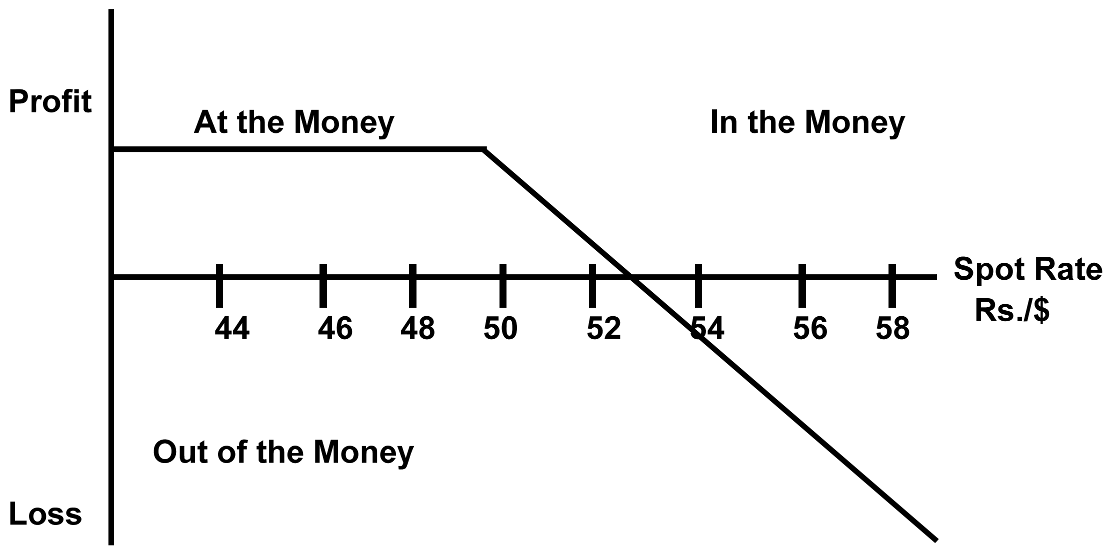

FIG. 6.7: PROFIT/LOSS OF A WRITER OF A CALL OPTION

Buyer of a put option: In a currency put option the investor will exercise the option if the current spot rate is lower than the strike price.

The profit in this case will be

Profit = Strike price – (Sport rate + premium).

Buyer of the currency put option has enormous potential to earn and the lost is limited to the amount of premium paid to the writer.

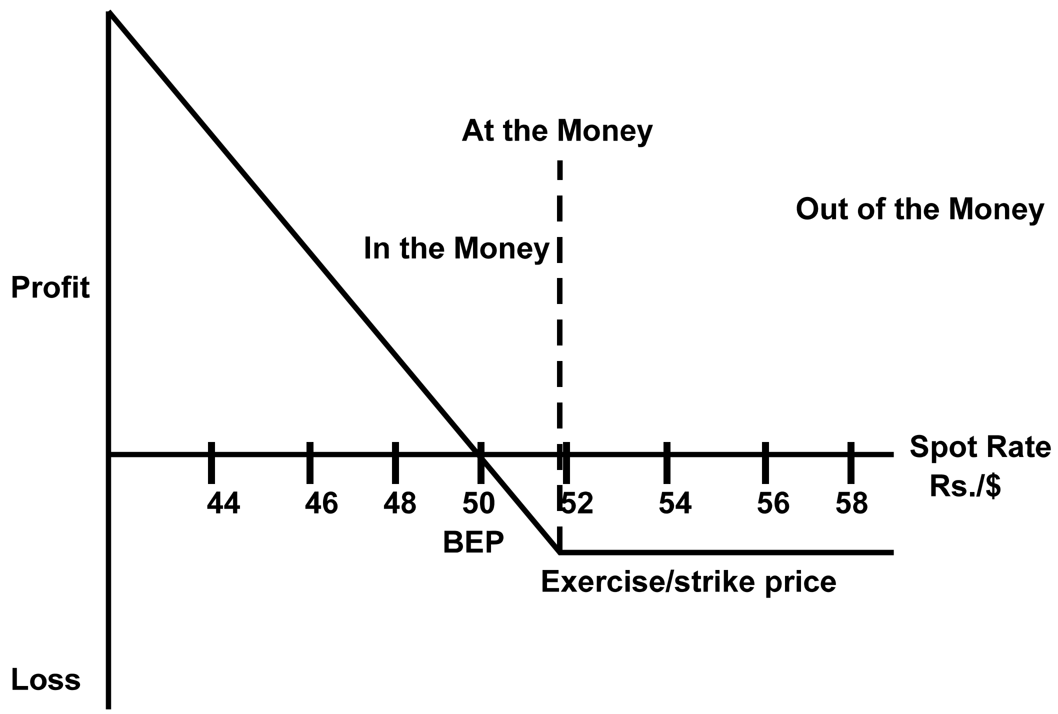

FIG. 6.8: PROFIT/LOSS FROM BUYING A CURRENCY PUT OPTION

The profit/pay off of a writer (seller) of a put option is given by the following Fig. 6.9. The writer will not exercise the option if the spot price is less than the strike price.

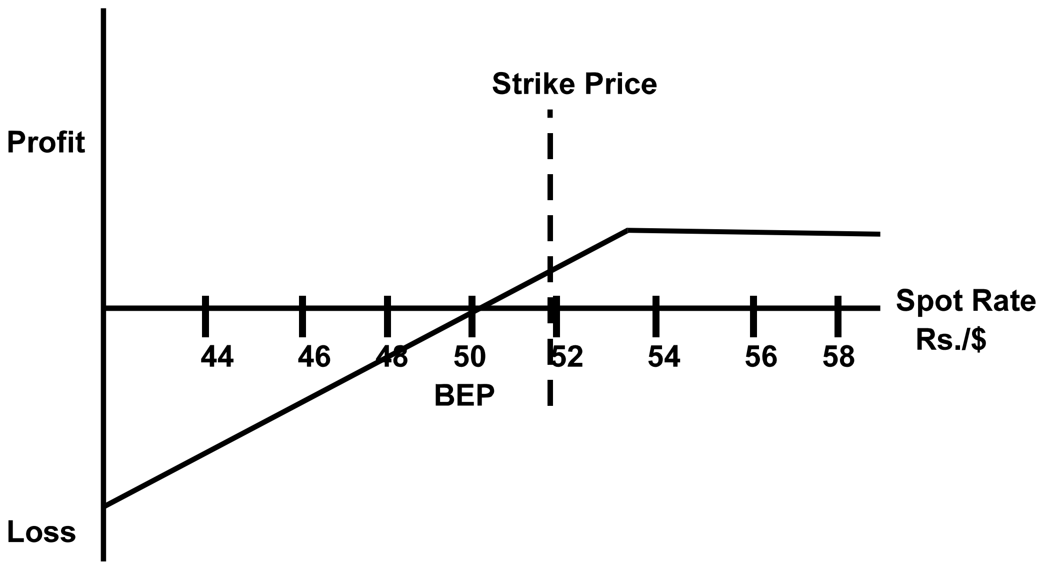

FIG 6.9: PROFIT OF A WRITER OF A PUT OPTION

The profit will be given by:

Profit = Premium – (Strike rate – Spot price)

Spread strategies: In these strategies both call or puts are purchased or sold simultaneously. There may be bull spread, bear spread, butterfly spreads, calendar spread and diagonal spreads etc. (For further detail please refer to lesson 8).

Straddle strategies: A straddle of currency options is created by buying or selling a call and put with similar strike rate and expiration date.

Strangle strategies: Like in straddle, strangle has the same strategy but for the difference in strike prices of call and the put. For more details please refer to lesson 8.

6.10 Futures and options trading system

The futures and options trading system of NSE, called NEAT-F & O trading system, provides a fully automated screen-based trading for Nifty futures and options and stock futures and options on a nationwide basis as well as an online monitoring and surveillance mechanism. It supports an order driven market and provides complete transparency of trading operations. It is similar to that of trading of equities in the cash market segment. The software for the F & O market has been developed to facilitate efficient and transparent trading in futures and options instruments. Keeping in view the familiarity of trading members with the current capital market trading system, modifications have been performed in the existing capital market trading system so as to make it suitable for trading futures and options.

6.10.1 Participants in the trading system

These are four entities in the trading system. Trading members, clearing members, professional clearing members and participants.

- Trading members: Trading members are members of NSE. They can trade either on their own account or on behalf of their clients including participants. The exchange assigns a trading member ID to each trading member. Each trading member can have more than one user. The number of users allowed for each trading member is notified by the exchange from time to time. each user of a trading member must be registered with the exchange and is assigned an unique user ID. The unique trading member ID functions as a reference for all orders/trades of different users. This ID is common for all users of a particular trading member. It is the responsibility of the trading memb3er to maintain adequate control over persons having access to the firm's user IDs.
- Clearing members: Clearing members are members of NSCCL. They carry out risk management activities and confirmation/inquiry of trades through the trading system.

- Professional clearing members: A professional clearing members is a clearing member who is not a trading member. Typically, banks and custodians become professional clearing members and clear and settle for their trading members.
- Participants: A participant is a client of trading members like financial institutions. These clients may trade through multiple trading members but settle through a single clearing member.

6.10.2 Basis of trading

The NEAT F & O system supports an order driven market, wherein orders match automatically. Order matching is essential on the basis of security, its price, time and quantity. All quantity fields are in units and price in rupees. The lot size on the futures market is for 100 Nifties. The exchange notifies the regular lot size and tick size for each of the contracts traded on this segment from time to time. when any order enters the trading system, it is an active order. It tries to find a match on the other side of the book. If it finds a match, a trade is generated. If it does not find a match, the order becomes passive and goes and sits in the respective outstanding order book in the system.

6.10.3 Corporate hierarchy

In the F & O trading software, a trading member has the facility of defining a hierarchy amongst users of the system. This hierarchy comprises corporate manager, branch manager and dealer.

- Corporate manager: The term 'corporate manager' is assigned to a user placed at the highest level in a trading firm. Such a user can perform all the functions such as order and trade h related activities, receiving reports for all branches of the trading member firm and also all dealers of the firm. Additionally, a corporate manager can define exposure limits for the branches of the firm. This facility is available only to the corporate manager.

- Branch manager: The branch manager is a term assigned to a user who is placed under the corporate manager. Such a user can perform and view order and trade related activities for all dealers under that branch.
- Dealer: Dealers are users at the lower most level of the hierarchy. A dealer can perform view order and trade related activities only for oneself and does not have access to information on other dealers under either the same branch or other branches.

6.10.4 Client broker relationship in derivative segment

A trading member must ensure compliance particularly with relation to the following while dealing with clients:

1. Filling of 'know your client' form
2. Execution of client broker agreement
3. Bring risk factors to the knowledge of client by getting acknowledgement of client on risk disclosure document
4. Timely execution of orders as per the instruction of clients in respective client codes
5. Collection of adequate margins from the client
6. Maintaining separate client bank account for the segregation of client money
7. Timely issue of contract notes as per the prescribed format to the client
8. Ensuring timely pay-in and pay-out of funds to and from the clients
9. Resolving complaint of clients if any at the earliest

10. Avoiding receipt and payment of cash and deal only through account payee cheques
11. Sending the periodical statement of accounts to clients
12. Not charging excess brokerage
13. Maintaining unique client code as per the regulations

6.11 Summary

Options are the contracts where buyers and sellers have the right to buy or sell a particular underlying asset at a pre-determined price on or before a specific time period. There are two types of options- call and put options. A call option gives the holder the right not the obligation to buy a particular asset at a particular point of time at a specified price, while a put option gives the writer (seller) the right not the obligation to sell a particular at a particular point of time on a specified price. There are two parties in option contract- one is the buyer, which is also called holder of the contract and another is the seller, which is known as writer of the contract. Depending upon the usage, there are various types of options, e.g. index options, currency options. The option is said to be in-the-money when on exercising immediately it gives a profit, while the option is said to be out-of-the money if it gives losses when exercised immediately. European option can be exercised only on the date of maturity while American option can be exercised on or before the date of expiry. The price at which the option is exercised is known as strike price/exercise price. The premium of the option is the value or the price which is paid by the holder of the option to the writer of the option. The pay-off from the exercise of the options can be the maximum of either zero or the difference between the intrinsic value and the time value. The intrinsic value of the option is nothing but the price of the option at the time of exercise, while the time value approaches to zero when the option tends towards its expiry date. The time value of an option is the difference between its premium and its intrinsic value. Currency options are the options which

give the holder/writer the right not the obligation to buy/sell a specified currency at a pre-determined exchange rate on or before the date of expiration. As in the case of other options, the pay-off from currency options can also be easily calculated.

6.12 Keywords

Commodity options: Commodity options are options with a commodity as the underlying. For instance a gold options contract would give the holder the right to buy or sell a specified quantity of gold at the price specified in the contract.

Stock options: Stock options are options on individual stocks. Options currently trade on over 500 stocks in the United States. A contract gives the holder the right to buy or sell shares at the specified price.

Buyer of an option: The buyer of an option is the one who by paying the option premium buys the right but not the obligation to exercise his option on the seller/writer.

Writer of an option: The writer of a call/put option is the one who receives the option premium and is thereby obliged to sell/buy the asset if the buyer exercises on him.

Call option: A call option gives the holder the right but not the obligation to buy an asset by a certain date for a certain price.

Put option: A put option gives the holder the right but not the obligation to sell an asset by a certain date for a certain price.

Option price: Option price is the price which the option buyer pays to the option seller. It is also referred to as the option premium.

Expiration date: The date specified in the options contract is known as the expiration date, the exercise date, the strike date or the maturity.

Strike price: The price specified in the options contract is known as the strike price or the exercise price.

American options: American options are options that can be exercised at any time upto the expiration date. Most exchange-traded options are American.

European options: European options are options that can be exercised only on the expiration date itself. European options are easier to analyse than American options, and properties of an American option are frequently deduced from those of its European counterpart.

In-the-money options: An in-the-money (ITM) option is an option that would lead to a positive cashflow to the holder if it were exercised immediately. A call option on the index is said to be in-the-money when the current index stands at a level higher than the strike price (i.e. spot price> strike price). If the index is much higher than the strike price, the call is said to be deep ITM. In the case of a put, the put is ITM if the index is below the strike price.

At-the-money option: An at-the-money (ATM) option is an option that would lead to zero cashflow if it were exercised immediately. An option on the index is at-the-money when the current index equals the strike price (i.e. spot price = strike price).

Out-of-the-money option: An out-of-the-money (OTM) option is an option that would lead to a negative cashflow if it were exercised immediately. A call option on the index is out-of-the-money when the current index stands at a level which is less than the strike price (i.e. spot price < strike price). If the index is much lower than the strike price, the call is said to be deep OTM. In the case of a put, the put is OTM if the index is above the strike price.

Intrinsic value of an option: The option premium can be broken down into two components- intrinsic value and time value. The intrinsic value of a call is the amount the option is ITM, if it is ITM. If the call is OTM, its intrinsic value is zero. Putting it another way, the intrinsic value of a call is Max [0, $(S_t - K)$] which means the intrinsic value of a call is the greater of 0 or $(S_t - K)$. Similarly, the intrinsic value of a put is Max [0, $K - S_t$], i.e., the greater of 0 or $(K - S_t)$. K is the strike price and S_t is the spot price.

Time value of an option: The time value of an option is the difference between its premium and its intrinsic value. Both calls and puts have time value. An option that is OTM or ATM has only time value. Usually, the maximum time value exists when the option is ATM. The longer the time to expiration, the greater is an option's time value, all else equal. At expiration, an option should have no time value.

6.13 Self assessment questions

1. What is an option market? Explain the significance of options market in financial markets with suitable examples.
2. Define option? Explain various types of options with examples?
3. Write a detailed account of value of an option.
4. Outline the basic features of option and options market.
5. Differentiate between exchange traded and OTC options with suitable examples.
6. Determine a long and short position in option trading with some hypothetical illustration.

7. "Option holder has limited losses and unlimited profits, while option writer has unlimited losses and limited profits". Critically examine this statement with suitable examples.

8. Write notes on the following:
   i) In-the-money
   ii) Out-of-the-money
   iii) At the money
   iv) Time value of an option
   v) Intrinsic value of an option
   vi) Write and holder of an option
   vii) Distinction between futures and options contracts

9. An investor buys a put option with an exercise price of 'K' and write a call option with the same strike price. Describe the payoff of the investor.

10. An investor has 1000 shares of Rs. 500 each. How can put option be used to provide him, with insurance against risk when the value of the share is assumed to fall in next six months.

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Subject: **Financial Derivatives**	
Course Code: **FM-407**	Author: **Dr. Sanjay Tiwari**
Lesson No.: **7**	Vetter: **Prof. B.S. Bodla**
OPTION PRICING	

Structure

7.0 Objectives

After going through this lesson you will be able to:

- Learn concept and theories of option pricing.
- Understand the mechanics of binomial option pricing.
- Calculate price of calls and put with the help of Black-Scholes formulae.
- Have an idea of sensitivity and implied volatility calculations.

7.1 Introduction

In the previous lesson you have got an idea of the options markets and its mechanisms. The present lesson is devoted to options pricing. Any option holder takes decision on the basis of price of the option. If he finds price favourable, then he can either hedge, arbitrage or speenlage. Pricing of an option involves complex mathematical calculations and treatment. In case of put and call the pricing is decided based on some factors like exercise price, time to exercise the option, hedge ratio, nature and expectations of the investors, current market price of option, variance on return on stock (σ^2), risk free rate of return etc. Two models are there to determine price of an option- (a) Binomial option pricing model and (b) Black-Scholes option pricing model. In binomial model, it is considered that underlying stock follows a binomial return generating process (i.e. the stock's value is bound to change by one or two constant values either upside or downside within any period during life of the option. On the other hand, the Black-Scholes option pricing model is based on some assumptions that there exists no taxes, no restriction on short selling or writing of calls, constant risk-free rate of borrowing and lending, etc.

7.2 Pricing an Option

For recapitulation, you already know that an option is a legal contract, which grants its owner the right (not the obligation) to either buy or sell a given stock. A call grants its owner the right to purchase stock (called underlying shares) for a specified exercise price (also known as a strike price or exercise price) on or before the expiration date of the contract.

Suppose, for example, that a call option with an exercise price of Rs. 100 currently exists on one share of stock. The option expires in one year. This share of stock is expected to be worth either Rs. 90 or Rs. 120 in one year, but we do not know which at the present time. If the stock were to be worth Rs. 90 when the call expires, its owner should decline to exercise the call. It would simply not be practical to use the call to purchase stock for Rs. 100 (the exercise price) when it can be purchased in the market for Rs. 90. The call would expire worthless in this case. If, instead, the stock were to be worth Rs. 120 when the call expires, its owner should exercise the call. Its owner would then be able to pay Rs. 100 for a share which has a market value of Rs. 120, representing Rs. 20 profit. In this case, the call would be worth Rs. 20 when it expires. Let T designate the options term to expiry, let S_T be the stock value at option expiry, and let c_T be the value of the call option at expiry. The value of this call at expiry is determined as follows:

$c_T = MAX[0, S_T - X]$:

when $S_T = 90$, $c_T = MAX[0, 90\text{-}100] = 0$.

When $S_T = 120$, $c_T = MAX[0, 120\text{-}100] = 20$. … (7.1)

A put grants its owner the right to sell the underlying stock at a specified exercise price on or before its expiration date. A put contract is similar to an insurance contract. For example, an owner of stock may purchase a put contract ensuring that he can sell his stock for the exercise price given by the put contract. The value of the put when exercised is equal to the amount by which the put exercise price exceeds the underlying stock price (or zero if the put is never exercised). Further suppose that a put with an exercise price of Rs. 100 expires in one year. The stock is expected to be worth either Rs. 90 or Rs. 120. The value of the put will be calculated as follows:

$P_T = MAX[0, X - S_T]$:

when $S_T = 90$, $p_T = MAX[0, 100\text{-}90] = 10$.

When $S_T = 120$, $p_t = MAX[0, 100 - 120] = 0$ … (7.2)

The owner of the option contract may exercise his right to buy or sell; however, he is not obligated to do so. Stock options are simply the contracts between two investors issued with the aid of a clearing corporation, exchange, and broker which ensures that investors should honour their obligations. For each owner of an option contract, there is a seller or 'writer' of the option who crates the contract, sells it to a buyer, and must satisfy an obligation to the owner of the option contract. The option writer sells (in the case of a call exercise) or buys (in the case of a put exercise) the stock when the option owner exercises. The owner of a call is likely to profit if the stock underlying the option increases in value over the exercise price of the option (he can buy the stock for less than its market value); the owner of a put is likely to profit if the underlying stock declines in value below the exercise price (he can sell stock for more than its market value). Since the option owner's right to exercise represents an obligation to the option writer, must be purchased from the option writer; the option writer receives a 'premium' from the option purchaser for assuming the risk of loss associated with enabling the option owner to exercise.

Illustration 7.1: A call option with an exercise price of Rs. 90 can be bought at a premium of Rs. 2. A put option with an exercise price of Rs. 95 is available at a premium of Rs. 5. How can you combine these options to form a portfolio? What will be your pay-off at expiration?

Solution: You can create a portfolio by buying both options. It is called a straddle. The pay-off will be as follows:

	Share Price	**Profit/Loss**	**Option Exercised**
Call + Put	$S_t > 90$	$(S_t - 90) - (2 + 5)$	call exercised, put not exercised
Call + Put	$S_t < 95$	$(95 - S_t) - (2 + 5)$	call not exercised, put

			exercised
Call + Put	$95 < S_t < 100$	– (2 + 5)	both call and put not exercised

Illustration 7.2: A call option with an exercise price Rs. 50 is available at a premium of Rs. 5. A put with same maturity and exercise price can be purchased at a premium of Rs. 3. If you create a straddle, show the pay-off from it. When would the staddle result in loss?

Solution: The profit from the straddle will be as follows:

	Share Price	**Profit/Loss**	**Option Exercised**
Call + Put	$S_t > 50$	$[(S_t - 50) - (5+3)] > 0$, *if* $S_t > 58$	call exercised, put not exercised
Call + Put	$S_t < 50$	$[(50 - S_t) - (5 + 3)] > 0$, *if* $S_t > 42$	call not exercised, put exercised
Call + Put	$42 < S_t < 48$	– (5 + 3)	both call and put not exercised

7.3 Binomial Option Pricing: One Time Period

The binomial option pricing model is based on the assumption that the underlying stock follows a binomial return generating process. This means that for any period during the life of the option, the stock's value will change by one of two potential constant values. For example, the stock's value will be either u (multiplicative upward movement) times its current value or d (multiplicative downward movement) times its current value. Thus, in an upcoming period, there are two potential outcomes, which we might name u and d.

Suppose a stock is currently selling for 100 and assume for this stock that u equals 1.2 and d equals 0.8. The stock's value in the forthcoming period will be either 1.20 (if outcome u is realized) or 80 (if outcome d is realized). Further suppose that there exists a European call trading on this particular stock during this one-time-period model, with an exercise price of 90. The call expires at the end of this period when the stock value is either 120 or 80. Thus, if the stock were to increase to 120, the call would be worth 30 ($c_u = 30$), since one could exercise the call by paying 90 for a stock having worth 120. If the stock value were to decrease to 80, the value of the call would be zero ($c_d = 0$), since no one would wish to exercise by paying 90 for shares which are worth only 80. Furthermore, suppose that the current risk-free return rate is 0.10. Based on this information, we should be able to determine the value of the call based on the methodology discussed below.

Until now we have not specified probabilities of a stock price increase or decrease during the period prior to option expiration. We have also not specified a discount rate for the option or made inferences regarding investor risk preferences. We will neither determine *ex ante* expected option values, nor will we employ a risk-adjusted discount rate to value the option. We will value this call based on the fact that, during this single time period, we can construct a riskless hedge portfolio consisting of a position in a single call and offsetting positions in α shares of stock, we can create a portfolio whose value is the same regardless of whether the underlying stock price increases or decreases. Let us first define the following terms for numerical illustration:

$S_0 = 100$ = initial stock price

$u = 1.2$ = multiplicative upward stock price movement

$d = 0.8$ = multiplicative downward stock price movement

$c_u = 30 = MAX[0, uS_0 - X]$: value of call if stock price increases

$c_d = 0 = MAX[0, dS_0 - X]$: value of call if stock price decreases

α = hedge ratio

$r_f = 0.10$ = riskless return rate.

The first step in determining the price of the call might be to determine α, the hedge ratio. The hedge ratio defines the number of shares of stock that must be sold (or short sold) in order to maintain a risk-free portfolio. This riskless portfolio is comprised of one call option along with a short position in α shares of stock (Short selling is selling of share without owing them. In other words, one party can borrow the stock and sell it with the obligation of repurchasing of a later date). In this case, the riskless hedge portfolio made up of one call option and (1-α) shares of stock will have the same value whether the stock price increases to uS_0 or decreases to dS_0. If we were to purchase one call and sell α number of shares of stock, our riskless hedge condition would be given as follows:

$$c_u - \alpha u S_0 = c_d - \alpha d S_{0,}$$

$$30 + \alpha (0.120) = 0 - \alpha (0.80). \qquad \ldots (7.3)$$

The hedge ratio is defined as α the number of shares to sell for every call purchased. This value is known as a hedge ratio; by maintaining this hedge ratio, we maintain our hedged portfolio. Solve for the hedge ratio α as follows:

$$\alpha = \frac{c_u - c_d}{S_0(u-d)}, \qquad \alpha = \frac{30-0}{100(1.2-0.8)} = 0.75 \qquad \ldots (7.4)$$

In this example, α = 0.75, meaning that the investor should sell 0.75 shares of under-lying stock for each call option that he purchases to maintain a riskless portfolio. Since this hedge portfolio is riskless, it must earn the riskless rate of return, otherwise arbitrage opportunities will exist:

$$c_u - \alpha u S_0 = c_d - \alpha d S_0 = (c_0 - \alpha S_0)(1 + r_f). \qquad \ldots (7.5)$$

Here, r_f stamp for risk-free rate of return.

From here, we can work equally well with either with outcome u or outcome d; since it makes no difference, we will work with outcome d. Note that the time-zero option value c_0 can be solved for by rearranging equation (7.5). Again, if equation (7.5) does not hold, or if the current price of the option is inconsistent with equation (7.5) a risk-free arbitrage opportunity will exist. Thus, equation can be written to solve for the zero *NPV* condition that eliminates positive profit arbitrage opportunities:

$$c_0 - \alpha S_0 - \frac{c_d - \alpha d S_0}{1 + r_f} = 0 . \qquad \ldots (7.6)$$

It is now quite simple to solve for the call value c_0 by rewriting equation (7.6):

$$c_0 = \frac{(1 + r_f)\alpha d S_0 + c_d - \alpha d S_0}{1 + r_f}, \qquad \ldots (7.7)$$

$$c_0 = \frac{(1 + 0.10) * 0.75 * 100 + 0 - 0.75 * 0.8 * 100}{1 + 0.10} = 20.4545$$

7.4 Binomial Option Pricing: Multiple Time Periods

In multi-period setting, how the price of the option is calculated? Let's discuss this in detail.

Equation (7.7) is quite appropriate for evaluating a European call in a one-time-period framework. That is, in the model presented thus far, share prices can either increase or decrease once by a pre-specified percentage. Thus, there are only two potential prices that the stock can assume at the expiry of the stock. Thus, there are only two potential prices that the stock can assume at the expiration of the stock. The binomial option pricing model can be further extended to cover as many potential outcomes and time periods as necessary for a particular situation. The next step in the development of a more realistic model is extension of the framework to two time periods. One complication is that the hedge ratio only holds for the beginning of the first time period. After this period, the hedge ratio must be adjusted to reflect price changes and movement through time. Thus, the next step in extending the model to two time periods is to substitute for the hedge ratio based on equation (7.4):

$$c_0 = \frac{\left(1+r_f\right)\left(\dfrac{c_u - C_d}{S_0(u-d)}\right)S_0 + c_d - \left(\dfrac{c_u - c_d}{S_0(u-d)}\right)dS_0}{1+r_f} \quad \text{... (7.8)}$$

After simplifying equation (7.8), we get:

$$c_0 = \frac{\left(\dfrac{1+r_f(c_u - c_d) + c_d(u-d) - d(c_u - c_d)}{u-d}\right)}{1+r_f} \quad \text{... (7.9)}$$

$$c_0 = \frac{c_u\left(\dfrac{(1+r_f)-d}{u-d}\right) + c_d\left(\dfrac{u-(1+r_f)}{u-d}\right)}{1+r_f} \quad \text{... (7.10)}$$

This expression (7.10) is quite convenient because of the arrangement of potential cash flows in its numerator. Assume that investors will discount cash flows derived from the call based on the risk-free rate r_f. This assumption is reasonable if investors investing in options behave as though they are risk neutral; in fact, they will evaluate options as though they are risk neutral because they can eliminate risk by setting appropriate hedge ratios. Their extent of risk aversion will already be reflected in the prices that they associate with underlying stock. Note that equation (7.10) defines the current call value in terms of the two potential call prices c_u and c_d and this risk-free return rate. Since it is reasonable to assume that investors behave toward options as risk neutral, the numerator of equation (7.10) may be regarded as an expected cash flow. Hence, the terms that c_u and c_d are multiplied by investor associates with the stock price changing to uS_0 and (1-π) as the probability that the stock price changes to dS_0:

$$\pi = \frac{\left(1 + r_f\right) - d}{u - d}, \qquad 1 - \pi = \frac{u - \left(1 + r_f\right)}{u - d} \qquad \text{... (7.11)}$$

Simplifying equation (7.10) by substituting in equation (7.11):

$$c_0 = \frac{c_u \pi + c_d (1 - \pi)}{1 + r_f} \qquad \text{... (7.12)}$$

This equation (7.12) represents a slightly simplified form of the one-time-period option pricing model. However, it is easily extended to a two-period model. Let c_u^2 be the call's expiration value after two time periods, assuming that the stock's price has risen twice; c_d^2 is the value of the call assuming the price declined twice during the two periods and c_{ud} is the value of the call assuming the stock price increased once and decreased once during this period. Thus, the two-time-period model becomes:

$$c_0 = \frac{c_u^2 \pi^2 + 2\pi(1 - \pi)c_{ud} + (1 - \pi)^2 c_d^2}{\left(1 = r_f\right)^2} \qquad \text{... (7.13)}$$

Using the binomial distribution function, this model is easily extended to n time periods as follows:

$$c_0 = \frac{\sum_{j=0}^{n} \frac{n!}{j!(n-j)!} \pi^j (1 - \pi)^{n-j} MAX[0, (u^j d^{n-j} S_0) - X]}{\left(1 + r_j\right)^n} \qquad \text{... (7.14)}$$

The number of computational steps required to solve eqation (7.14) is reduced if we eliminate from consideration all of those outcomes where the option's expiration day price is zero. The first step in estimating the probability that the call will be exercised is to determine the minimum number of price increases j needed for S_n to exceed X:

$$S_n = u^j d^{n-j} S_0 > X. \qquad \text{... (7.15)}$$

This inequality is solved for the minimum non-negative integer value for j such that $u^j d^{n-j} S_0 > X$. Take logs of both sides, to obtain

$$j * ln\,(u) + n * ln\,(d) - j * ln\,(d) + ln\,(S_0) > ln\,(X).$$

$$j * ln\left(\frac{u}{d}\right) > ln(X) - n * ln(d) - ln(S_0). \qquad \text{... (7.16)}$$

Next, divide both sides by $log\ (u/d)$ and simplify. Thus, we shall define a to be the smallest non-negative integer for j, where $S_n > X$:

$$a = MAX\left[\frac{ln\left(\frac{X}{S_0 d^n}\right)}{ln\left(\frac{u}{d}\right)}, 0\right] \qquad \text{... (7.17)}$$

The call option is exercised whenever $j > a$. The probability that this will occur is given by the following binomial distribution:

$$P[j > a] = \sum_{j=a}^{n} \frac{n!}{j!(n-j)!} \pi^j (1-\pi)^{n-1} \ , \qquad \text{... (7.18)}$$

where π denotes the probability that an increase in the stock's price will occur in a given trial. It is assumed that π does not vary over trials. Finally, substituting equation (7.17) into equation (7.14) to obtain the binomial option pricing model:

$$c_0 = \frac{\sum_{j=a}^{n} \frac{n!}{j!(n-j)!} \pi^j (1-\pi)^{n-1} \left[u^j d^{n-j} S_0 - X\right]}{\left(1+r_f\right)^n} \qquad \text{... (7.19)}$$

or

$$c_0 = S_0\left[\sum_{j=a}^{n}\frac{n!}{j!(n-j)!} * \frac{(\pi u)^j[(1-\pi)d]^{n-j}}{(1+r_f)^n}\right] - \left(\frac{X}{(1+r_f)^n}\right)\left[\sum_{j=a}^{n}\frac{n!}{j!(n-j)!} * \left(\pi^j(1-\pi)^{n-j}\right)\right]$$

… (7.20)

or, in short form,

$C = S_0 B\,[a, n, \pi'] - X\,(1 + r_f)^{-n} B\,[a, n, \pi].$ … (7.21)

Where $\pi' = \pi u/(1+r_f)$. Two points regarding equation (7.21) need further discussion. First, assuming that investors behave as risk neutral, $B\,[\alpha, n, \pi]$ may be interpreted as the probability that the stock price will be sufficiently high at the expiration day of the option to warrant its exercise. Second, $B[\alpha, n, \pi]$ may be interpreted as the probability that the stock price will be sufficiently high at the expiration date of the option to warrant its exercise. Second, $B[\alpha, n, \pi']$ may be interpreted as a hedge ratio, although it must be updated at every period.

One apparent difficulty in applying the binomial model as it is presented above is in obtaining estimates for u and d that are required for π; all other inputs are normally quite easily obtained. However, if we assume that stock returns are to follow a binomial distribution, we can relate u and d to standard deviation estimates as follows:

$u = c^{\sigma\sqrt{1/n}}$,

$d = 1/\mathrm{u}.$ … (7.22)

In the model presented here, σ might be regarded as a standard deviation of annual historical returns, r_f as the annual risk-free return rate, and n as the number of jumps or trials over the period. This model may be regarded as appropriate for discrete time, discrete jump processes where $n < \infty$. Appropriate adjustments to a specific problem should be made if years are not the standard unit of measure for time. The Black-Scholes model presented in the following section is more appropriate when it is necessary to assume continuous time and continuous stock price movement. It may also be computationally more simple, since it is not necessary to work through large summations.

7.5 Black-Scholes Option Pricing Model

In case the number of trials in a binomial distribution approaches to infinity $(n \rightarrow \infty)$, the binomial distribution approaches the normal distribution. Black and Scholes provided a derivation for an option pricing model based on the assumption that the natural log of stock price relative will be normally distributed. The other assumptions of Black-Scholes option pricing model are as follows:

Assumptions

- There exists no restriction on short sales of stock or writing of call options.
- There are no taxes or transactions costs.
- There exists continuous trading of stocks and options.
- There exists a constant risk-free borrowing and lending rate.
- The range of potential stock prices is continuous.
- The underlying stock will pay no dividends during the life of the option.
- The option can be exercised only on its expiration date; that is, it is a European option.
- Shares of stock and option contracts are infinitely divisible.

- Stock prices follow an Îto process; that is, they follow a continuous time random walk in two-dimensional continuous space.

Assume that investors' behaviour is risk neutral. That is, investors price options as though they are risk neutral because they can always construct riskless hedges comprising of options and their underlying securities. From an applications perspective, one of the most useful aspects of the Black-Scholes model is that it only requires five inputs. With the exception of the variance of underlying stock returns, all of these inputs are normally quite easily obtained:

- The current stock price *(S_0)*. Use the most recent quote.
- The variance of returns on the stock *(σ^2)*.
- The exercise price of the option *(X)* given by the contract.
- The time to maturity of the option *(T)* given by the contract.
- The risk-free return rate *(r_f)*. Use a treasury issue rate with an appropriate term to maturity.

It is important to note that the following less easily obtained factors are not required as model inputs:

1. The expected or required return on the stock or option.
2. Investor attitudes toward risk.

If the assumptions given above hold, the Black-Scholes model holds that the value of a call option is determined by

$$c_0 = S_0 N(d_1) - \frac{X}{e^{r_f T}} N(d_2) = c_0\left[S_0, T, r_f, \sigma, X\right] \qquad \text{... (7.23)}$$

where

$$d_1 = \frac{\ln\left(\frac{S_0}{X} + \left(r_f + \frac{1}{2}\sigma^2\right)T\right)}{\sigma\sqrt{T}} \qquad \dots (7.24)$$

$$d_2 = d_1 - \sigma\sqrt{T}\,. \qquad \dots (7.25)$$

and $N(d^*)$ is the cumulative normal distribution function for (d^*). This is a function that is frequently referred to in a statistics setting as the *z-value* for d^*. From a computational perspective, one would first work through equation (7.24) and then equation (7.25), before valuing the call with equation (7.23).

$N(d_1)$ and $N(d_2)$ are areas under the standard normal distribution curves (z-values). Simply locate the z-value corresponding to the $N(d_1)$ and $N(d_2)$ values on the z-table. From a computational perspective, it is useful to generate an equation to determine normal density functions (z-values) rather than rely on z-tables.

Illustration 7.3: An investor purchases a six-month call option for Rs. 7.00 on a stock which is currently selling for Rs. 75. The exercise price of the call is Rs. 80 and the current riskless rate of return is 10% per annum. The variance of annual returns on the underlying stock is 16%. At its current price of Rs. 7.00, does this option represent a good investment?

Hence the values fit for Black-Scholes formula are given as:

$T = 0.5,$ $\quad r_f = 0.10,$ $\quad e = 2.71828.$

$X = 80,$ $\quad \sigma^2 = 0.16,$

$\sigma = 0.4,$ $\quad S_0 = 75.$

The first step in solving for the call value is to find d_1 and d_2;

$N(d_1) = N(0.09) = 0.535864,$

$N(d_2) = N(-0.1928) = 0.423558.$

Finally, we use $N(d_1)$ and $N(d_2)$ to value the call;

$$c_0 = 75 * 0.536 - \frac{80}{e^{0.10.0.5}} * 0.42 = 7.958.$$

Since the 7.958 value of the call exceeds its 7.00 market price, the call represents a good purchase.

Illustration 7.4: Suppose a stock of ABCL is currently selling at Rs. 59, risk free rate of return 11.5%. Strike/exercise price Rs. 60. Time to expiration 3 months and σ is 0.2.

Solution: Here, $S_0 = 59$

$\sigma = 0.2 \qquad \therefore \sigma^2 = 0.04$

$X = 60 \qquad r_f = 0.115 \qquad e = 2.71828 \quad T = 3/12 = 0.25$

$$d_1 = \frac{ln\left(\frac{59}{60}\right) + \left[0.115 + \frac{0.04}{2}\right]0.25}{0.2(0.25)^{1/2}}$$

$$= \frac{ln(0.98334) + 0.03375}{0.1} = 0.9694$$

$d_2 = (d_1 - \sigma (T)^{½}$

$= 0.1694 – 0.1 = 0.0694$

From Table the values of $N(d_1)$ and $N(d_2)$ can be calculated as:

$N(d_1) = 0.5670$

$N(d_2) = 0.5275$

$Xe^{-rT} = 60\ e^{-(0.115)\ (0.25)}$

$= 58.299$

$C_0 = S_0N(d_1) = ke^{-rt} N(d_1)$

$= 59 \times 0.5670 - 58.299 \times 0.5275$

$= 2.70$

7.6 Valuation of Puts

A put is defined in the previous section as an option that grants its owner the right to sell the underlying stock at a specified exercise price on or before its expiration date. Put values are closely related to call values. This framework, generalized here, results from *put-call parity*. There is a fixed relationship between put and call on the same share with similar strike price and maturity period which is called put-call parity. Assume that there exists a European put (with a current value of P_0) and a European call (with a value of c_0) written on the same underlying stock, which currently has a value equal to X. Both options expire at time T and the riskless return rate is r_f. The basic put-call parity formula is as follows:

$$c_0 + Xe^{-r_f T} = S_0 + p_0 . \qquad \text{… (7.26)}$$

or value of call + PV of exercise price = Value of put + value of share.

TABLE 7.1: PUT-CALL PARITY

Outcome	If $S_T \leq X$	If $S_T > X$
Ending stock price, S_T	S_T	S_T
Ending put price, p_T: $MAX[0, X - S_T]$	$X - S_T$	0
Ending call price, c_T: $MAX [S_T - X]$	0	$S_T - X$
Ending Treasury bill	X	X

value, X		
Ending value for portfolio A: $c_T + X$	X	S_T
Ending value for portfolio B: $p_T + S_T$	X	S_T

That is, a portfolio consisting of one call with an exercise price equal to X and a pure discount risk-free note (zero coupon riskless bond) with a face value equal to X must have the same value as a second portfolio consisting of a put with exercise price equal to X and one share of the stock underlying both options. This relation is proven by first assuming the existence of a portfolio A consisting of one call with an exercise price equal to X and a pure discount risk-free note with a face value equal to X. It is also assumed that portfolio B, which consists of a put with exercise price equal to X and one share of the stock underlying both options (see Table 7.1). Irrespective of the final stock price, portfolio A will have the same terminal value as portfolio B at time 1. Therefore, at time 0, the two portfolios must have equal value. This is put-call parity.

There are a number of useful implications of the put-call parity relation. One is that we can easily derive the price of a put given a stock price, call price, exercise price, and riskless return:

$$p_0 = C_0 + Xe^{-r_f T} - S_0 . \qquad \ldots (7.27)$$

Thus, value of a put can be calculated in a Black-Scholes environment by first valuing the call with identical terms or value the put in the binomial environment by first valuing the call.

7.7 Sensitivity Calculations (Greeks)

There are some factors which lead to changes in the value of options. Option traders find it very useful to know how values of option positions change as factors used in the pricing model vary. Sensitivity calculations (also called Greeks) are particularly useful to investors holding portfolios of options and underlying shares. For example, the sensitivity of the call's value to the stock's price is given by *delta*:

$$\frac{\partial C}{\partial S} = N(d_1) > 0 \qquad \delta\varepsilon\lambda\tau\alpha,\ \Delta \qquad \ldots (7.28)$$

Where $\frac{\partial C}{\partial S}$ is the rate of change of call with respect to stock price. However, Δ is based on partial derivatives w.r.t. the share price; it holds exactly only for an infinitesimal change in the share price. If change in delta is due to change in share price; then this is known as gamma, Γ.

$$\frac{\partial^2 C}{\partial S^2} = \frac{\partial \Delta}{\partial S} = \frac{\partial N(d_1)}{\partial S} = \frac{e^{-d_1^2/2}}{\sqrt{2\pi}.S\sigma\sqrt{T}} > 0 \quad \text{gamma, } \Gamma. \qquad \ldots (7.29)$$

This change in delta resulting from a change in the share price is known as *gamma*. Since gamma is positive, an increase in the share price will lead to an increase in delta. However, again, this change in delta resulting from a finite share price change is only approximate. Each time the share price changes, the investor must update his portfolio. Gamma indicates the number of additional shares that must be purchased or sold given a change in the stock's price.

Since call options have a date of expiration, they are said to amortize over time. As the date of expiration draws nearer, the value of the European call option might be expected to decline, as indicated by a positive *theta*:

$$\frac{\partial C}{\partial T} = r_f X e^{-r_f T} N(d_2) + S \frac{\sigma}{\sqrt{T}} \frac{e^{-d_1^2/2}}{\sqrt{2\pi}} > 0 \quad theta, \theta. \qquad \dots (7.30)$$

Vega measures the sensitivity of the option price to the underlying stock's standard deviation of returns. One might expect the call option price to be directly related to the underlying stock's standard deviation:

$$\frac{\partial C}{\partial \sigma} = S\sqrt{T} \frac{e^{-d_1^2/2}}{\sqrt{2\pi}} > 0 \qquad \text{vega}, \upsilon. \qquad \dots (7.31)$$

In addition, one would expect that the value of the call would be directly related to the riskless return rate and inversely related to the call exercise price:

$$\frac{\partial C}{\partial e^{r_f}} = TXe^{-r_f T} N(d_2) > 0 \qquad \text{rho}, \rho; \qquad \dots (7.32)$$

$$\frac{\partial C}{\partial X} = -e^{-r_f T} N(d_2) < 0 \qquad \dots (7.33)$$

Put sensitivities are given in Table 7.2. Sensitivities for the call option given in the example in section 7.4 are computed as follows:

TABLE 7.2: BLACK-SCHOLES OPTION SENSITIVITIES

Sensitivity	**Call**	**Put**
Δ	$N(d_1)$	$1 - N(d_1)$
θ	$-r_f X^{-r_f T} N(d_2) - S\frac{\sigma}{\sqrt{T}}\frac{e^{-d_1^2/2}}{2\sqrt{2\pi}}$	$r_f X^{-r_f T} N(d_2) - S\frac{\sigma}{\sqrt{T}}\frac{e^{-d_1^2/2}}{2\sqrt{2\pi}}$
ϖ	$S\sqrt{T}\frac{e^{-d_1^2/2}}{\sqrt{2\pi}}$	$S\sqrt{T}\frac{e^{-d_1^2/2}}{\sqrt{2\pi}}$
ρ	$TXe^{-r_f T} N(d_2)$	$TXe^{-r_f T} N(-d_2)$
$\frac{\partial C}{\partial X}$	$-e^{-r_f T} N(d_2)$	$-e^{-r_f T} N(d_2) + e^{-r_f T}$

Γ	$\dfrac{e^{-d_3^2}}{\sqrt{2\pi}.S\sigma\sqrt{T}}$	$\dfrac{e^{-d_3^2}}{\sqrt{2\pi}.S\sigma\sqrt{T}}$

$$\frac{\partial C}{\partial S} = N(d_1) = \Delta = 0.536.$$

$$\frac{\partial^2 C}{\partial S^2} = \frac{\partial \Delta}{\partial S} = \frac{\partial N(d_1)}{\partial S} = \frac{e^{-d_1^2/2}}{\sqrt{2\pi}.S\sigma\sqrt{T}} = \Gamma = 0.0187.$$

$$\frac{\partial C}{\partial T} = -r_f Xe^{-r_f T} N(d_2) - S\frac{\sigma}{\sqrt{T}}\frac{e^{-d_1^2/2}}{2\sqrt{2\pi}} = \upsilon = 21.06.$$

$$\frac{\partial C}{\partial e^{r_f}} = TXe^{-r_f T} N(d_2) = \rho = 16.1156.$$

$$\frac{\partial C}{\partial X} = -e^{-r_f T} N(d_2) = -0.4028.$$

7.8 Implied Volatilities

Analysts often employ historical return variances to estimate the volatility of securities. However, one cannot always assume that variances will be constant over time or that historical data properly reflects current conditions. An alternative procedure to estimate security variances is based on the assumption that investors price options based on consideration of the underlying stock risk. If the price of the option is taken to be correct, and if the Black-Scholes option pricing model is appropriate for valuing options, then one can infer the underlying stock standard deviation based on the known market price of the option and the option pricing model. Consider the following example pertaining to a six-month call currently trading for \$ 8.20 and its underlying stock currently trading for \$ 75:

$T = 0.5$, $r_f = 0.10$, $c_0 = 8.20$.

$X = 80,$ $S_0 = 75.$

If investors have used the Black-Scholes options pricing model to evaluate this call, the following must hold:

$$8.20 = 75 * N(d_1) - 80.\ e^{-0.1*0.5} * N(d_2).$$

$$d_1 = \{ln\ (75/80) + (0.1 + 0.5\sigma^2)*0.5\} + \sigma\sqrt{0.5}.$$

$$d_2 = d_1 - \sigma\sqrt{0.5}.$$

Thus, we wish to solve the above system of equations for σ. This is equivalent to solving for the root of

$$f(\sigma *) = 0 = 75 * N(d_1) - 80 * e^{-0.1*0.5} * N(d_2) - 8.20.$$

There is no closed-form solution for $f(\sigma^*)$. That is, we cannot algebraically solve for σ^*. Thus, we will substitute values for σ^* into $f(\sigma^*)$ until we find one that satisfies the equality. While this may seem cumbersome at first, there are a number of 'tricks' that will make the process much more efficient. When systemizing a procedure to find implied volatilities, attempt the following:

1. Have a model that generates a good initial trial value. Many analysts use historical variances. Pakinson extreme value estimators, or Brenner-Subrahmanyam estimators. (We will discuss the latter two later.)

2. Remember that an increase in the volatility (variance or standard deviation) will increase the value of the call; a decrease in volatility decreases call value.

3. Use an efficient numerical technique to iterate for improved trial solutions. Interpolation, the method of bisection, Newton-

Raphson, and finite difference methods are frequently used by professional analysts. We will focus on Newton-Raphson here.

First, we need to obtain an initial trial estimate for σ^*. In our example, we could compute a historical volatility if we had relevant historical data. Unfortunately, such data is not always available (for new stocks, for example) and computations can be very time-consuming. We can save substantial time using the extreme value indicators (based on security high and low prices) such as that derived by Parkinson (1980). It is most useful for reducing the amount of data required for statistically significant standard deviation estimates:

$$\sigma_p = 0.601 * ln\left(\frac{HI}{LO}\right) \qquad \text{... (7.35)}$$

where *HI* designates the stock's high price for a given period and *LO* designates the low price over the same period.

If there are no historical returns from which to obtain an initial trial value, or if risk circumstances are substantially different today, we may work with an estimate from a variation of the Black-Scholes formula. Brenner and Subrahmanyam (1988) provide a simple formula to estimate an implied standard deviation (or variance) from the value c_0 of a call option whose striking price equals the current market price S_0 of the underlying asset:

$$\sigma_{BS}^2 = \frac{2\pi c_0^2}{TS_0^2} \qquad \text{... (7.36)}$$

where T is the number of times periods prior to the expiration of the option. As the market price differs more from the option striking price, the estimation accuracy of this formula will worsen. For the option in our example, we may obtain a trial value for volatility as follows:

$$\sigma_{BS}^2 = \frac{2\pi c_0^2}{TS_0^2} = \frac{2 * 3 * 141 * 8.20^2}{0.5 * 75^2} = \frac{422.40}{2{,}812.5} = 0.15, \qquad \sigma_{BS} = 0.387.$$

Now, we use the method of Newton-Raphson to iterate for an improved volatility estimate, as in Table 7.3. By the Newton-Raphson method, we first select an initial trial solution x_0. We have selected 0.387 as our initial trial value. We substitute this trial value for σ* into equation (10.35), to obtain $f(\sigma^*)$ = –0.515551 as in the first row of Table 10.3. Then we iterate for an improved trial value based on a first order Taylor approximation from section 8.6 to solve for x_1 as follows:

$$f(x_0) + (x_1 - x_0)f'(x_0) = -0.515551 + (x_1 - 0.387) * f'(x_0) \quad \ldots (7.37)$$

Here, we use –0.515551 as $f(\sigma^*)$ and we use equation (7.31) from section 10.6 to obtain $f'(x_0)$ = 21.831:

$$v = \frac{\partial C}{\partial \sigma} = S\sqrt{t}\,\frac{e^{-d_1^2/2}}{\sqrt{6.282}} = 75 * \sqrt{0.5} * \frac{2.71828^{-0.0836971^2/2}}{\sqrt{6.282}} = 21.831 \ldots (7.38)$$

7.9 Summary

The various factors which influence the price of any option are: exercise/strike price, expiry date of the option, expected price volatility, risk-free rate of return, expected cash payments of the stock etc. The option price is directly proportional to the current price of the underlying. In case of a call lower the strike price, higher will be the value of option and vice-versa in put case. Longer the expiry period of the option, the higher will be the option price. There are two models to express pricing of option. One-time binomial model is based on assumptions of no market friction, transaction costs, no bid/ask spread, no margin requirement, no restrictive on short-selling etc. It predicts the value of an option with the help of two possible outcomes either upward or downward movements of prices of stocks. The one time binomial model can be expanded to a multiple time Binomial model with some modifications. Based on certain assumptions and in view of the log normal distribution of returns, Black and Scholes developed a model in 1973 known as B-S model which is programmable into a computer and call and put prices can be found out easily by inputing some variables into the formula.

Sensitivity calculations are possible to know the effect of rate of changes in some variable on value of an option. These are known as Greeks and the value can be calculated using derivatives/differential calculus. Similarly, implied volatility is the volatility that the option price implies.

7.10 Keywords

Intrinsic value of an option is the fundamental or underlying value which denotes a difference between the market price and the exercise price of the underlying asset.

Time value of an option is the difference between the value of an option at a particular time and its intrinsic value at the time.

Implied volatility is the volatility that the option price implies. It is different from actual volatility observed in market place.

Basis is the difference between the spot price and the futures price of a commodity.

7.11 Self Assessment Questions

1. Discuss various factors affecting pricing of an option?
2. How does volatility affect the pricing of an option? Discuss various methods of volatility measurement.

3. What are assumptions of Binomial option pricing models in one time and multiple time dimension?

4. Discuss the derivation of one time period Binomial option pricing model with some hypothetical example?

5. What are different parameters to understand option pricing models?

6. Describe various assumptions of the Black-Scholes model for calculating the prices of an option.

7. Discuss in detail the Black-Scholes model of pricing on option with suitable illustrations.

8. What is implied volatility? Why this concept is required for option pricing?

9. With the help of the following data in a European call option, calculate the value of call by applying B-S model.

   Stock price = Rs. 90

   Months to expiration = 3 months

   S.D. (σ) of stock = 0.35

   Risk-free interest = 10% p.a.

   Exercise price = Rs. 96

10. Write note on the following:
    (a) Log normal assumption of option pricing
    (b) Implied volatility
    (c) Greeks or sensitivity calculations
    (d) Valuation of a put

11. Suppose stock price of Satyam which is an option expiring six months is Rs. 4200. The exercise price of the option is Rs. 4000

and risk free rate of interest is 10% p.a. and the volatility is 20% p.a. Compute the option price using Black-Scholes model.

12. Suppose stock of SRKL has the following data:

    Stock price = Rs. 1200

    Call exercise price = Rs. 1000

    Exercise date = 6 months

    Estimated volatility = 20%

    Current market price = Rs. 500

    Risk free interest rate = 10% p.a.

Compute the call option price as per the Black-Scholes model.

7.12 References/suggested readings

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Subject: **Financial Derivatives**	
Course Code: **FM-407**	Author: **Dr. Sanjay Tiwari**
Lesson No.: **8**	Vetter: **Dr. N.S. Malik**
STRATEGIES INVOLVING OPTIONS	

Structure

8.0 Objectives

After going through this lesson you will be able to:

- Understand trading strategies involving options.
- Know profit diagrams.
- Differentiate between different types of spreads.

- Know about various combinations of call and put with two put options.
- Know various combinations strategies and their types.

8.1 Introduction

In the previous lessons you have got an understanding of pricing mechanism of options. Now in this lesson an attempt has been done to let you understand that how options can be used for the purpose of trading. Also the profit patterns obtained through this trading exercise has been discussed in this lesson. Now to answer the questions that what will happen an investment is made in two or more different options on the same stock and how the profit patterns obtained should be examined, a lot of detail is provide with suitable illustrations to impart more clarity. Pay-off profiles are the relationship depicted on diagrams between profit and losses from an option investment strategy as a function of the price of the underlying asset at expiration. These are also known as "payoff pattern or profiles". Straddles and strangles are 'combinations' strategies which involve both puts and calls. On the other hand a spread is a combination of a put and a call with different exercise prices. A strip is a combination of two puts and one call with the same exercise price and the expiration date, while a strap is a combination of two calls and one put. A vertical spread or price spread is the buying and selling options for the same share and expiration date but different strike price. On the other hand a calendar spread or horizontal spread involves buying and selling options for the same share and strike price but different expiration date. Spread may be bullish, in case when the investor expects rise in prices of share and bearish when the investor expects decline in share or index. Butter-fly spread involves buying and selling of calls. In a long butterfly spread there is a buying of a call with low exercise price or buying a call with high exercise price and selling two calls with an exercise price in between the two. In a short-butterfly spread there is either selling a call with low exercise price or selling a call with a high exercise price and buying two calls with an exercise price in between the two. A collar strategy involves limiting a portfolio's value between two bounds.

8.2 Profit diagrams and option strategies

There is a profit/loss from an option investment strategy. This profit and loss is a function by the price of the underlying at expiration. The relationship between these two is depicted by pay off patterns or profiles known as "profit diagrams". Suppose an investor owns a share and its price goes up by Rs. 1 then the profit is Rs. 1. This is linear relationship. But in case of an option (call or put) the profit will occur in case when it is in-the-money (ITM). If the option owned by an investor is a call then at expiration, the profit rises by Rs. 1 for every one rupee increase in the stock price, if it is ITM. In case of out-of-the-money (OTM) option the profit is constant for any expiration day price of the underlying asset, i.e. investor looses the initial premium paid for the option. When several different options are used, more unusual pay-off are possible. To understand this concept of profit diagram in a more explanatory way, let us assume some conditions. Assume that there are only two relevant dates for the purchase and/or sale of the assets involved; the initial date (time 0) and the expiration date (time T). There is rarest possibility of exercising the option very early. Also, ignore for some time the dividends, commissions and margin requirements.

Profit diagrams for a long stock and short-stock

Suppose on x-axis there lies prices of stock at expiration date and profit and losses on y-axis. Let's assume that the investor buys the asset for S_0 (today) and sells it at a future date at an unknown price S_T. Once purchase, the investor is said to be 'long' the asset (Table 8.1 shown below).

TABLE 8.1: NOTATIONS

Variables	Subscripts
S = stock price	O = (today time)
K = strike price	T = (expiration date)
C = call premium	H = high strike price
P = put premium	L = low strike price
T = time to expiration	

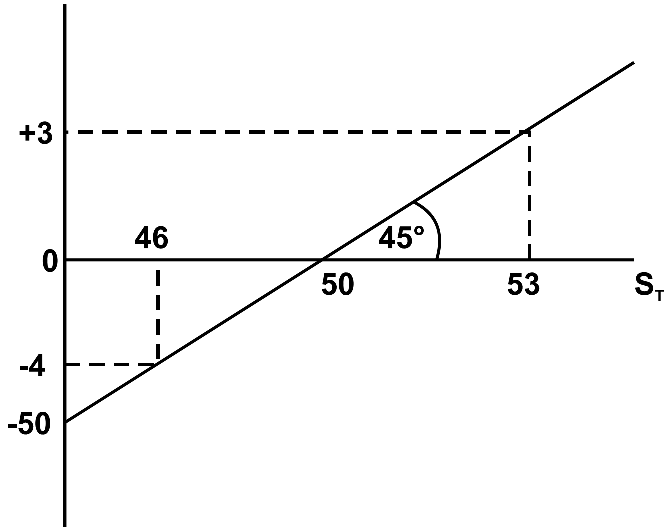

FIG. 8.1: PROFIT DIAGRAM FROM A LONG STOCK

Supposing the stock at initial date i.e. S_0 = Rs. 50/share. At later date the stock is sold at S_t = Rs. 53/share then there is a profit of Rs. 3/share. In case if the stock is sold at say Rs. 46/share then there is a loss of Rs. 4/share. The maximum loss (y-intercept) is Rs. 50/share, which occurs if S_T falling below Rs. 50 and the profit diagram is a straight line that passed through Rs. 50 point on x-axis. Thus if the stock is later sold for Rs. 50 (the purchase price), a Rs. 0 profit results from the diagram that a stock purchase is a bullish strategy.

Similarly the investor can sell short the stock, Fig 8.2 below shows the profit diagram from a short selling position. Suppose an investor sells a stock today at Rs. 50 to repurchase it on a later date. If at time T the stock is purchased at Rs. 50/- share, there is profit of Rs. 0/share.

If the stock price declines to Rs. 45 at time T. The S_T = Rs. 45 and the short seller's profit is Rs. 4/share. In case of rising the price, the investor looses. As a result of these, the stock only positions are straight lines that passes through the original transaction price with zero profit. The line for long stock position has a +1 slope (Tan 45° = 1) and short-stock has -1 slope (tan 45° = -1). These are examples of single stock. On the contrary option positions can create many other pay-off patterns.

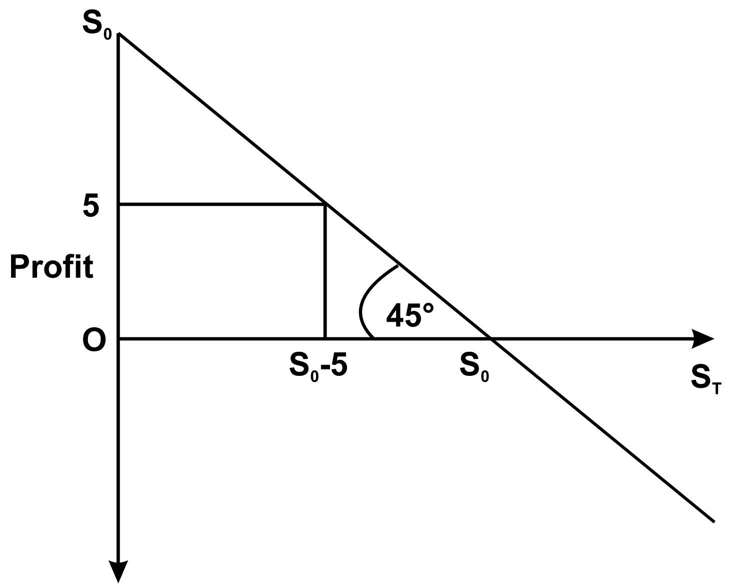

FIG. 8.2: PROFIT PATTERN OF SHORT-STOCK

8.3 Strategies involving a single option and a stock

Now let's discuss different trading strategies involving a single option on a stock and the stock itself. The dotted lines show the relationship between profit and the stock price for the individual securities constituting the portfolio. While the solid lines show the relationship between profit and the stock price for whole portfolio.

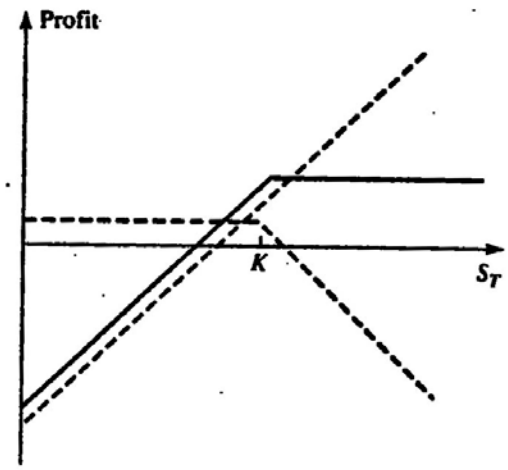

FIG. 8.3 (I): LONG POSITION IN A STOCK COMBINED WITH SHORT POSITION IN A CALL

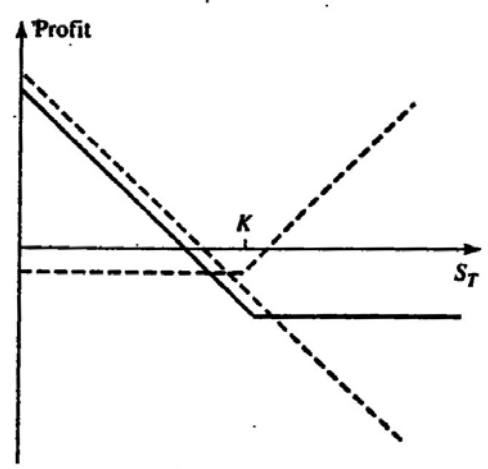

FIG. 8.3 (II): SHORT POSITION IN A STOCK COMBINED WITH LONG POSITION IN A CALL

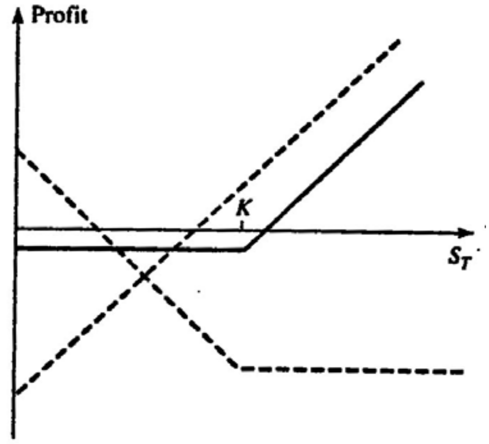

FIG. 8.3 (III): SHOWING LONG POSITION IN A PUT COMBINED WITH LONG POSITION IN A STOCK

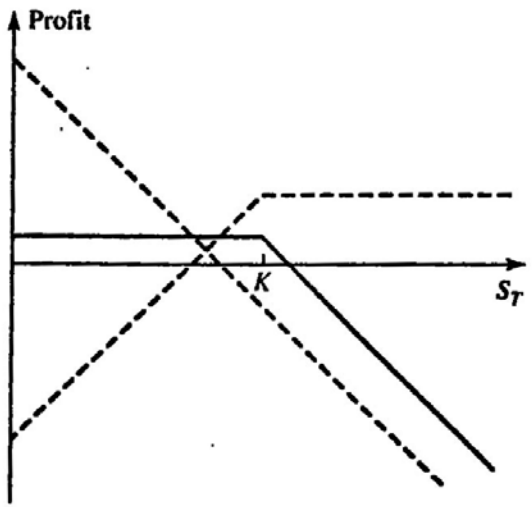

FIG 8.3 (IV): SHORT POSITION IN A PUT COMBINED WITH SHORT POSITION IN A STOCK

Hence from these simplest strategies, it is clear that option trading is based on the strike price and the time of exercising the option. The strategy in Fig 8.3 (I) is known as writing a covered call. In this strategy, the portfolio consists of a long position in stock with a short position in a call. The long stock position 'covers' on 'protects' the investor from the payoff on the short-call which is inevitable if there is a steep rise in the stock price. The Fig. 8.3 (II) showing short position in a stock with a long position in a call option is known as "reverse of writing a covered call". Protective put strategy is depicted in Fig. 8.3(III) which involves buying a put option on a stock and the stock itself. The reverse of a protective put is shown in Fig. 8.3 (IV).

8.4 Spreads

It is a combination of buying and selling of two or more options of the same type in anticipation of net profit due to offsetting of one's sale with other's purchase, i.e. the simultaneous purchase of one option and sale of another of same type. More categorically, the spreads can be classified into three categories: Vertical spreads may be publish or bearish and can be further classified as put and call. The spread may be of different strikes price and same expiration or different expiration date but same strike price. The diagonal spreads have different strike price and different expiration periods.

8.4.1 Vertical spread

This strategy involves the simultaneous buying and selling of options of the same type (underlying asset) for the same expiration date with different strike/exercise prices. These are of two types: vertical bull spreads and vertical bearish spread.

In vertical bull spread, an investor buys a call option on a stock with certain strike price and sells a call option on the same stock with a higher strike price. Both the options having the same expiration date. Suppose K, is the strike price of a call option bought K_1 is the strike price of the call option sold, S_T is the stock price on expiration of the option.

TABLE 8.2: PAYOFF FROM A VERTICAL BULL SPREAD

Stock price range	Payoff from long call option	Payoff from short call option	Total payoff
$S_T \geq K_2$	$S_T - K_1$	$K_2 - S_T$	$K_2 - K_1$
$K_1 < S_T < K_2$	$S_T - K_1$	0	$S_T - K$
$S_T \leq K_1$	0	0	0

There may be three conditions where the bull strategy can be distinguished:

(a) Both the calls are out of the money.

(b) One call is initially in-the-money and other call is initially out of the money.

(c) Both calls are out of the money.

In first condition (a) is more aggressive since they cost very less to set up and have a little probability of giving a relatively higher payoff (= $K_2 - K_1$). The other two types (b) and (c) are more conservative.

In a bullish call option spread, the investor purchases a call option with a low strike price and sells a call option with higher strike price, both with same expiration date. Thus he will have to pay a premium when he buys a call and will receive premium on selling the call option. The difference between these premia is called 'Net debit among option traders', which is a cost to the investor on option.

Thus, the maximum cost (loss) to the investor will be:

Maximum profit = Lower strike premium to be received – Higher strike premium to be paid.

In case when the stock price rises prior to expiration date the lower strike call will gain faster than the higher strike call will incur losses, resulting in net gain in the spread value. If the strike price goes higher than both the strike prices on expiration, then both the options will become in-the-money and will be exercised. The maximum profit will be:

Maximum profit = Higher strike price – Lower strike price – Net premium paid

Illustration 8.1: Assume that an investor buys for Rs. 6 a call with strike price of Rs. 60 and sells for Rs. 2 a call with a strike price of Rs. 65. The payoff from this bull spread strategy is Rs. 5 (65-60) if the stock price is above Rs. 35 and 0 if it is below Rs. 60. If the strike price is between 60 and 65, the payoff is the amount by which the stock price exceeds Rs. 60. The cost of strategy is Rs. 6 – Rs. 2 = Rs. 4. The profit is shown as under:

Stock price change	Profit

$S_T \leq 60$	- 4
$60 < S_T < 65$	$S_T - 64$
$S_T \geq 65$	6

Bullish put vertical option spread

In this spread, there is a buying a put with a low strike price and selling a put with a high strike price, both having the same date of expiration. In this strategy, the premium paid to buy the lower strike put option will always be less than the premium received from the sale of the higher strike put so that the net option premium generates a cash inflow.

The Fig. 8.4 shown below depicts this relationship very well.

If $S_T \geq$ Higher of the two strike prices i.e. K_1, K_2, the investors' maximum profit will be the Net premium income:

Maximum profit = Maximum premium received – Minimum premium paid.

Maximum loss will be where the stock price is less than the lower of the two-strike prices. In this situation both put will be exercised leading to maximum loss.

Maximum loss = Higher strike price – Lower strike price – Net option premium

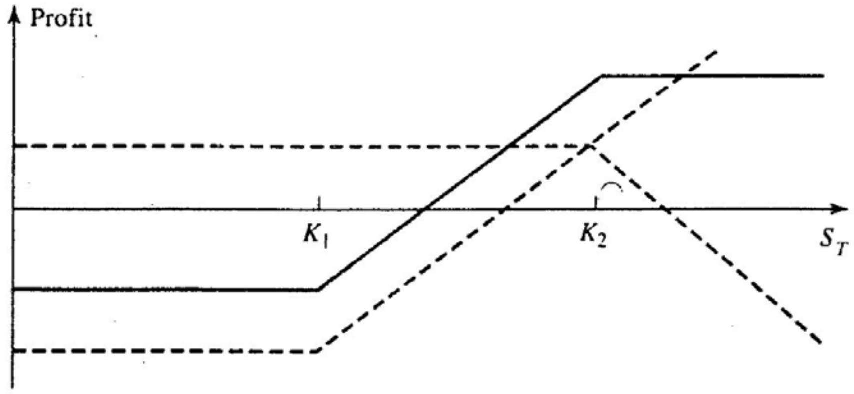

FIG. 8.4 (I): BULLISH VERTICAL CALL SPREADS

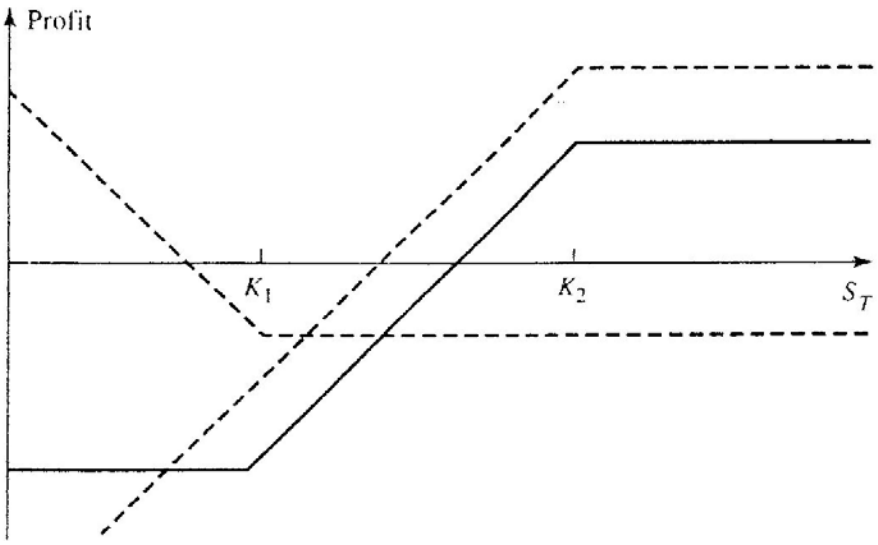

FIG. 8.4 (II): BULLISH VERTICAL PUT SPREADS

Bearish vertical option strategy

Bearish vertical option spread yields profit in case of decline in the price of the underlying assets. In this strategy the investor buys an option with higher strike price and sells at relatively lower strike price, both with same expiration date.

Bearish vertical option spreads are of two types: Bearish vertical call spread and Bearish vertical put spread. In bearish vertical call spread, the investor purchases the call option with higher strike price and sells at a lower strike price, both having the same expiration dates. If the stock price is less than the lower strike price, both the options will be out of the money. The pay off from a bearish vertical spread is shown in the Table 8.3 below:

TABLE 8.3: PAYOFF FROM BEARISH VERTICAL SPREAD

Strike price range	Payoff from long call option	Payoff from short call option	Total payoff
$S_T \geq K_2$	$S_T - K_2$	$K_1 - S_T$	$-(K_2 - K_1)$
$K_1 < S_T < K_2$	0	$K_1 - S_T$	$-(S_T - K_1)$
$S_T \leq K_1$	0	0	0

Illustration 8.3: Suppose an investor buys a call option with strike price of Rs. 100 for a Rs. 10 and sells for Rs. 20 a call with a strike price of Rs. 90. The payoff with this bear spread is Rs. 10 (100 – 90), if the stock price is more than Rs. 100 and zero if is below Rs. 90. If the stock price is between 90 and 100, the payoff is $-(S_T - 90)$. The investment creates Rs. 20 – 10 = Rs. 10 upfront premium. The profit will be calculated as

Stock price range	Profit (Rs.)
$S_T \leq 90$	+ 10
$90 < S_T < 100$	$100 - S_T$
$S_T \geq 100$	0 [100 – (90 + 10)]

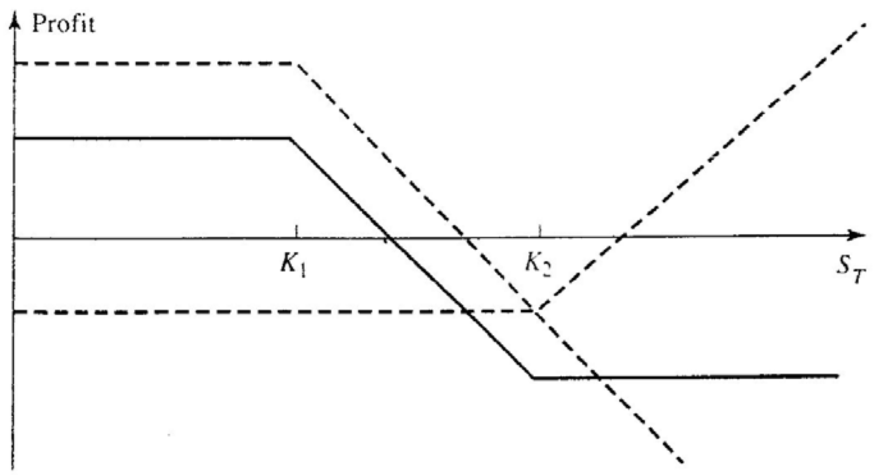

FIG. 8.5 (I): BEAR SPREADS CREATED USING CALL OPTIONS

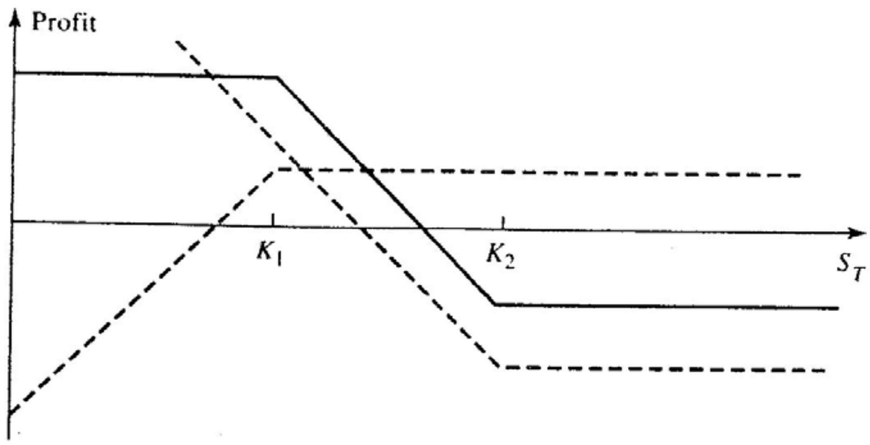

FIG. 8.5 (II): BEAR SPREADS CREATED USING PUT OPTIONS

8.4.2 Butterfly spread

It involves positions in options with three different strike prices as follows:

The investor purchases a call option with a relatively low strike price K, with higher strike price K_3, and selling two call options with a strike price K_2, half way between K_1 and K_3. Usually K_2 is closer to current strike price. A butterfly spread leads to a profit if the strike price is closer to K_2 but there is a small loss in case of significant price movement in either direction.

To understand this concept let's take following illustration.

Illustration 8.4: Assume that the current price of a stock is Rs. 81. An investor expects the movement in the price within six months as follows:

Strike price (Rs.)	Call price (Rs.)
78	12
80	9
85	5

The investor can create a butterfly spread by purchasing one call with a Rs. 78 strike price and another call Rs. 85 and selling two calls with strike price of Rs. 80. It costs to the investor Rs. 12 + 5 – (2 × 9) = Rs. (-2) to create the spread. If the stock price within six months is greater than Rs. 85 and less than Rs. 78, the payoff will be zero. If the stock price is between Rs. 79 and Rs. 84, then profit will be made. The payoff from a butterfly spread will be as shown in the Table 8.4.

TABLE 8.4: PAYOFF FROM A BUTTERFLY SPREAD

Strike price range	Payoff from first long call	Payoff from second long call	Payoff from short call	Total payoff
$S_T < K_1$	0	0	0	0
$K_1 < S_T < K_2$	$S_T - K_1$	0	0	$S_T - K_1$
$K_2 < S_T < K_3$	$S_T - K_1$	0	$-2 (S_T - K_2)$	$K_3 - S_T$
$S_T > K_3$	$S_T - K_1$	$S_T - K_3$	$- 2 (S_T - K_2)$	0

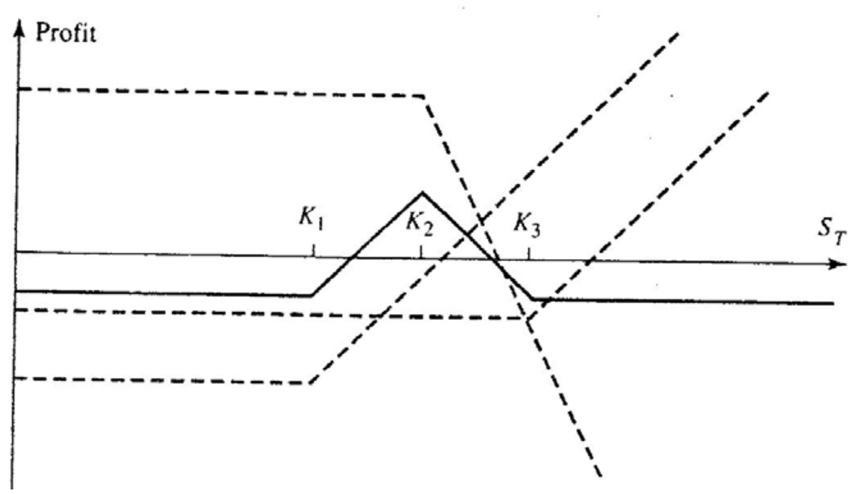

FIG. 8.6 (I) BUTTERFLY SPREAD USING CALL OPTIONS

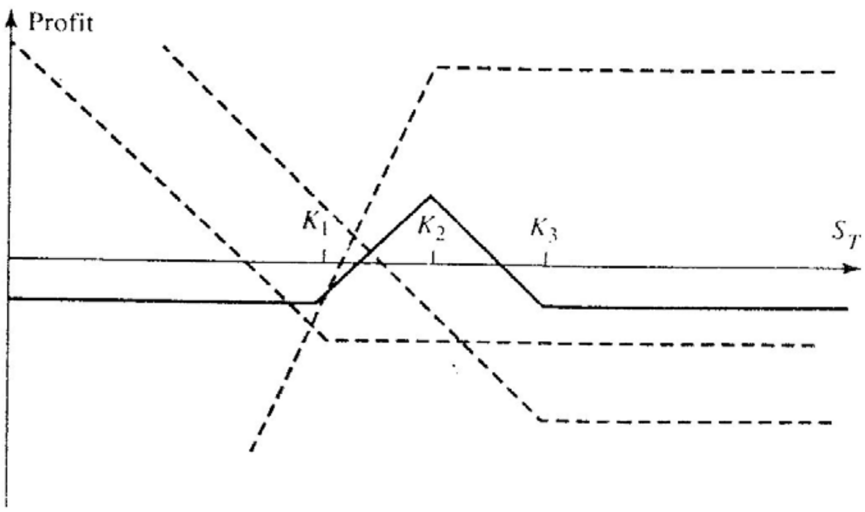

FIG. 8.6 (II) BUTTERFLY SPREAD USING PUT OPTIONS

Similarly butterfly spread can be used with help of put options. In this spread the investor buys a put with low strike price, buys a put with high strike price and sells two puts with intermediate price (between two strike prices) as shown in Fig. 8.6 (ii), e.g. a butterfly put spread can be created by buying two put options with strike price of Rs. 78, Rs. 85 and selling two put options with strike price of Rs. 80.

8.4.3 Calendar spread or horizontal spread

A calendar spread is also known as horizontal spread in which the options have the same strike price and different expiration dates. A horizontal/calendar spread can be created by selling a call with certain strike price and buying a longer maturity call option with the same strike price. The time remained to expiration is an important factor to decide time value of the option. The time value of the option with nearby maturing date moved decay at a faster rate than that of the option with distant maturity. The longer the matrity of the option the more expensive it would be. Therefore, it requires an initial investment the investor earns a profit if the stock price at the expiration of the short-maturity option is close to the strike price of the short maturity option. In case where the strike price is significantly higher or lower than this strike price. Consider the case that what happens when the stock price is very low when the short-maturity option expires. The short-maturity option is worthless and the value of the long-maturity option is almost zero. The investor incurs a loss which is equal to the cost of setting up the spread initially. What happens if the stock price is very high when short-maturity option expires. The short-maturity option will cost the investor S_T – K and the long-maturity option and is worth little more than S_T – K, K being the strike price of the option. Suppose S_T is close to K, the short term option will cost the investor either a small amount or nothing at all. In long term option net profit will be made. A reverse calendar spread ca also be created in which an investor buys a short-maturity option and sells a long maturity option.

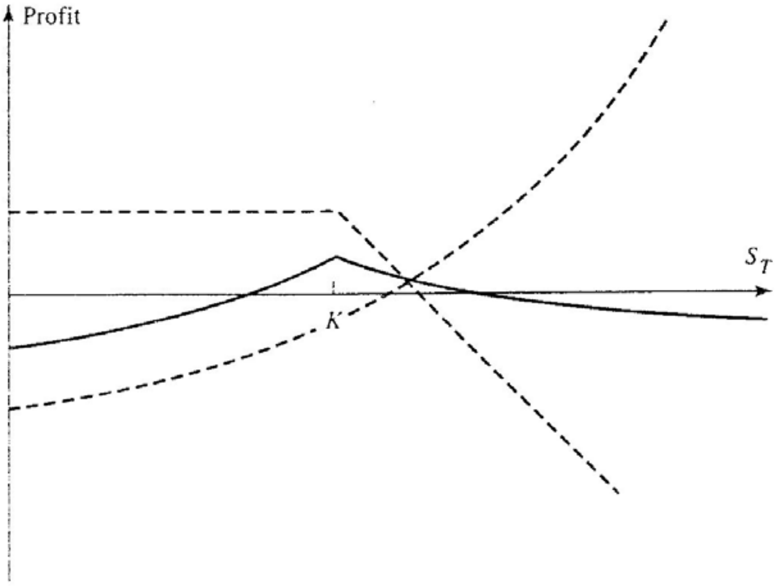

FIG. 8.7 (I): CALENDAR SPREAD CREATED USING TWO CALLS

Dotted lines show short-term call of a single stock and solid line shows profit and loss of calendar spread.

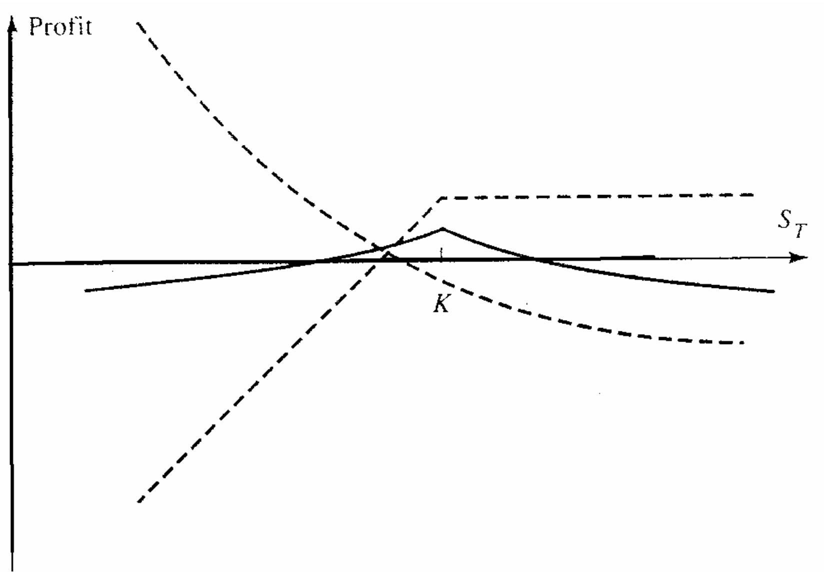

FIG. 8.7 (II): CALENDAR SPREAD WITH TWO PUT OPTIONS

8.4.4 Diagonal spread

A diagonal spread involves both types of vertical and horizontal spread. In this spread both strike prices as well as expiration dates are different, several types of diagonal spreads can be created. The profit profiles can be drawn by considering bull and bear spreads.

8.5 Combination strategies

These strategies involve taking a position in both call and put on the same asset. The various strategies in this combination are straddles, strangles, strips and straps.

8.5.1 Straddle strategies

These strategies involve simultaneous buying a call and selling a put with same strike price and expiration date. There are two types of straddles: Long straddle and short straddle. A long straddle involve buying an equal number of calls and puts with the same stock, at the same strike price and for the same expiration date. In case of price movement in any direction, the investor is not aware of the movement, therefore if the stock price falls, the put option will be used and if the price rises, the call option will be used. Fig. 8.7 (i) shows the profit pattern of a long straddle.

The solid line denotes the position of long straddle while two options put and call are marked by dotted lines.

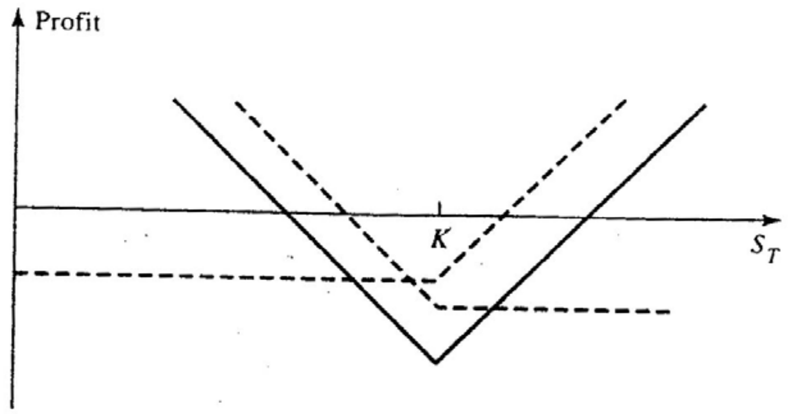

FIG. 8.8 (I)

Short Straddle: A short straddle is simultaneous sale of a call and a put on the same stock, at same expiration date and strike price.

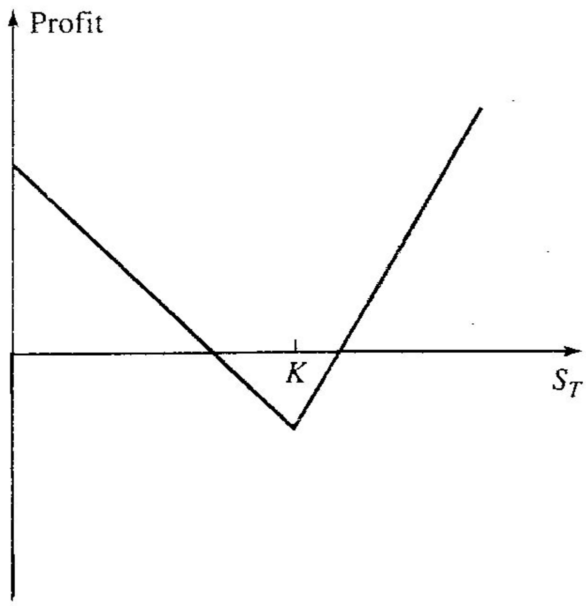

FIG. 8.8 (II): SHORT STRADDLE

Illustration 8.5: Suppose an investor create straddle strategy by buying three-month call with strike price of Rs. 70 for a premium of Rs. 5 and sells a three month put with same strike price at price of Rs. 3 Assume that after three months the price goes up to Rs. 75 or comes down to Rs. 65. What is your pay off at expiration of the options.

Solution: Premium paid = Rs. 5 + Rs. 3 = Rs. 8

Profit or Loss at expiration

Share price Rs. 75: Call (Rs. 75 – Rs. 70) + Put (0) - Premium Rs. 8

= - Rs. 3.

Share price Rs. 65 : Call : (0) + Put : Rs. (70 – 65) – Premium : Rs. 8 = - 3.

8.5.2 Strips and straps

The strategies can also be derived by variations of a straddle, these are known as strips and straps. A strip is a combination of two puts and one call with the same exercise price and the expiration date. On the other hand strap involves combination of two calls and one put with same exercise dates and strike prices. The profit patterns of the two can be understood by taking the example. Let's assume that the strike price of puts and calls is Rs. 50 and the share price at expiration is Rs. 45, Rs. 50 and Rs. 55. Irrespective of the price movements, the investor has the positive pay offs, except in the case where the price equals the strike price.

The potential payoffs would be higher under a strap strategy for share price above the strike price. The Fig. 8.8 (i) and 8.8 (ii) shows profit pattern for a strip and a strap.

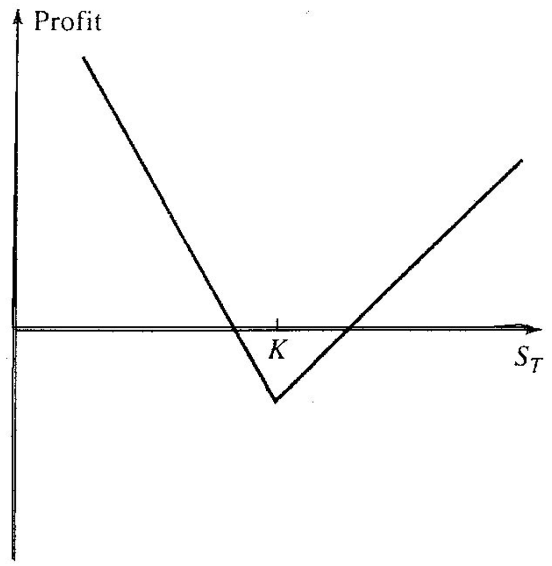

FIG. 8.8 (I) PROFIT PATTERN FOR A STRIP

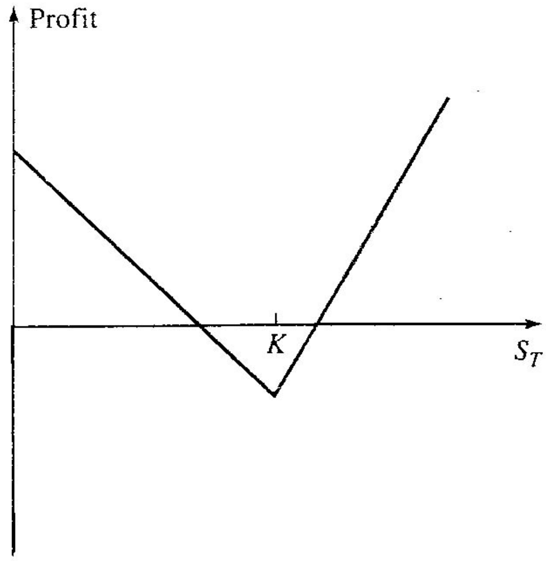

FIG. 8.8 (II) PROFIT PATTERN FOR A STRAP

The investor takes a strip position in anticipation of big movement of stock price in downward side rather than upward, that is why he goes for two puts and one call. In a strap position the investor expects a rise in share price and as a result he opts for two calls and a put.

8.5.3 Strangle

It is different from a straddle only in term of strike price. A strangle is a combination (portfolio) of a put and a call with the same expiration date but with different strike prices. The investor combines an out-of-the-money call with an out-of-the-money put. He will buy a call with strike price higher than the underlying stock's current price and a put with a strike price lower than the underlying stock's current price. When a strangle position is bought, it is called as long strangle and when it is sold, it will become short strangle. A strangle can either be created by in-the-money-call and in-the-money put or with one option being in-the-money and the other be out-of-the-money.

To have more understanding of the concept, suppose that KBC share is being sold for Rs. 55. The strike price for KBC put and call are Rs. 50 and Rs. 60 respectively. What will be the pay-off if the price of KBC increases to Rs. 75 in next three months. Definitely you will forego put option and exercise call option. Your pay off will be excess of the share price over the call strike price i.e. Rs. 75 – Rs. 60 = Rs. 15. If the stock price of KBC goes down to Rs. 45 in three months. Definitely you will exercise put option and forgo the call. In this case your payoff will be the excess of strike price over the current share price, i.e., Rs. 50 – Rs. 40 = Rs. 10.

Your payoff will be zero when the share price ranges between two strike prices – Rs. 50 and Rs. 60.

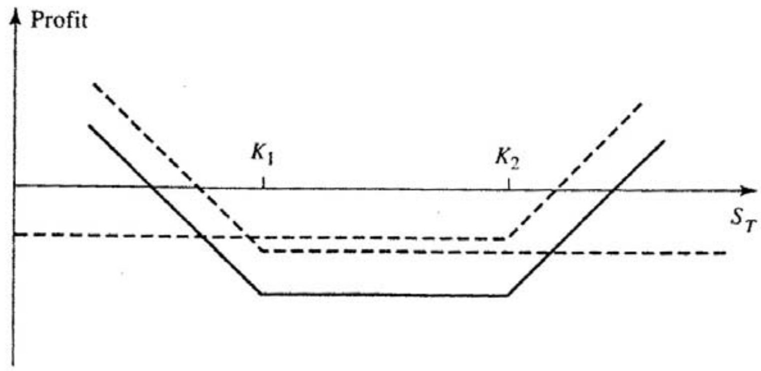

FIG. 8.9 (I): PAYOFF FROM A STRANGLE

The following Table 8.9 helps to understand different option strategies in easy way.

Strategy	**Share**	**Call option**	**Put option**	**Strike price**	**Expiration date**
Spread	Same	One	One	Different	Same
Vertical spread	Same	Buying/selling	Buying/selling	Different	Same
Calendar spread	Same	Buying	Selling/selling	Same	Different
Straddle	Same	Buying (combination)	Selling (combination)	Same	Same
Strangle	Same	Buying (combination)	Selling (combination)	Different	Same

8.6 Summary

Option trading is done for hedging, speculation and arbitrage purposes. The profit patterns or trade off is a graph where on x-axis there lies price and on y-axis profit and loss. The options can be exercised in either case of rising of the current prices or in case of declining of the current prices. Based on the expectations of rise/fall in the current prices, the option traders either sell or buy them within or on maturity date. The buying an selling of options are dependent on intrinsic value and time value of options. If there is simply selling and buying of an option series, it is called simple trading strategies. These strategies may be: long position combined with short-position in call; short position combined with long position in call; long position combined with long position in put; short position combined with short position in put.

The ultimate objective of using these strategies is to get the maximum net payoff. There are a number of strategies involving buying and selling of two or more than two options having either same exercise price or date or different strike price and dates. In spread strategy, there is simultaneous buying of one option and selling of another option of the same type. This strategy is based on the expectation of change in prices of the option and the payoff will be obtained by offsetting of the two positions. Spreads are of three types- vertical, horizontal and diagonal spread. In vertical spread involves the trading of option having different strike prices but same expiration dates. The vertical options strategies have two categories: the Bullish vertical spread on both put and call and bearish vertical spread on both put and call. In horizontal spreads, the trading of options having same strike prices but different expiration date is done. Diagonal spread has a combination of both vertical and horizontal spreads.

There are strategies for the investors who use both call and put on the same asset. Straddles, strangles, strips and straps are such strategies. Straddle strategy involves simultaneous buying a call and put with the same exercise price and expiration date. A long straddle is created by buying an equal number of calls and puts with same stock at same exercise price same expiration date. On the other hand a short straddle involves simultaneous sale of a call and put the same stock, at the same strike price and exercise date. Strip strategy involves a long position with one call and two put options with same exercise price and expiration date. A strap is created by a long position with two calls and one put options with the same price and same expiration date. A strangle is just similar to a straddle except one difference i.e. in a straddle, the position is taken on the same strike price while in a strangle the position is taken with different exercise prices. The investor buys a put and a call with the same expiration date but with different exercise price i.e. the exercise price of put and call is different strangle may be of long and short strangles. Different strategies have different profit patterns.

8.7 Keywords

Butterfly spread is a spread by taking a particular position in options with three different strike prices. In this strategy the investor buys a call with a relatively lower exercise price say K_1 and higher strike price K_3 and selling two call options with an exercise price say K_2 which lies between K_1 and K_3.

Combination is a position involving both calls and puts on the same underlying asset.

Covered call option writing is a technique used by investors to help funding their underlying positions, which is used in equity market.

Diagonal spread is a combination of both types of vertical as well as horizontal spreads in which both expiration dates and the strike prices of calls are different.

Horizontal/time/calendar spread is the spread which is created by selling an option with a relatively shorter period to expiration and buying an option of the same type with a longer period to expiration.

Long straddle is the strategy which is created by an equal number of calls and puts with the same stock at the same exercise price and the same expiration date.

Short straddle is the simultaneous sale of a call and a put on the same stock at the same strike price and on the same exercise date.

Spread is a trading strategy which can be created by taking a position into or more options of the same type i.e. by combining two or more calls or two or more puts.

Straddle is a combination strategy in which the position is taken in the same number of puts and calls with the same strike prices.

Strangle is a position where an investor buys a put and a call option with the same exercise date but with different strike prices.

Strap is a long position with two call and one put options with the same exercise price and same date of expiration.

Strips is a long position with one call and two put options with the same exercise price and expiration date.

Vertical Bearish call option is an option in which an investor buys the option with a higher strike price and sells at a lower strike price both having same expiry periods.

Vertical Bullish spread is the spread in which an investor buys a call option on a stock with a certain strike price and selling a call option on the same stock with a higher strike price. Both options have the same expiry date.

Vertical spread is buying and selling puts or calls having same expiration date but with different strike prices.

8.8 Self assessment questions

1. Explain various positions of option? Discuss with suitable illustrations and diagrams.

2. What do you know by profit diagrams? How profit diagram can be useful in making strategies of option trading?

3. Discuss different strategies of option trading with suitable examples.

4. How do you differentiate spread and straddle strategies? Explain with suitable examples.

5. What are different types of vertical and horizontal spreads? Explain with suitable examples.

6. Write notes on the following-
   (i) Bullish call option spread
   (ii) Bearish call option spread
   (iii) Long straddle
   (iv) Short straddle
   (v) Features of diagonal spread
   (vi) Profit diagrams
   (vii) Butterfly spread
   (viii) Straddle vs. Strangle

7. A stock is currently selling for Rs. 500. The price of call option expiring six months are as follows:
   Strike price = Rs. 450, Call price = Rs. 15
   Strike price = Rs. 490, Call price = Rs. 10
   Strike price = Rs. 525, Call price = Rs. 8
   Investor expects that the stock price will move significantly in next six months. Draw a butterfly spread with suitable options.

8. A call option with a exercise price of Rs. 100 costs Rs. 5. A put option with a strike price of Rs. 95 costs Rs. 4. Discuss how a strangle can be created from these two options. And show profit profile of strangle, suppose stock price on expiration date is Rs. 110.

9. How option strategies can be utilised in trading of currency call and currency put options? For more elaboration, please refer lesson 6 and explain with suitable examples.

10. Write detail notes on combination strategies involving positions in both call and put options on the same asset with suitable examples.

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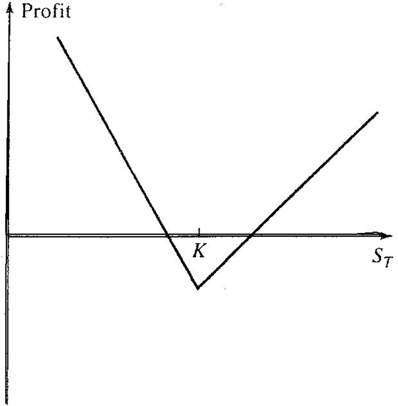
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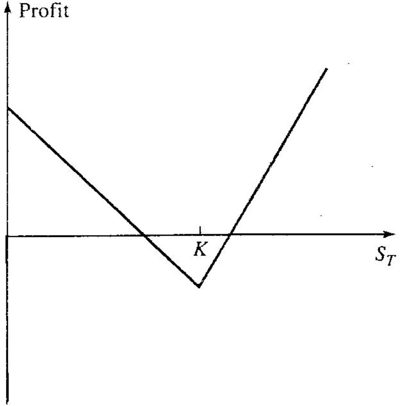
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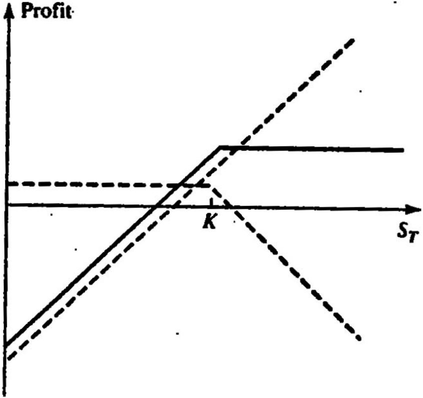

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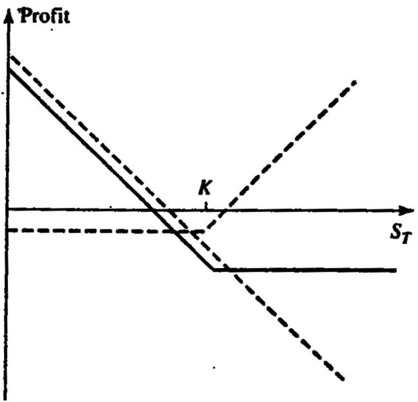
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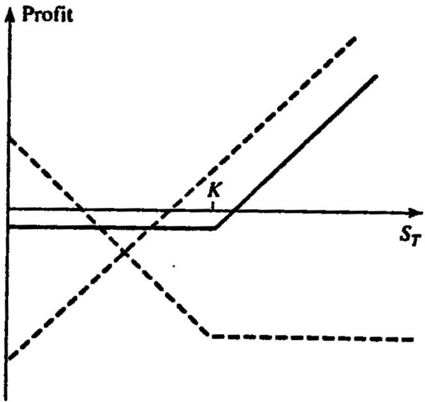
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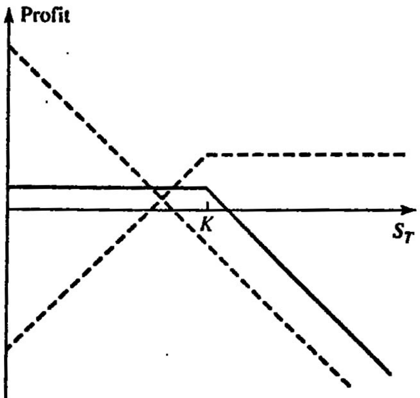
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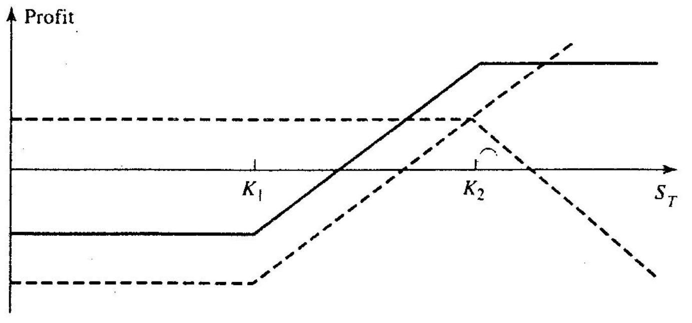

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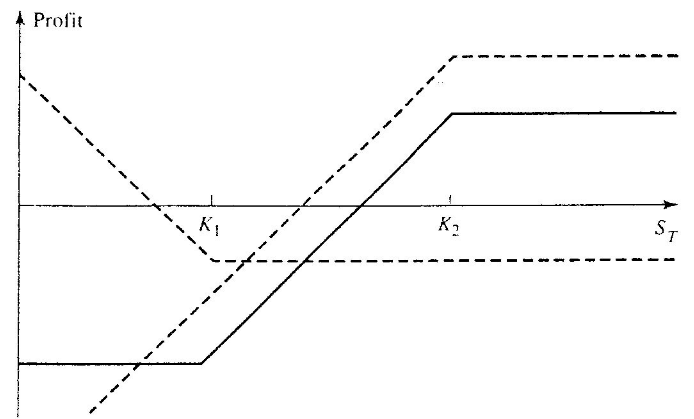

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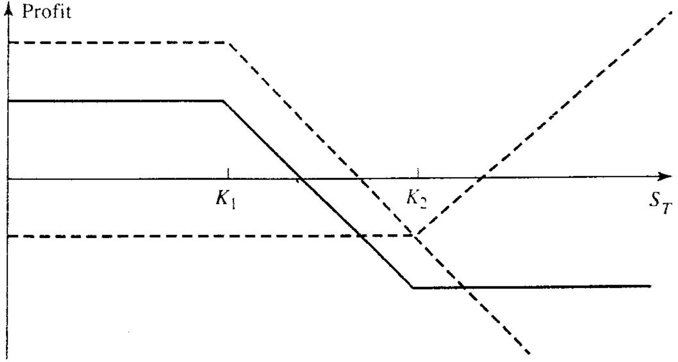

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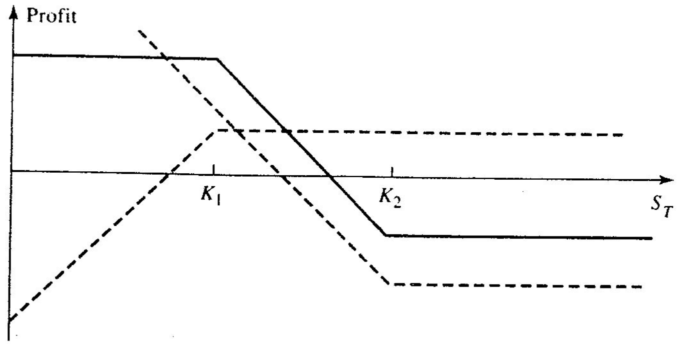
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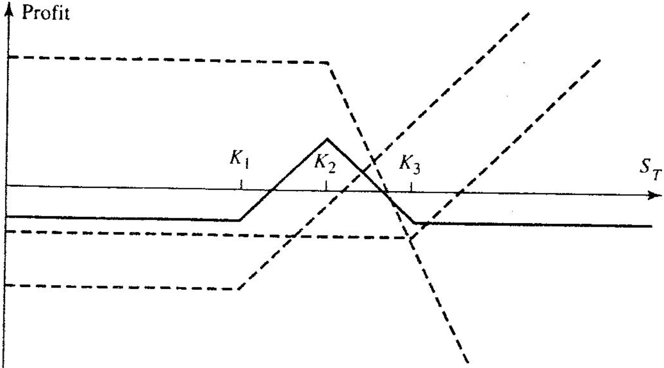
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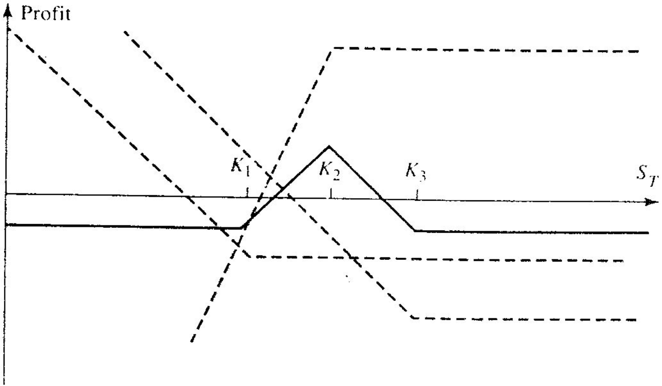

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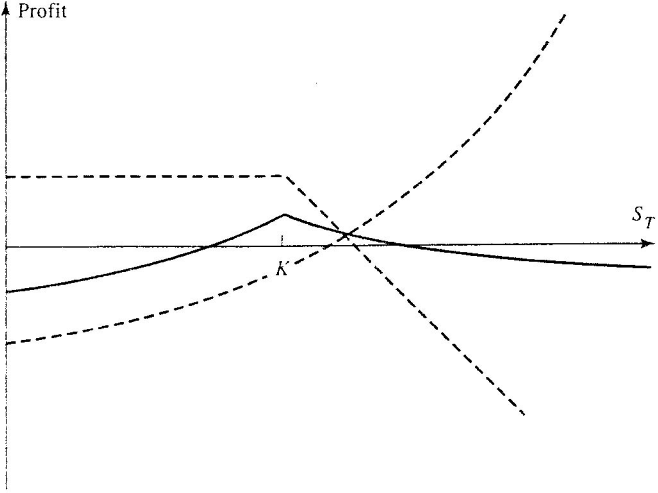
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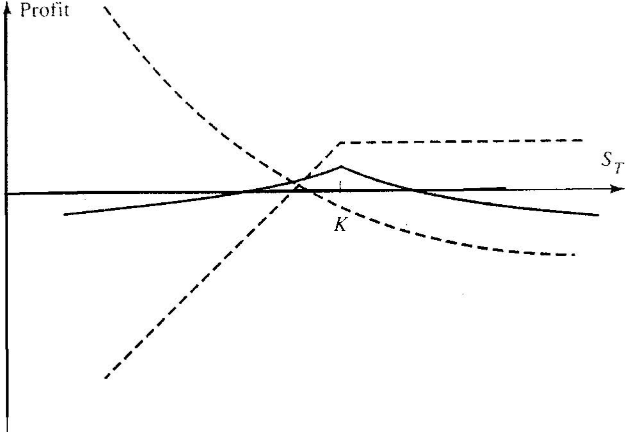

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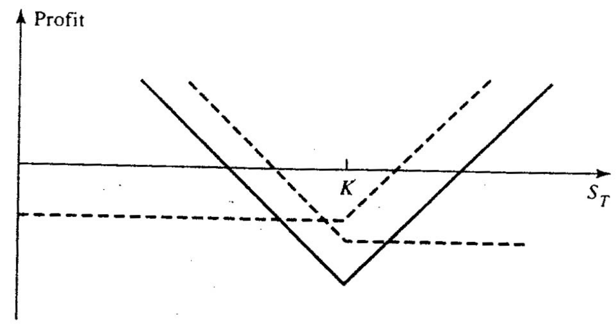
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Subject: **FINANCIAL DERIVATIVES**
Code: **FM-407**
Author: **Prof. B.S. Bodla**
Lesson No.: **09**

DERIVATIVE MARKETS IN INDIA: EVOLUTION AND REGULATION

STRUCTURE

9.0 OBJECTIVE

After studying this lesson, you should be able to

- Bring out evolution and growth of derivatives market in India

- Describe regulatory framework regarding derivatives trading at various stock exchanges in India
- Discuss eligibility conditions for becoming member at derivative exchange
- Differentiate between *Badla* system and derivatives trading
- Describe SEBI guidelines to protect traders in the derivatives market

9.1 INTRODUCTION

With markets now driving economic and financial globalization, India's geopolitical importance has assumed new dimensions. Geographically, it commands access to the Indian Ocean, Arabian Sea and Central Asia i.e. the world's main hydrocarbon reservoir whose resources are likely to be much more important for India than they have been in the past. Even with the size, demography and latent capability of its population-one sixth of the world- India has become one of the fastest growing potential consumer markets of the 21^{st} century. At the same time, an increasingly powerful, wealthy and educated Indian Diaspora is wielding considerable intellectual artistic, cultural, culinary, literary, political & financial influence in the US & Europe, bolstering India's global significance. All this is of crucial interest to global finance markets and hence to the emergence of global derivatives market. Since 1990, India's financial system has become more exposed to the global bonding of the financial, IT and telecommunications industries whose linkages keep widening, deepening and growing because it is most tactile, open and non physical. Therefore, it has felt the earliest & greatest pressure to accommodate and adapt to globalization more quickly than other systems and markets.

Financial Market liberalization since early 1990's has brought about major changes in the financial market in India. The creation and empowerment of Securities Exchange Board of India (SEBI) has helped in proceeding higher-level accountabilities in the market. New Institutions like National Stock Exchange of India Ltd. (NSEIL), National Securities Depository Ltd. (NSDL), and National Securities Clearance Corporation (NSCCL) have been the change agents and helped in bringing transparency and providing safety to investing public at large with modern technology in hand. Microstructure changes have brought about reduction in transaction cost and that has helped investors to lock in a deal faster and cheaper. The pursued reform process have helped to improve efficiency in information dissemination, enhancing transparency, prohibiting unfair trade practices like insider trading and price rigging. The objective has been to move the Indian market to such a level where it would fully integrate with the global developed markets. As global financial markets have already abandoned inefficient, ineffective, obsolescent approaches to risk hedging and risk management two decades ago, it was natural that India would eventually (but inevitably) go the same way, especially if its financial market was to adapt global financial market. Therefore, the opaque *Badla* System was banned and financial derivatives were introduced subsequently in the market as a tool of risk management and price discovery.

The derivatives in Indian capital market were introduced on the recommendations of L C Gupta committee in December 1997. But due to lack of proper regulatory framework, it couldn't be possible to introduce derivatives before June 2000. Basically, derivatives are risk management tools. The derivatives provide the facility of risk hedging in the most cost efficient way against risk. Since its inception, exchange traded derivatives have progressed considerably. Starting from a climate of suspicion and ignorance, we are now a country with a thriving equity derivatives market, with policy makers seeking to develop similar markets in other areas.

The word 'Derivatives' comes from the verb 'to derive'. It indicates that it has no independent value. A derivative is a contract whose value is entirely derived from the value of the asset, known as the underlying, which could be a share, stock market index, an interest rate, a commodity or a currency. The underlying is the identification tag for a derivative contract. When the value of underlying changes, the value of derivatives also changes. Without an underlying, derivatives don't have any meaning. For example, a gold futures contract derives its value from the value of the underlying asset, that is, gold.

According to Section 2(aa) of the Securities Contract (regulation) Act, 1956, Derivatives includes:

a) A security derived from a debt instrument, share, and loan whether secured or unsecured, risk instrument or contract for differences or any other form of security.

b) A contract, which derives its value from the price or index of prices of underlying securities.

In simple terms, Derivatives means forward, futures or option contract of pre-determined fixed duration, linked for the purpose of contract fulfilment to the specified real or financial or asset or to index of securities. Derivatives offer organizations the opportunity to break financial risk into smaller components and then to buy and sell those components to best meet specific management objectives. One thing should be clear in mind that derivatives don’t eliminate the risk. It is only a tool to transfer the risk from one, who is not able to bear to other who is ready to bear it.

9.2 EVOLUTION OF DERIVATIVES IN INDIA

In India, commodity futures date back to 1875. The government banned futures trading in many of the commodities in the sixties and seventies. Forward trading was banned in the 1960s by the Government despite the fact that India had a long tradition of forward markets. Derivatives were not referred to as options and futures but as 'tezi-mandi'.

In exercise of the power conferred on it under section 16 of the securities contracts (regulation), the government by its notification issued in 1969 prohibited all forward trading in securities. However, the forward contracts in the rupee dollar exchange rates (foreign exchange market) are allowed by the reserve bank and used on a fairly large scale. Futures trading are permitted in 41 commodities. There are 1 8 commodity exchanges in India. The forward markets commission, under the ministry of food and consumer affairs, act as a regulator.

In the case of capital markets, the indigenous 125-year-old *Badla* system was very popular among the broking community. The advent of foreign institutional investors in the nineties and a large number of scams led to a ban on *Badla*. The foreign institutional investors (FIIs) were not comfortable with the system and they insisted on adequate risk management tools. Hence, the Securities Exchange Board of India (SEBI) decided to introduce financial derivatives in India. However, there were many legal hurdles, which had to be overcome before introducing financial derivatives. The preamble of Securities Contract (Regulations) Act was to prevent undesirable transactions in securities by regulating business of dealing therein, by prohibiting options, and by proving for certain other matters connected therewith. Section 20 of the act explicitly prohibits all options in securities. The first step, therefore, was to withdraw all these prohibitions and make necessary amendments in the act. The securities Law (Amendment) Ordinance, 1995, promulgated on January 25, 1995, withdrew the prohibition on options in securities. This has opened the possibility of starting options trading in India. The market for derivatives, however, did not take off, as there was no regulatory framework to govern trading of derivatives. Hence, SEBI set up a committee under the chairmanship of Dr. L C Gupta on November 18, 1996, to develop a regulatory framework for derivatives trading in India. The committee submitted its report on March 17, 1998.

The committee recommended that derivatives should be declared as 'securities' so that regulatory framework applicable to trading of securities could also govern the trading of derivatives. SEBI also set up a group in June 1998 under the chairmanship of Prof. J. R. Verma, to recommend measures for risk containment in derivatives market in India.

The report, which was submitted in October 1998, worked out the operational details of margining system, methodology for charging initial margins, broker net worth, deposit requirement and real-time monitoring requirements. The major recommendations of this committee were accepted by SEBI in March 1999.

On the recommendations of L C Gupta Committee, the Securities Contract Regulation Act (SCRA) was amended in Dec. 1999 to include derivatives in the ambit of 'securities' and the regulatory framework was developed for governing derivatives trading. The act also made it clear that derivatives should be legal and valid if such contracts are traded on a recognized stock exchange, thus precluding OTC derivatives. The Government also rescinded in March 2000, the three-decade old notification, which prohibited forward trading in securities.

Derivatives trading formally commenced in June 2000 on the two major stock exchanges, BSE and NSE. Futures trading based on the Sensex commenced at the BSE on June 9, 2000, while futures trading based on S&P CNX Nifty commenced at the NSE on June 12, 2000.

SEBI setup a technical group to lay down the broad framework for risk management of index options. The trading in Index options commenced in June 4, 2001. The options on individual stocks were introduced in July 4, 2001 and that stocks were followed by futures on individual stocks in Nov. 9, 2001. Now, the National Stock Exchange is the leading stock exchange for both equity and derivatives trading in India. Turnover in the equity derivative market in India is shown in Table 9.1.

9.3 PARTICIPANTS IN DERIVATIVES MARKET

The derivatives market is growing considerably all over the world. The main reason is that they have attracted many types of traders having a great deal of liquidity. When an investor wants to take one side of contract, there is usually no problem in finding someone that is prepared to take the other side. The different traders active in the derivatives market can be categorized into three parts:

1. Hedgers

Hedging is an activity to reduce risk and hedger is someone who faces risk associated with price movement of an asset and who uses derivatives as a means of reducing that risk. A hedger is a trader who enters the futures market to reduce a pre-existing risk.

For example, an importer imports some goods from USA for $ 100 and the payment is to be made after three months. Suppose, today the dollar-price quote is 1 $= Rs. 45. Therefore, if the payment is to be made today, the cost of goods in Indian currency will be Rs. 4500. But due to uncertainty in future movement in prices, there may be chance of dollar appreciation thereby increasing the cost of goods for the importer. In that case, there would be a loss to the importer. To avoid such risk, he enters in the three months futures contract to buy $100 at Rs. 45/$. This would have the effect of fixing the price to be paid to the US exporter at Rs. 4500 regardless of the dollar-price quote after three months that may appreciate or depreciate.

TABLE 9.1: BUSINESS GROWTH IN DERIVATIVES SEGMENT

Month / Year	Index Futures		Stock Futures		Index Options		Stock Options		Interest Rate Futures		Total		Average Daily Turnover (Rs. cr.)
	No. of contracts	Turnover (Rs. cr.)	No. of contracts	Turnover (Rs. cr.)	No. of contracts	Turnover (Rs. cr.)	No. of contracts	Turnover (Rs. cr.)	No. of contracts	Turnover (Rs. cr.)	No. of contracts	Turnover (Rs. cr.)	
Current Month													
Nov.06	4,644,632	180,781	10,539,507	388,800	1,546,642	60,018	553,738	20,229	0	0	17,284,519	649,829	29,538
Oct.06	4,556,984	166,974	7,929,018	272,516	1,352,788	49,744	474,936	16,425	0	0	14,313,726	505,658	25,283
Sep.06	5,081,055	177,518	8,644,137	275,430	1,524,721	53,647	507,553	16,351	0	0	15,757,466	522,946	24,902
Aug.06	5,250,973	173,333	7,530,310	229,184	1,596,255	53,103	446,520	14,042	0	0	14,824,058	469,662	21,348
Jul.06	6,103,483	186,760	5,614,044	222,539	1,750,455	54,711	316,876	13,245	0	0	13,784,858	477,255	22,726
Jun.06	8,437,382	243,572	6,241,247	243,950	1,911,398	57,969	264,487	11,306	0	0	16,854,514	556,797	24,209
May.06	7,666,525	257,326	9,082,184	409,401	1,655,677	58,789	359,678	16,874	0	0	18,764,064	742,390	33,745
Apr.06	5,847,035	204,236	10,021,529	460,552	1,489,104	52,421	460,485	20,623	0	0	17,818,153	737,832	40,991
2005-06	58,537,886	1,513,755	80,905,493	2,791,697	12,935,116	338,469	5,240,776	180,253	0	0	157,619,271	4,824,174	19,220
2004-05	21,635,449	772,147	47,043,066	1,484,056	3,293,558	121,943	5,045,112	168,836	0	0	77,017,185	2,546,982	10,107
2003-04	17,191,668	554,446	32,368,842	1,305,939	1,732,414	52,816	5,583,071	217,207	10,781	202	56,886,776	2,130,610	8,388
2002-03	2,126,763	43,952	10,676,843	286,533	442,241	9,246	3,523,062	100,131	-	-	16,768,909	439,862	1,752
2001-02	1,025,588	21,483	1,957,856	51,515	175,900	3,765	1,037,529	25,163	-	-	4,196,873	101,926	410
2000-01	90,580	2,365	-	-	-	-	-	-	-	-	90,580	2,365	11

Note: Notional Turnover = (Strike Price + Premium) * Quantity Index Futures, Index Options, Stock Options and Stock Futures were introduced in June 2000, June 2001, July 2001 and November 2001 respectively.

Basically futures contracts are used to eliminate risk when the future course of action regarding the receipt or payment is certain while the option contract are used when the future course of action is uncertain.

2. Speculators

While hedgers are interested in reducing or eliminating the risk, Speculators buy and sell the derivatives to make profit and not to reduce the risk. They buy when they believe futures or options to be under priced and sell when they view them as over-priced. John Stuart Hill (1871) elaborated by observing that speculators play an important role in stabilizing prices. Because they buy when prices are low and sell when prices are high, in turn improve the temporal allocation of resources and have a dampening effect on seasonal price fluctuations. Speculators willingly take increased risks. Speculators wish to take a position in the market by betting on the future price movements of an asset. Futures and options contracts can increase both the potential gains and losses in a speculative venture. Speculators are important to derivatives market as they facilitate hedging, provide liquidity, ensure accurate pricing and help to maintain price stability. It is the speculators who keep the market going because they bear the risk, which no one else is willing to bear.

It is unlikely in any market that hedgers wishing to buy, for example, will precisely match hedgers selling futures in terms of number of contracts. It is only the speculators who take the opposite position with the hedgers and therefore, provide liquidity to the market. A liquid market is one in which there is considerable buying and selling on a continuous basis. In a liquid market, hedgers can make their transactions with ease and with little effect on prices. In the absence of speculators, hedgers may have difficulty in finding counter parties and they may need to move prices in order to attract counter parties.

Speculators also help to make a market informationally efficient. A market is informationally efficient when prices fully reflect all available relevant information. Speculators are likely to consider all relevant information when deciding upon the appropriate price of a future or option contract. If actual prices differed from those judged appropriate, they will be brought into line with the estimated prices by speculative traders, under priced futures will be bought (and so their prices will tend to rise), while overpriced futures will be sold until their prices have fallen to the level considered correct.

Therefore, it is rightly said that a well-regulated speculative transactions are the backbone of an efficient and liquid market.

3. Arbitrageurs

An arbitrageur is a person who simultaneously enters into a transaction in two or more markets to take advantage of price discrepancy in those markets. It is totally a riskless activity. For example, if the futures prices of an asset are very high relative to the cash price, an arbitrageur will make profit by buying the asset in spot market and simultaneously selling the futures. Hence, arbitrage involves making profits from relatively mispricing and thereby enhancing the price stability in the market.

All three types of traders and investors are required for a healthy functioning of the derivatives market. Hedgers and investors provide economic substance to the market and without them market would become mere tools of gambling. Speculators provide liquidity and depth to the market. Arbitrageurs help in bringing about price uniformity and price discovery. The presence of hedgers, speculators, and arbitrageurs, not only enables the smooth functioning of the derivatives market but also helps in increasing the liquidity of the market.

9.4 REGULATORY FRAMEWORK FOR DERIVATIVES TRADING IN INDIA

With the amendment in the definition of 'securities' under SC(R) A (to include derivative contracts in the definition of securities), derivatives trading takes place under the provisions of the Securities Contracts (Regulation) Act, 1956 and the Securities and Exchange Board of India Act, 1992.

Dr. L C Gupta Committee constituted by SEBI had laid down the regulatory framework for derivative trading in India. SEBI has also framed suggestive byelaws for Derivative Exchanges/Segments and their Clearing Corporation/House, which lays down the provisions for trading and settlement of derivative contracts. The Rules, Bye-laws & Regulations of the Derivative Segment of the Exchanges and their Clearing Corporation/House have to be framed in line with the suggestive Byelaws. SEBI has also laid the eligibility conditions for Derivative Exchange/Segment and its Clearing Corporation/House. The eligibility conditions have been framed to ensure that Derivative Exchange/Segment & Clearing Corporation/House provide a transparent trading environment, safety & integrity and provide facilities for redressal of investor grievances. Some of the important eligibility conditions are-

- Derivative trading should take place through an on-line screen based trading system.
- The Derivatives Exchange/Segment shall have on-line surveillance capability to monitor positions, prices, and volumes on a real time basis so as to deter market manipulation.
- The Derivatives Exchange/Segment should have arrangements for dissemination of information about trades, quantities and quotes on a real time basis through at least

two information-vending networks, which are easily accessible to investors across the country.

- The Derivatives Exchange/Segment should have arbitration and investor grievances redressal mechanism operative from all the four areas/regions of the country.
- The Derivatives Exchange/Segment should have satisfactory system of monitoring investor complaints and preventing irregularities in trading.
- The Derivative Segment of the Exchange would have a separate Investor Protection Fund.
- The Clearing Corporation/House shall interpose itself between both legs of every trade, becoming the legal counter party to both or alternatively should provide an unconditional guarantee for settlement of all trades.
- The Clearing Corporation/House shall have the capacity to monitor the overall position of Members across both derivatives market and the underlying securities market for those Members who are participating in both.
- The level of initial margin on Index Futures Contracts shall be related to the risk of loss on the position. The concept of value-at-risk shall be used in calculating required level of initial margins. The initial margins should be large enough to cover the one-day loss that can be encountered on the position on 99% of the days.
- The Clearing Corporation/House shall establish facilities for electronic funds transfer (EFT) for swift movement of margin payments.
- In the event of a Member defaulting in meeting its liabilities, the Clearing Corporation/House shall transfer client positions and assets to another solvent Member or close-out all open positions.

- The Clearing Corporation/House should have capabilities to segregate initial margins deposited by Clearing Members for trades on their own account and on account of his client. The Clearing Corporation/House shall hold the clients' margin money in trust for the client purposes only and should not allow its diversion for any other purpose.
- The Clearing Corporation/House shall have a separate Trade Guarantee Fund for the trades executed on Derivative Exchange/Segment.

9.4.1 Types of Membership in the derivatives market in India

The various types of membership in the derivatives market are

- Trading Member (TM)- A TM is a member of the derivatives exchange and can trade on his own behalf and on behalf of his clients.
- Clearing Member (CM)- These members are permitted to settle their own trades as well as the trades of the other non-clearing members known as Trading Members who have agreed to settle the trades through them.
- Self-clearing Member (SCM)- A SCM are those clearing members who can clear and settle their own trades only .
- Professional Clearing Member (PCM)- PCM is a CM who is not a TM. Typically, banks or custodians could become a PCM and clear and settle for TMs.

Details of the eligibility criteria for membership on the F & O segment are provided in Tables 9.2 and 9.3. The TM-CM and the PCM are required to bring in additional security deposit in respect of every TM whose trades they undertake to clear and settle. Besides this, trading members are required to have qualified users and sales persons, who have passed a certification programme approved by SEBI.

Table 9.2 gives the requirements for professional clearing membership. As mentioned earlier, anybody interested in taking membership of F&O segment is required to take membership of "CM and F&O segment" or "CM, WDM and F&O segment". An existing member of CM segment can also take membership of F&O segment. A trading member can also be a clearing member by meeting additional requirements. There can also be only clearing members.

TABLE 9.2: ELIGIBILITY CRITERIA FOR MEMBERSHIP ON F & O SEGMENT

Particulars (all values in Rs. lakh)	CM and F & O segment	CM, WDM and F & O segment
Net worth[1]	100	200
Interest free security deposit (IFSD)[2]	125	275
Collateral security deposit (CSD)[3]	25	25
Annual subscription	1	2

1: No additional networth is required for self clearing members. However, a networth of Rs. 300 Lakh is required for TM-CM and PCM.
2 & 3: Additional Rs. 25 Lakh is required for clearing membership (SCM, TM-CM). In addition, the clearing member is required to bring in IFSD of Rs. 2 Lakh and CSD of Rs. 8 lakh per trading member he undertakes to clear and settle.

TABLE 9.3: REQUIREMENTS FOR PROFESSIONAL CLEARING MEMBERSHIP

Particulars (all values in Rs. Lakh)	F & O segment	CM & F&O segment
Eligibility	Trading members of NSE/SEBI registered custodians/recognized banks	Trading members of NSE/SEBI registered custodians/recognized banks
Networth	300	300
Interest free security deposit (IFSD)	25	34
Collateral security deposit	25	50
Annual subscription	Nil	2.5

Note: The PCM is required to bring in IFSD of Rs. 2 Lakh and CSD of Rs. 8 Lakh per trading member whose trades he undertakes to clear and settle in the F & O segment.

The derivatives member is required to adhere to the code of conduct specified under the SEBI Broker Sub-Broker regulations. The stipulations laid down by SEBI on the regulation of sales practices are:

Sales Personnel: The derivatives exchange recognizes the persons recommended by the Trading Member and only such persons are authorized to act as sales personnel of the TM. These persons who represent the TM are known as Authorized Persons.

Know-your-client: The member is required to get the Know-your-client form filled by every one of client.

Risk disclosure document: The derivatives member must educate his client on the risks of derivatives by providing a copy of the Risk disclosure document to the client.

Member-client agreement: The Member is also required to enter into the Member-client agreement with all his clients.

9.4.2 Eligibility of indices and stocks for futures and option trading

In the beginning futures and options were permitted only on S&P Nifty and BSE Sensex. Subsequently, sectoral indices were also permitted for derivatives trading subject to fulfilling the eligibility criteria. Derivative contracts may be permitted on an index if 80% of the index constituents are individually eligible for derivatives trading. However, no single ineligible stock in the index shall have a weightage of more than 5% in the index. The index is required to fulfill the eligibility criteria even after derivatives trading on the index have begun. If the index does not fulfill the criteria for 3 consecutive months, then derivative contracts on such index would be discontinued. By its very nature, index cannot be delivered on maturity of the Index futures or Index option contract, therefore, these contracts are essentially cash settled on Expiry.

A stock on which stock option and single stock future contracts can be introduced is required to fulfill the following broad eligibility criteria:

1. The stock should be amongst the top 200 scrips, on the basis of average market capitalization during the last six months and the average free float market capitalization should not be less than Rs.750 crore. The free float market capitalization means the non-promoters holding in the stock.

2. The stock should be amongst the top 200 scrips on the basis of average daily volume (in value terms), during the last six months. Further, the average daily volume should not be less than Rs 5 crore in the underlying cash market.

3. The stock should be traded on at least 90% of the trading days in the last six months, with the exception of cases in which a stock is unable to trade due to corporate actions like demergers etc.

4. The non-promoter holding in the company should be at least 30%.

5. The ratio of the daily volatility of the stock vis-à-vis the daily volatility of the index (either BSE-30 Sensex or S&P CNX Nifty) should not be more than 4, at any time during the previous six months. For this purpose the volatility would be computed as per the exponentially weighted moving average (EWMA) formula.

6. The stock on which option contracts are permitted to be traded on one derivative exchange/segment would also be permitted to trade on other derivative exchanges/segments.

A stock can be included for derivatives trading as soon as it becomes eligible. However, if the stock does not fulfill the eligibility criteria for 3 consecutive months after being admitted to derivatives trading, then derivative contracts on such a stock would be discontinued.

9.4.3 Minimum size of derivatives contract

The Standing Committee on Finance, a Parliamentary Committee, at the time of recommending amendment to Securities Contract (Regulation) Act, 1956 had recommended that the minimum contract size of derivative contracts traded in the Indian markets should be pegged not below Rs. 2 Lakh. Based on this recommendation SEBI has specified that the value of a derivative contract should not be less than Rs. 2 Lakh at the time of introducing the contract in the market. In February 2004, the Exchanges were advised to re-align the contracts sizes of existing derivative contracts to Rs. 2 Lakh. Subsequently, the Exchanges were authorized to align the contracts sizes as and when required in line with the methodology prescribed by SEBI

9.4.4 Measures specified by SEBI to protect the rights of investor in Derivatives Market

The measures specified by SEBI include:

- Investor's money has to be kept, separate at all levels and is permitted to be used only against the liability of the investor and is not available to the trading member or clearing member or even any other investor.
- The Trading Member is required to provide every investor with a risk disclosure document that will disclose the risks associated with the derivatives trading so that investors can take a conscious decision to trade in derivatives.
- Investor would get the contract note duly time stamped for receipt of the order and execution of the order. The order will

be executed with the identity of the client and without client ID order will not be accepted by the system. The investor could also demand the trade confirmation slip with his ID in support of the contract note. This will protect him from the risk of price favor, if any, extended by the Member.

- In the derivative markets all money paid by the Investor towards margins on all open positions is kept in trust with the Clearing House/Clearing corporation and in the event of default of the Trading or Clearing Member the amounts paid by the client towards margins are segregated and not utilized towards the default of the member. However, in the event of a default of a member, losses suffered by the Investor, if any, on settled/closed out position are compensated from the Investor Protection Fund, as per the rules, bye-laws and regulations of the derivative segment of the exchanges.

The Exchanges are required to set up arbitration and investor grievances redressal mechanism operative from all the four areas/ regions of the country.

9.5 RATIONALE BEHIND DERIVATIVES

When the L C Gupta Committee recommended the introduction of derivatives in India, the brokers of BSE opposed its introduction. And the senior regulators of BSE felt strongly that derivatives were going to introduce just because of the experience of some bright 'boys' who had gone to Wharton and returned insistent on applying what they had learnt there instead of listening to the counsel of their elders and betters who know India and what would work in it. Even the NSE brokers threatened to withdrew their initial deposits. But the MD of NSE, Dr. R H Patil pacified the brokers by saying that with the introduction of derivatives trading in the NSE, their sagging future will undergo a sea change.

Therefore, the professionally managed NSE took the opposite view, pressing for the early introduction of derivatives for which it had prepared assiduously and meticulously. The BSE brokers used every means to maintain inefficient, opaque *Badla* system by arguing that it is not the right time to introduce derivatives trading in India, as the market is not fully efficient. So, first of all, we should understand what is *Badla* and how are derivatives superior to *Badla*:

9.5.1 Meaning of *Badla*

The *Badla* system as prevailed in the Indian capital market, prior to ban by SEBI in December 1993, was a unique system. The term '*Badla*' denotes the system whereby the buyers or sellers of shares may be allowed to postpone the payment of money, or delivery of the shares, as the case may be, in return for paying or receiving a certain amount of money. It is also known as carry forward trading.

For example, on January 2, A buys the share of company X at a price of Rs. 100/- A is required to pay Rs. 100 to take the delivery of share on the settlement day, i.e., 15th January. On that day, the price of the share is still Rs. 100/-. Instead of paying Rs. 100, he informs his broker that he would like to carry forward the transaction to the next settlement date ending on January 30. The broker locates a seller who is also willing to carry forward the transaction, i.e., who does not want payment of the share price on the 15th. In return for agreeing to postpone the receipt of money from January 15th till 30th, the seller levies charges on the buyer. This charge is known as a *Badla*. Essentially *Badla* is a form of interest on the postponed payment to be made by A. Suppose; the prevailing *Badla* rate is 4 percent per month. A, therefore pays the seller Rs. 2 per share being the *Badla* charge for half a month.

In this example, it is assumed that there is no change in the prices of shares on the settlement date. Under the *Badla* system if the share has appreciated, the seller has to pay the buyer the amount of appreciation. Of course he would separately receive from the buyer the *Badla* charge.

The strength of *Badla* system were:

1. In India, there are restrictions on bank lending against shares. As a result, the liquidity of the stock market is lower than in other countries where bank land liberally against the security of shares. In such an environment, *Badla* provided a system of financing share transactions and thereby promoted the flow of funds into the secondary market, making for better price discovery and lower transaction costs.

2. It had the merit of providing liquidity with narrow spreads between the 'buy' and 'sell' quotes. This difference was very narrow ranging from one fourth of one percent to two percent in comparison to the scrips in which *Badla* facility was not available, where it varied between 5 to 10 percent.

3. It increased the volume of trading resulting in a decrease in the spread between buy-sell quotes.

4. It was well-established system; besides, the brokers and investors were well conversant with it.

The weaknesses of *Badla* system were:

1. Sometimes even investors with inadequate funds to pay or shares to deliver were attracted to speculate, usually leading to speculation in the market; according to a study conducted by Capital Market Research and Development (CMRD), the liquidity provided by the speculators involved in *Badla* was not necessarily genuine liquidity.

2. On an average around 30-40 percent of the volume was accounted for by delivery and payment while the rest was carried forward.

3. Unhealthy speculation sometimes leads to payment problems which were many times followed by closure of the markets.

4. While *Badla* allows speculation, it does not perform the information function. Details regarding volume, rates of *Badla* charges, open positions etc. were totally absent in the traditional *Badla* system. This made it susceptible to manipulation. The zero margin requirements also meant that trading volume could be increased easily by manipulators having little or no capital base. The revised carry forward system provided data on several parameters, but still didn't publicize the *Badla* charges, which may vary from seller to seller.

9.5.2 *Badla* v/s futures

In fact, a *Badla* transaction is identical to a spot market transaction in shares financed by lending against the security of shares while the futures contracts are those contracts in which agreement is made today for a transaction that will take place at a future date. Having established the precise nature of *Badla*, the comparison with futures trading can be made as follows:

Similarities

a) *Badla* and futures, both allow speculation without paying the full price.

b) *Badla* and futures, both perform the liquidity function by enhancing the liquidity of the market, since they attract speculative volume.

Differences

a) In futures trading, the price for future delivery is defined in advance. In *Badla*, the price ultimately paid, inclusive of *Badla* charges, is indeterminate and becomes known only when the transaction is fully concluded. The *Badla* charges changes from time to time.

b) In the futures trading system, the futures trade is for a specified period defined in advance. In *Badla*, the period of transaction is undefined, as a transaction can be carried forward indefinitely from settlement to settlement, provided a willing counter party can be found.

c) In the *Badla* system, no margins were required and hence the scope for speculation was theoretically unlimited. In practice, the only limit on speculative volume was the risk perception of seller and broker with respect to the buyer's credit worthiness. In futures trading, there is inevitably a deposit on margin requirement, usually ranging from 5 to 15 percent of the transaction value. However, in the revised *Badla* system, margins were payable.

d) As the *Badla* system has an indeterminate final price. This means it is not possible to hedge using the *Badla* transactions since the relationship between the spot price and the future price is uncertain. But in futures, the relationship between future and spot price is certain, so it performs the hedging or price stabilization function.

9.5.3 Options v/s *Badla*

To fully appreciate the working of derivatives as against *Badla*, a comparative analysis of options and *Badla* is also desirable. To facilitate this, the silent features in comparative manner are given below:

i) Carrying forward the transaction

In *Badla*, all net positions at the end of the settlement period can be carried forward and members pay or receive *Badla* charges while the option contract enables the buyer to close his position at any time till the maturity date but carrying forward the position with same option contract is not possible.

ii) Financing mechanism

Badla financiers provide the finance to members with net bought positions; usually buyers pay the *Badla* charges to short sellers. In the option contract, no such financing mechanism exists.

iii) Hedging

Options contract can be used for hedging purposes even when the future cash flows are unknown to the holder of the option because it gives the right to holder to exercise the contract rather than obligation while *Badla* contracts can't be used for hedging purposes.

After analyzing the above points, it is clear that *Badla* only leads to speculation activities in the market while the derivatives perform the function of price discovery and risk management. It is also true that our market comes under the semi- efficient category with the introduction of depositories, on-line trading, increase in mutual fund activity and foreign portfolio investors, but even then it seems that the stage was right for the introduction of derivatives trading. Therefore, when derivatives had become the standardized key to unbundling the risk in banking, investment, capital and insurance market around the world, it was Inevitable that we would also need to established derivatives market in India. In a globalize world, there was no other choice.

Hence, it is clear that derivatives have been introduced in the Indian market in the place of *Badla* to continue its advantages and to avoid its disadvantages. In the derivatives market, the major participants are hedgers; speculators and arbitrageurs who bring efficiency and liquidity in the market. But it is not necessary that the liquidity brought by speculators is genuine liquidity. Unhealthy and undesirable bubbles created by the speculator may crash the market. It is also true that introduction of derivatives contracts in India has not been very old (as it is approximately 4 years old) but even then it is not short run when the notional trading volumes in derivatives contracts are much more than cash market. The derivatives reported a total trading volume (notional) of Rs. 2,130,649 crore during the year 2003-04 as against Rs. 439,869 crore in 2002-03, a rise of more than 300 percent in the past one year. Derivatives are useful instruments that have numerous applications but using them without an understanding of their nuances and behavior can lead to unanticipated risk. And as it is rightly said that don’t use theory unless you understand the principles. Use whatever you learn. Therefore, it is the right time to revisit the status and issues relevant for derivatives market in India. Once more, we need to understand where we have reached, what we have achieved and where we go next.

9.6 SUMMARY

In India, commodity futures date back to 1875. However, forward trading was banned in the 1960s by the government. However, the forward contract in the rupee-dollar exchange rates were allowed by the Reserve Bank and used on a fairly large scale.

The advent of foreign institutional investors in the 90's and a large number of scams led to a ban on the indigenous 125 year old *Badla* system. The Securities Exchange Board of India, set-up a committee under the chairmanship of L C Gupta on November 18, 1996, to develop a regulatory framework for derivatives trading in India. The committee submit its report on March 17, 1998 and on the recommendation of the committee the Securities Contract Regulation Act was amended in December 1999 to include derivatives in the ambit of securities and the regulatory framework was developed for governing derivatives trading. Derivatives trading formally commenced in June 2000 on the two major stock exchanges, BSE and NSE. Futures trading on the sensex commenced at the BSE on June 2000 and on S & P CNX Nifty commenced at the NSE on June 12, 2000. The options on index and individual stocks were introduced in June 4, 2001 and July 4, 2001 respectively.

9.7 KEYWORDS

Forward Contract is an agreement between two parties to exchange an asset for cash at a predetermined future date for a price that is specified today.

Hedging: Hedgers are people who try to minimise risk or who try to protect themselves by buying (holding) different types or kinds of shares and/or assets and selling them so that they are able to set off their losses with gains. Hedging is meant to minimise losses, or investment risk, not to maximise profits. This is achieved because while one kind of shares or assets may fall in prices, others may rise in prices. It is the price which is quoted or provided by the fall in prices, others may rise in prices. It is the price which is quoted or provided by the buyer who wants to buy the assets.

Index derivative: It is a derivative whose underlying is some index number of prices of financial instrument at a given market.

Index fund: It is a fund which invests in the price index of a security (say equity index) with an objective to generate returns equivalent to the return on index.

Over-the-counter (OTC) market: It is a market which is not an organised exchange; it comprises a network of securities dealers who trade in financial assets; though not organised, it is officially recognised.

Stock derivative: It is a derivative whose underlying is a share of some company.

Badla: The term *Badla* denotes the system whereby the buyers or sellers of shares may be allowed to postpone the payment of money, or delivery of the shares, as the case may be, in return for paying or receiving a certain amount of money. It is also known as carry-forward trading.

9.8 SELF ASSESSMENT QUESTIONS

1. What is the scope of derivatives markets in India?

2. Show the evolution and growth of securities derivative market in India. Is the growth satisfactory? Give comments.

3. What is the difference between *Badla* system and futures contract?

4. Give a detailed account of regulatory framework regarding derivatives market in India.

5. List out various measures specified by SEBI to protect the rights of investors in derivatives market.

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