Chapter 2

Financial Derivatives

During the recent decades the unstable financial markets subsequent to liberalization and globalization have become increasingly one of the most important concerns of investors, researchers and policy makers in the universe of finance. The financial market volatilities can be attributed to the changes in a number of fundamental and technical factors. Therefore, the regulators and policy makers have been fueled to provide favorable instruments to mitigate these unpredictable fluctuations. For that reason, the derivatives instruments have been created primarily with the objective of minimizing the risks of investment or reducing the costs of constructing optimal portfolio. However, standardized derivatives contracts came into existence to act as risk management tools, currently they stand as main irritating obstacles in volatility hedging procedures. Inherent arbitrage opportunities of derivatives and in particular that of futures markets are due to lower transaction costs which catch the attention of potential speculative forces from the spot markets. The attraction of these speculative forces may result in increase information transmission from the spot to futures markets. The information transmission is identified as rationale behind stabilization and destabilization of spot price movements. Likewise, the information transmission might cause spillover effects from derivatives to spot prices and result in price discovery leadership of derivatives segment over a period of time.

2.1 History of Financial Derivatives Markets

Financial derivatives have come into existence as one of the largest markets of the world over the recent decades. A quick revolutionize in technology has amplified the processing power of computers and has made them a key vehicle for information processing in financial markets. Following globalization, liberalization and instability of financial markets, several emerging economies have been obliged to reform laws, rules and regulations and develop new financial contracts which have made it easier for the participants to carry out derivatives transactions. Over 100,000 years, it is well-known that people bartered their goods, agricultural products and other services. The different seasonal harvesting created the problem with bartering. It implies that it was somewhat impossible to barter the items harvested at different seasons. These types of problems eventually led to developments of the forward contracts. A forward contract is as agreement make between buyer and seller in which the seller undertakes the delivery of the
specified item by a certain date in exchange of predefined amount of money. Initially, forward contracts has commenced in the US to address the concerns of merchants in selling and buying their commodities. However, a severe problem has still remained namely Credit risk. To cope with this problem, a group of Chicago businessmen established the Chicago Board of Trade (CBOT) in 1848. The major objective of the CBOT was to establish a centralized place for the negotiations of buyers and sellers about the forward contracts. However, the first futures contracts can be traced to the Yodoya rice market in Osaka, Japan around 1650, there is no evident about its daily mark-to-market (MTM) and credit guarantees.

In 1865, the first exchange traded derivatives contract --i.e. futures contracts -- in the US was founded by the CBOT. Futures trading started in Chicago Butter and Egg Board, a spin-off of CBOT in 1919. Its name was changed to Chicago Mercantile Exchange (CME). The CBOT and the CME have still continued as the two largest organized futures exchanges over the globe.

Because of the downfall of fixed exchange rate system and acceptance of floating exchange rate systems, the first exchange-traded financial derivatives commenced in 1970's. As a result of this collapse in exchange rate system; currency volatility became a major problem for most countries. The foreign currency futures were established in 1972 at the Chicago Mercantile Exchange to hedge the participants in foreign exchange markets against currency unwanted fluctuations under the new floating exchange rate system.

The options trading have been facilitated on selected stocks with establishment of the Chicago Board Options Exchange (CBOE) by the Chicago Board of Trade (CBOT) in 1973. The CBOE developed an option on an index of stocks in 1983. However, initially it was known as the CBOE 100 Index, it was soon turned over to Standard and Poor's and now it is called S&P 100 which has still been the most actively traded exchange-listed option. For the first time the stock index futures contract have been traded at Kansas City Board of Trade. Presently the leading stock index futures contract in the world function based on S&P 500 index, traded on Chicago Mercantile Exchange.

The CBOT developed the first interest rate futures contract in 1975 which was based on Ginnie Mae (GNMA) mortgages. However, it initially attained relative success, it ultimately died down. Although, this contract has been revived and structurally changed by the CBOT several times, it has never got the initial achievements. The first successful pure interest rate futures contract was the Treasury bill futures contract which has been developed by Merc in 1975. It was
a paradigm of the immense leverage in futures by which one could control $1 million of T-bills for only about $1000. The T-bond futures contract was commenced by the CBOT in 1977 which has become the most active futures contract later on. The Eurodollar contract has been developed by the CME in 1982 which has now overtaken the T-bond contract with respect to the trading volumes and became one of the most popular traded of all futures contracts.

During the period between 1984 to 1986, financial futures has been the most active derivative instruments based on the higher generated trading volumes compared to the commodity futures. There are three most active futures contracts traded in today’s financial markets namely Index futures, futures on T-bills and EuroDollar futures. Some international exchanges that mostly popular for their derivatives segments are LIFFE in England, DTB in Germany, SGX in Singapore, TIFFE in Japan, MATIF in France, Eurex etc.¹

2.2 Derivatives Definition

A derivative can be defined as a financial instrument whose value depends on (or derives from) the values of other, more basic, underlying assets. The stocks, currencies, interest rates, bonds, commodities, and market indices are considered as the most regular underlying assets. Mostly, the variables underlying derivatives are the prices of traded assets. For example, a stock option is a derivative whose value depends on the price of a stock. However, derivatives can be dependent on almost any asset, from the price of hogs to the amount of snow falling at a certain ski resort (Hull, 2009, p.1).

The term ‘Derivative’ stands for a contract whose price is derived from or is dependent upon an underlying asset. The underlying asset could be a financial asset such as currency, stock and market index, an interest bearing security or a physical commodity. Today, around the world, derivative contracts are traded on electricity, weather, temperature and even volatility. According to the Securities Contract Regulation Act, (1956) the term “derivative” includes:

(i) A security derived from a debt instrument, share, loan, whether secured or unsecured, risk instrument or contract for differences or any other form of security;

¹Source: NSE, Derivative Market (Dealers) Module (DMDM):
(ii) A contract which derives its value from the prices, or index of prices, of underlying securities.¹

2.3 Products, Participants and Economic Functions of the Derivative Market

There are four major types of derivatives contracts namely forwards, futures, options and swaps. Likewise, the participants of derivatives can be mainly segregated into three categories namely hedgers, speculators and arbitrageurs. Hedgers apply derivatives contracts to guard against unfavorable changes in the values of their assets or liabilities. A decrease in the value of their assets will be compensated by an increase in the value of those derivatives contracts. Speculators attempt to gain profits from forecasting the future fluctuations of the market. According to the theoretical points of view spot and derivatives prices should move in tandem over periods of time. However, sometimes deficiencies in the capital market may cause the derivatives prices to be higher or lower than their underlying cash markets. Arbitrageurs exploit such the discrepancies between the prices of two markets and gain the value.

If derivatives are managed correctly, they may result in considerable economic benefits. A number of economic functions in derivatives market are explained as below:

- Prices in an F&O segment can be considered as the prediction of the future value of spot markets and lead the prices of underlying to the perceived future level. There would be convergence between the prices of derivatives and underlying spot at the expiry date of the derivative contract. Therefore, the derivatives may facilitate the price discovery process both for future and current prices.
- The risk can be transferred by the derivatives from those who are risk averse to those who are willing to take that risk with expectation of more future return.
- Because of the inherent nature of derivatives, they are linked to the underlying cash markets. The trading volume of underlying market increases with the commencement of derivatives. This is because of participation by more players who would not otherwise participate for lack of an arrangement to transfer risk.
- Speculative trades shift to a more controlled environment in derivatives market. Speculators trade in the underlying cash markets in the absence of a well-organized derivatives market. It

is really difficult to monitor and supervise the activities of different participants in such mixed markets.

- Another important benefit of derivatives trading is that it works as an accelerator for attracting intelligent, innovative and educated forces with the aim of running new entrepreneurial activities. They often strengthen other potentials to develop new businesses, new products and new employment opportunities, the benefit of which are immense.

- If derivatives are properly applied and managed, they may increase the elasticity of the market against turbulences. The chief concern of the regulators and policy makers is that they want to be assured that derivatives have been properly traded and cautiously managed.

In short, derivatives markets help increase savings and investment in the long run. Transfer of risk facilitates market participants to expand their volume of activity.

### 2.4 Types of Derivatives Contracts

There are for main types of derivative instruments which are widely and commonly used by large companies and financial institution for basically hedging the risks or sometimes speculating purposes. They are explained as follows:

#### 2.4.1 Forwards

A forward is a relatively simple derivative contract. It is an agreement between two parties to buy or sell an asset at a predetermined future date for a specified price. They are in contrast to a spot contract which is an agreement to buy or sell a security today (Hull, 2009, p.3). A forward contract trades in the OTC market commonly between financial institutions and their clients. One of the parties takes long position to purchase the underlying asset on a pre-agreed date in future. The opposite party takes short position to sell the same underlying asset on the same predefined future time. The private negotiations between two parties need to be simply developed to determine the delivery time and place, delivery price and quality and quantity of the delivery asset.

There are some chief specifications of forward contracts which are described as follows:

- They are exposed to the default risk of counterparties, because they are simple bilateral contracts and there is no guarantee that the commitments of both sides will be fulfilled on the pre-agreed date.
• They are customized contracts which are designed exclusively according to contract size, asset quality and expiration date.
• The prices of the forward contracts are not publicized in an organized stock exchange.
• The contracts must be settled on the expiration day and the underlying asset must be delivered to the buyer.
• If one side decided to reverse the contract, he/she is obliged to refer to the same counterparty that usually leads to a high price being charged.
• In some specific markets like foreign exchange markets forwards can be considered as a standardized contract which may help the market enhancement in terms of higher trading volume and lower transaction costs.

Hedging against uncertainties can be considered as salient role of forwards contracts. A typical example of such hedging application is an exporter who expects to receive his/her payments say within next three months. In this situation, the exporter is exposed to the sudden changes in the currencies exchange rates. By entering the currency forwards contract, the exporter sells the dollars forwards and lock in the today’s exchange rates which results in reducing the exposures of the exchange rates instabilities. The speculators are other main players in the forwards markets. If a speculator expects that there will be an increase in the prices, he/she may take long position in forwards contracts. He/she waits the price to increase and then take the reverse position to earn profits. They may be obliged to deposit a margin which is the small proportion of the value of forwards underlying asset. In addition, forwards markets provide leverage for the speculators. On the other hand, the forwards are troubled by some limitations like lack of centralization, low liquidity and default risk of the counterparties. This is similar to real estate where two parties make an agreement against each other which seems to be a very convenient deal; however, the contract is a non-tradable one. The probability of the default of any counterparties to fulfill the commitments of the contract can be considered as counterparty risk. Even in the standardized situation of the forwards contracts like foreign exchange markets, the problem of the counterparty default risk remains the severe one.

2.4.2 Futures

A futures contract is an agreement between two parties of to buy or sell an asset at a pre-agreed time in the future for a specified price (Hull, 2009, p.6). In other words, futures contracts
are standardized types of forwards contracts which are agreements between two parties to buy or sell special type of asset with standardized quality and quantity for a predetermined price on a certain date. In contrast to forwards contracts, futures are normally traded in an organized exchange on a daily basis. Certain standardized features of the futures contract are set by the exchange to start trading. As the futures contract specifies a trade taking place in the future and also the counterparties may not know each other, the exchange provides a mechanism to guarantee that the commitments of both parties will be fulfilled on the specified date. Therefore, both parties are required to put up initial amount of margin. Moreover, since the futures price will generally change daily, the difference in the predetermined price and the daily futures price is settled daily. The exchange draws this difference amount from the margin of the party who loses and puts in the margin of the party who profits. If the margin of the loser party has become under the certain value, the exchange call the party to rebalance his/her account to the determined level. This process is called mark-to-market (MTM). Therefore, the amount which is exchanged on the delivery dates is not the pre-agreed value but the spot price.

2.4.3 Differences between Forwards and Futures

Mostly, forwards are traded on over the counter (OTC) mechanism; however, futures are traded on the exchange. Such difference can be considered as the major distinction between forwards and futures which cause rise to notable differences between these two instruments. These differences are briefly explained as follows:

- Futures are the standardized contracts traded through a brokerage in an organized stock exchange. The futures contracts are standardized with respect to delivery places and dates, quantity and quality of underlying assets on the delivery date, and credit procedures. The futures are traded by the respective brokerage of counterparties; however, forwards are completely customized and are negotiated confidentially between both parties. In forwards settlement dates, volume of the contract and settlement types (whether cash or physical delivery) entirely depend on the counterparties decisions, however, in the case of futures these features are specified by the exchange and parties need to select their favorites out of the choices.

- In the case of futures contracts the clearing house of the exchange is responsible to the default risks of counterparties, while forwards are exposed to default risks of the parties and there is no one in charge of the possible failure of the deliveries performance.
• The mechanisms of daily trading and regular mark-to-market (MTM) are required to reset the value of the futures contracts to zero. These margin payments may result in the reduction of the counterparties default risks.

• The daily cash flows of futures margining may lead to a considerable divergence between the futures and the forwards prices.

• Futures are settled based on the last trading day of the contract, whereas forwards are settled based on the first trading day of the contract.

• Futures are generally subject to a single regulatory regime in one exchange, whereas forwards are traded across jurisdictional boundaries and are principally managed by the contractual relations between the counterparties.

• There are daily margining processes and periodic margin calls in futures, while in forwards there are no cash flows until the delivery date.

• In the case of forwards contracts it is specified that to whom the physical delivery have to be made, however, in futures the counterparties are chosen randomly by the exchange.

2.4.4 Glossary of Futures Terminology

**Cash / Spot Price:** The price in the stock exchange for actual cash or spot securities to be traded via customary market channels.

**Futures Price:** The price which is traded in the futures exchange or the price pre-agreed between the counterparties to be delivered on the futures date.

**Final Settlement Price:** The price at which the settlement of cash-settled futures contract is implemented at delivery date, according to a procedure specified by the exchange.

**Arbitrage:** A strategy includes purchase and sale futures contract and its underlying spot security in order to earn profit from a discrepancy in their price relationship.

**Basis:** It is computed by the difference between the spot or cash price of a security and the price of the nearest futures contract for the same security.

**Basis Risk:** It is the risk of the fluctuations in cash-futures spread between the time of contract implementation and expiration date.

**Broker:** He/she is a person who is in charge of orders executions for the clients. They are paid fee or commission for this task.
**Buyer:** A futures market participant who takes a long futures position. In the case of an option the buyer is also called a taker, owner or holder.

**Seller:** A futures market participant who takes a short futures position.

**Carrying Charges/Cost of Carry:** Cost of holding a financial instrument over a period of time. These costs consist of insurance, storage, and interest on the deposited funds and other miscellaneous costs.

**Cash Settlement:** A method of settling futures, options and other derivatives whereby the seller pays the buyer the cash value of the underlying security or a cash amount according to the level of an index or security price.

**Clearing Organization:** This is an organization responsible for implementation of the settlement and clearance of the futures and other derivatives transactions. It is in charge of the proper conduct of each contract’s delivery procedures and the daily margining of trading procedure. A clearing house may be a division of a particular exchange or can be an entity affiliated to the exchange. It is also called clearing house or clearing association.

**Commission:** The fee that charged by a futures broker for the execution of an order.

**Contract Size/Contract Unit:** The actual quantity of an underlying asset agreed to be delivered on the expiration of the derivatives contract.

**Convergence:** Narrowing the cash-futures spread or the tendency for prices of futures and underlying assets to approach one another, usually during the maturity.

**Counterparty:** The opposite party in a two-sided derivatives agreement, contract, or transaction.

**Counterparty Risk:** Failure of the counterparty to execute on a futures contract and fulfill of the agreement commitments as required by exchange rules, such as failure to meet a margin call, or to make or take delivery.

**Delivery:** The tender and receipt of the cash value of the securities or any other delivery instruments to settle the futures contracts.

**Delivery Date/ Maturity:** A day on which an underlying security must be delivered to fulfill the futures contracts.

**Futures Option:** An option contract made on a futures contract.

**Hedge Ratio:** Ratio of the value of futures contracts purchased or sold to the value of the cash security being hedged and the hedge ratio (HR) is calculated to reduce the risk of the payoff of the hedged portfolio.
**Hedger:** A trader who takes a futures positions market opposite to positions held in the cash market to reduce the risk of cash flow loss from an unfavorable price fluctuations.

**Initial Margin:** A market participant deposits specified amount of money in an account by the clearing house for a guarantee of contract fulfillment at the time a futures contract is delivered.

**Margin Call:** Due to the adverse changes in daily futures trading, the initial margin reduces below the specified level, therefore, a request from a brokerage firm/clearing house to a client to make margin deposits up to original levels.

**Mark-To-Market:** To maintain a specified level of margin for a given futures or option contract position by calculating the gain or loss in each contract position resulting from changes in the price of the futures or option contracts at the end of each trading session. These gains and losses are added to and deduct from the margin balance, respectively.

**Nearby Delivery Month:** The nearest month of the futures contract to delivery date.

**Over-The-Counter (OTC):** The trading of derivatives contracts or other instruments not listed on any organized exchange. OTC trading can be done electronically or over the telephone. Such type of trading also called Off-Exchange.

**Settlement:** The fulfillment of the delivery commitments of the futures contract.

**Settlement Price:** The daily price at which the settlement and clearance of all trades and accounts are made by the clearing house. Settlement prices are used to determine both margin calls and delivery prices.

**2.4.5 Options**

Options contracts are traded both on exchanges and in the OTC market. There are two salient types of option namely call option and put option.

- **Call Options**

  A call option gives the holder the right, but not the obligation, to buy the underlying asset on a pre-specified delivery date for a pre-agreed price. The seller gives the right to the buyer of the option for a payment called premium. The price of the contract is known as strike price or exercise price. The holder of the right will exercise the contract only if at the time of expiry or before that the market price of underlying asset is more than the strike price. If this condition is not met there is no obligation to the buyer to exercise the option.
• **Put Options**

A put option gives the holder the right, but not the obligation, to sell the underlying asset on the specified maturity date for a certain price. The price of the contract is called the strike price or exercise price; the date in which the contract is expired is called expiry date, delivery date or maturity. The exercise price is determined at the time entering the contract. The holder of the option will exercise the contract only if the market price of underlying asset is less than the strike price. Similarly, if this condition is not fulfilled, the option holder is not obliged to exercise the option.

American options can be exercised at any time during the contract life whether on or before the expiry date. On the other hand, the European options have to be exercised only on the delivery date itself. The American options that are most popular options traded on the exchanges. However, major indices, such as the S&P 500, have very actively traded European-style options. Furthermore, European options are generally easier to analyze than American options, and some of the properties of an American option are frequently deduced from those of its European counterpart.

It is to be noted that an option gives the holder the right to do something. The owner is not obliged to exercise this contract. This feature can make a distinction as between options and futures in which the holder of the futures contract is obligated to buy or sell the underlying asset on the delivery date. Moreover, to acquire an options contract it is required to pay a premium, whereas a futures contract costs nothing more than the price of the contract (Hull, 2009, p.6).

2.4.6 **Options vs. Futures Contracts**

There are several differences between options and futures. The salient distinction between them lies in the obligations they put on the buyers and sellers. An option gives the holder the right, but not the obligation, to buy or sell the underlying asset, however, in a futures contract the buyer of the contract is obligated to purchase the underlying asset on the pre-agreed date and the seller is obligated to deliver the underlying asset on the same date. In the futures contract no upfront cost is needed, whereas buying options requires an upfront cost (premium) to be paid. Therefore, options are only subject to the risk of losing the premium; however, futures are exposed to the risk of adverse changes in market prices. The size of underlying position can be considered as another main distinction between options and futures contracts. The size of underlying position is usually much larger for the futures contracts and the obligations of
fulfillment of contracts’ commitments cause the futures contracts to be more risky for an unskillful investor. The last major distinction between options and futures is the way the gains are realized. In the case in-the-money in options on or before delivery date, the options holder is going to the market and takes opposite position to take advantage of the difference between the asset market price and exercise price. While, in the case of futures gains are basically realized via daily mark-to-market and an increase in the value of futures positions depend on the parties’ futures margins at the end of each trading day. In addition, the futures holder can realize profits by taking opposite position in the market.

2.4.7 Glossary of Options Terminology

**Exercise Price/Strike Price:** The pre-agreed price in the option contract at which the underlying futures contract or a security will deliver from seller to buyer.

**Call Option:** This is an option that gives the holder the right, but not the obligation, to buy the underlying asset on a certain delivery date for a pre-agreed price.

**Put Option:** This is an option that gives the holder the right, but not the obligation, to sell the underlying asset on a certain delivery date for a pre-agreed price.

**American Style Option:** An option that can be exercised at any time prior to and including its expiration date. As the American option holders have choice to exercise the option all over the life of the contract, this style of options is more popular on the exchanges.

**European Style Option:** An option that can be exercised only at the expiry time of the contract. Compared to the American options, European options are traded at discount. This is because more exercise opportunities are offered by the American options during the life of the contract, while in European options the holder has a single choice to exercise the contract.

**Premium:** A specified amount of money that an option buyer pays the option writer for granting an option contract.

**Intrinsic Value of the Option:** An intrinsic value of an option is the value of exercising it now. There is positive intrinsic value, if the options’ strike is lower than the market price of underlying stock in the case of call options or if the options’ strike is higher than the market price of underlying stock in the case of put options.

**In-The-Money:** When a call options’ exercise price is lower than the market price of underlying security or a put options’ exercise price is higher than the market price of underlying security,
the option is called in-the-money. In other words, in-the-money option is an option contract with a positive intrinsic value if exercised.

**Out-Of-The-Money:** When a call options’ exercise price is higher than the market price of underlying security or a put options’ exercise price is lower than the market price of underlying security, the option is called in-the-money. In other words, it describes an option that has no intrinsic value.

**At-The-Money:** In an option contract when the price of underlying security is equal to the exercise price, the option is at the money.

**Holder of the Options:** An option holder is an entity who bought the option for a given amount of premium. An option holder can also sell the option later on.

**Writer of the Options:** It refers to a person who sells an option or sells the right, but not the obligation, to buy or sell a particular asset at a pre-agreed price, on or before its expiry date.

**Time Value:** The time value of an option indicates the probability of the option to be in-the-money. Therefore, the longer the life of the contract, the greater the time value will be. It can be calculated by the difference between option value and intrinsic value --i.e. Time Value = Option Value – Intrinsic Value. It is also called extrinsic value.

**Transferable Option:** A contract permitting a position in the option market to be offset by a transaction on the opposite side of the market in the same contract.

**Open Interest:** Open interest reflects the total number of outstanding option/futures contracts in the exchange market which is not exercised or delivery at the end of each trading day.

### 2.4.8 Other Types of Derivatives

Apart from futures and options there are other major types of derivatives namely swaps, Swaptions, LEAPS, baskets and warrants which are explained as follows:

**Swaps:** A swap is a derivative contract in which one party’s financial instruments’ cash flows are exchanged with those of the opposite party’s financial instrument. In the other words, two counterparties make an agreement to exchange one stream of cash flows against another stream.

**Swaptions:** An option which gives the right, but not the obligation, to enter into a particular type of swap at a predefined future date. In the other words, Swaptions are options that include rights of buying and selling of a swap till the expiration date of that option.

**Baskets Options:** Similar to other options, a baskets option grants the holder the right, but not obligation, to buy or sell the underlying basket of assets --i.e. a group of securities, currencies or
commodities-- at a pre-agreed price on or before a specific date. Basket options incur lower costs than buying an option on individual security. These options are popular in hedging the risk of portfolios.

**LEAPS:** Long Term Equity AnticiPation Security (LEAPS) are options contracts which have longer life --which are normally ranging from nine months to three years-- than the common options. Like other options, LEAPS are available in two types, i.e. call options and put options. LEAPS can be used for both investment and risk hedging purposes. However, they are more popular as risk mitigating tools.

**Warrants:** A warrant is an option which gives the holder the right to buy a security from the writer at a certain price on a specific date. However, there are some main differences between warrants and the options. The warrants’ lifetime is measured in years, whereas the common options’ lifetime is measured in months. The warrants are commonly issued by a company or a private party and generally considered as OTC traded instruments, while the common options are exchange traded instruments.

### 2.5 Derivatives Market Segments (Exchange-Traded vs. OTC Derivatives)

The securities market has two inter-reliant and indivisible components namely primary market and secondary market where secondary market, in turn, operates into two segments namely exchange traded market and over-the-counter (OTC) market. The exchange-traded derivatives (ETD) contracts are the standardized derivatives contracts which are traded in an organized exchange. The derivatives exchange can be considered as a physical location which regulates the rules, provides the clearing facilities and governs trading and information flows about the contract transactions. A derivatives exchange is also defined as a centre which offers bid and ask prices to all direct market participants, who can respond by selling or buying at one of the quotes or by replying with a different quote. According to the exchange, the medium of communication can be voice, hand signal, a discrete electronic message, or computer-generated electronic commands. With the emergence of electronic trading, no physical trading exchange has required. In fact, large part of traditional trading system on physical exchanges has been replaced by electronic system of orders and executions --e.g. London Stock Exchange and NASDAQ Stock Market entirely maintain electronic transaction system and derivatives exchanges like CME group include both traditional trading style and electronic trading system.
On the other hand, OTC derivatives contracts are customized derivatives contract which are simply traded between two financial institutions of between a financial institution and one of its clients. However, the well-organized trading networks relationships are located around one or more dealers; there is no standardized and physical location of trading in the OTC market. In such market, dealers are considered as market makers by quoting bid-ask prices for buying or selling the contracts to the other clients or dealers. However, their price quotations should not necessarily be equal for all clientele. Furthermore, as there is no clearing organization to guarantee the execution of contract commitments, the possible withdrawal of OTC dealers from market making can cause the liquidity to be dried up. In summary, OTC markets are less transparent than the organized exchanges. The OTC quotations and transactions are usually negotiated and executed over the phone, mass e-mail messages and computer-linked network of the counterparties. It is called as bilateral trading system as only two dealers directly observe the price quotes, negotiate and execute the contract. Their transaction information such as trading quotes, quality and quantity are not necessarily accessible to other market participants. Following the development of electronic trading platforms, the trading system in many OTC market has been changed and this sometimes cause the difference between OTC derivatives markets and standardized derivatives exchange become blurred. Since the recent financial crisis, policymakers have significantly tightened the regulation of OTC derivatives markets. However, derivatives markets are not considered as the sole cause of this financial turmoil, the complex counterparties’ exposures of OTC derivatives markets increase the financial distress. The regulatory authorities over the globe has responded by introducing a series of measures in order to reduce the counterparty risks and make OTC derivatives markets more transparent. These included setting up a central clearing organization for OTC derivatives contracts wherever appropriate and raising the capital charges and margin requirements in other cases.\(^3\)

2.6 Derivatives Pricing

A number of derivatives pricing models are used to measure the market value of a derivatives contract. The Black-Scholes and binomial options pricing models and cost of carry model are mainly used in options and futures pricing. The options pricing models are commonly

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\(^3\) Source: BIS, Bank for International settlements, BIS Quarterly Review, December 2013: http://www.bis.org/publ/qtrpdf/r_qt1312h.pdf, accessed on 05/02/2014.
used by professional options traders. The cost of carry model is considered as the basic futures pricing model. These derivatives pricing models are described in details as follows:

2.6.1 Black-Scholes Pricing Model

The Black-Scholes model has been developed by three economists --Fischer Black, Myron Scholes and Robert Merton-- in 1973 in favor of calculating the premium of an option. It has been introduced in a paper published in The Journal of Political Economy, entitled “The Pricing of Options and Corporate Liabilities”. It is possibly considered as the most popular options pricing model in the world. The authors have been awarded the Noble Prize in 1997 for the development of this model. However, Black had passed away two years before this event in 1995. Since Nobel Prize is not given posthumously, the Noble committee has prominently acknowledged Black for his significant role in the development of this landmark work on option pricing.

The Black-Scholes-Merton differential equation needs to be satisfied by the price of any derivative dependent on its underlying non-dividend-paying stock. The Black-Scholes model is analogous to non-arbitrage models. A riskless portfolio is made up of a position in a derivative and a position in its underlying stock. The portfolios’ returns have to be the risk-free interest rate, $r$, when there are no opportunities for arbitrage activities. A riskless portfolio can be constructed since both derivatives price and its underlying stock price are influenced by the same source of uncertainty which is stock price volatility. During the short term, the price of call option is perfectly correlated with the price of the underlying stock and the price of put option is negatively correlated with the price of the underlying stock. When an appropriate portfolio of the stock and the derivative is set up, the gain or loss from the stock position always offsets the gain or loss from the derivative position, therefore, there would be a perfect certainty relating to the total value of the portfolio at the end of the short period of time (Hull, 2009, p.285).

The underlying assumptions of Black-Scholes differential equation are as follows:

1. The salient assumption is that volatility, a measure of a stock price fluctuation in the short-term, is a constant over time.
2. The returns on the underlying stock are normally distributed.
3. There are no costs or commission fees for buying and selling options and stocks and no barriers to trading.
4. The risk free interest rates are also assumed to be constant over time and for all maturities.
5. There are no riskless arbitrage opportunities.
6. The underlying stock does not pay dividends during the option's life.
7. Trading in the underlying security is continuous.

2.6.2 The Black-Scholes Differential Equation

The Black-Scholes differential formulas for the premium price of a European call option, equation (2.1), and a European put option, equation (2.2), on a non-dividend-paying stock can be indicated, respectively, as follows:

\[ C = S_0 N(d_1) - \frac{K}{e^{rT}} N(d_2) \]  
\[ P = N(-d_2) Ke^{-rT} - N(-d_1)S_0 \]  

where

\[ d_1 = \frac{1}{\sigma \sqrt{T}} \left[ \ln \left( \frac{S_0}{K} \right) + \left( r + \frac{\sigma^2}{2} \right) (T) \right] \]

\[ d_2 = \frac{1}{\sigma \sqrt{T}} \left[ \ln \left( \frac{S_0}{K} \right) + \left( r - \frac{\sigma^2}{2} \right) (T) \right] = d_1 - \sigma \sqrt{T} \]

\( N(x) \) = the cumulative distribution function of the standard normal distribution.

\( C \) = premium price of European call option.
\( P \) = premium price of European put option.
\( S_0 \) = underlying stock price at time zero.
\( K \) = the exercise (strike) price of the option.
\( r \) = continuously compounded risk free interest rate.
\( T \) = the time to maturity of the option contract.
\( \sigma \) = the underlying stock price volatility.

However, there has not been introduced a proper formula for calculating American call and put options. The difficulty of calculating the price of an American option is because of the optimal stopping problem of finding the time to exercise the option.
2.6.3 The Binomial Options Pricing Model

The binomial pricing model is widely used as an option pricing technique. This option pricing model has been initially introduced by Cox, Ross and Rubinstein in 1979. This model can be considered as an alternative for Black-Scholes option pricing model using relative simple techniques. The binomial pricing model traces the evolution of the option's key underlying variables in discrete-time. This is done by means of a binomial lattice (tree), for a number of time steps between the valuation and expiration dates. In other words, this is a diagram indicating different possible paths that might be followed by the stock price over the life of an option (Hull, 2009, p.237). The tree of prices is produced by working forward from valuation date to expiration. At each step, it is assumed that the underlying stock price will move up or down by a specific factor. The up and down factors are calculated using the underlying volatility, \( \sigma \), and the time to maturity, \( T \). These factors are constant throughout the tree. If the underlying stock price moves up and then down (\( u, d \)), the price will be the same as if it had moved down and then up (\( d, u \)). This is the property of recombination which accelerates the calculation of the option price. According to this property the price of underlying stock at each node of the tree can be computed as follows:

\[
S_n = S_0 \times u^{N_u - N_d}
\]  

where \( S_n \) is the underlying stock price at node \( n \) and \( N_u \) and \( N_d \) are the number of up and down ticks, respectively.

Next step, the option value is calculated at the end of each final node of the tree (expiration date). It is simply considered as intrinsic value of the option.

\[ Max [(S_n - K), 0], \text{ for a call option.} \]
\[ Max [(K - S_n), 0], \text{ for a put option.} \]

where \( K \) denotes the strike (exercise) price.

After this step, the value of the option in each node is computed, starting at the penultimate time step, and working back to the present time (valuation date). The binomial value (option price) at each node derives the option price at the next node using the risk neutrality assumption. Based on this assumption, present fair value of an option is equal to the expected value of its future payoff discounted by the risk free rate. The expected values are calculated using the option values from the later two nodes weighted by their probabilities of up (\( p \)) and down (\( 1-p \)) moves.
The expected value is then discounted at \( r \), the risk free rate based on the life of the option. The expected value at each node of the tree can be calculated using the following equation:

\[
f = e^{-r \Delta t} [pf_u + (1 - p)f_d]
\]

\[
p = \frac{e^{(r-q) \Delta t} - d}{u - d}
\]

The repeated applications of equation (2.4) are indicated as follows:

\[
f_u = e^{-r \Delta t} [pf_{uu} + (1 - p)f_{ud}]
\]

\[
f_d = e^{-r \Delta t} [pf_{ud} + (1 - p)f_{dd}]
\]

\[
f = e^{-r \Delta t} [pf_u + (1 - p)f_d]
\]

\( f \) = The option value (binomial value) at each node of the tree.

\( f_{uu} \) = The value of the option after two up movements.

\( f_{dd} \) = The value of the option after two down movements.

\( f_{ud} \) = The value of the option after one up and one down movements.

\( r \) = The risk-free interest rate.

\( \Delta t \) = The length of the time step.

\( q \) = The dividend yield of the underlying stock to the life of the option.

The main restriction of the binomial model is that it is relatively time consuming. Very large calculations need to be done at a time but even with today's fastest computers it's not a practical to calculate thousands of prices in a few seconds.

There are similar stock price assumptions which underpin both the binomial and Black-Scholes models: that stock prices follow a stochastic process described by geometric Brownian motion. Accordingly, for European options, as the number of binomial calculation steps increases, the binomial model converges on the Black-Scholes formula. Actually, in the case of binomial model with infinite steps, the Black-Scholes model for European options is in fact a special case of such binomial model. In other words, the binomial model provides discrete approximations to the continuous process underlying the Black-Scholes model. Whilst the Cox, Ross & Rubinstein binomial model and the Black-Scholes model eventually touch as the number of time steps gets substantially large and the length of each step gets considerably small, this
convergence, excluding at-the-money options, is not smooth or monotonic. The on-line Black-Scholes/Binomial convergence analysis calculator\(^4\) examine graphically how convergence changes as the number of steps in the binomial calculation increases and how convergence changes may be affected by the strike price, stock price, time to expiration, volatility and risk free interest rate.

There are two reasons for differences between the Binomial Model (BM) and Black’s approximation (BA). The first concerns the timing of the early exercise decision; the second concerns the way volatility is applied. The timing of the early exercise decision tends to make BM greater than BA. In BA, the assumption is that the holder has to decide today whether the option will be exercised after 5 months or after 6 months; BM allows the decision on early exercise at the 5-month point to depend on the stock price at that time. The way in which volatility is applied tends to make BA greater than BM. In BA, when we assume exercise occurs after 5 months, the volatility is applied to the stock price less the present value of the first dividend; when we assume exercise takes place after 6 months, the volatility is applied to the stock price less the present value of both dividends (Hull, 2009, p.301).

### 2.6.4 The Cost of Carry Model

To calculate the present fair value of the futures contracts, cost of carry model is considered as the most popular one. The major underlying principal of the cost of carry model is that the main cost considered in the pricing of futures contracts are costs of financing like storage and transportation costs plus the interest paid for financing the asset deduct income received on that asset. In the case of non-dividend paying stocks the cost of carry is \( r \), since there are no storing costs and no dividend is yielded. In the case of a stock index, it is \( r-q \) as the rate of yield on the stock is equal to \( q \). In the case of a commodity that yields income at rate \( q \) and incurs storage cost at rate \( u \), it is \( r-q+u \). According to the cost of carry model, for an investment, the futures price can be calculated as follows:

\[
F_0 = S_0 e^{cT} \tag{2.9}
\]

- \( F_0 \) = Futures price at time zero.
- \( S_0 \) = underlying stock price at time zero.

---

\( c = \) the cost of carry of the asset for \( T \) years.

In the case of physical consumption asset which provides convenience yield, it can be defined as follows:

\[
F_0 = S_0 e^{(c-y)T} \tag{2.10}
\]

\( y = \) the convenience yield.

### 2.7 The Options Greeks

Understanding the Options Greeks is very essential in an option position or setting up a portfolio holding options and underlying stocks. The Options Greeks are those tools that measure the factors affecting options prices such as price and volatility of underlying stocks, risk free rate of return, strike price and time to expiration of the options’ contract. Each of these Greeks measures one of these affecting factors to manage the risks of options trading. The analyses of these Greeks are applicable to either professional market makers on the organized exchanges or traders in the OTC markets. The Options Greeks are Delta, Gamma, Theta, Vega and Rho.

#### 2.7.1 Delta

Delta is considered as the most familiar Options Greeks which is the ratio of the change in an option price with respect to the changes of its underlying stock (Hull, 2009, p.247). The result of this ratio indicates the number of units of the stocks that is required to be held opposite to each option position in order to form a riskless hedge. Sometimes, the creation of such riskless hedge is called Delta hedging. It can be calculated using slope of the curve that shows the relationship between the option price and its underlying stock price (See Figure 2.1). The slope can be calculated using the following formula:

\[
\Delta = \frac{\partial c}{\partial S} \tag{2.11}
\]

where \( c \) is the price of call option and \( S \) is the price of underlying stock.
It is to be noted that calls and puts have opposite deltas - call options are positive and put options are negative whose relevant delta values ranges from 0 to +1 and 0 to -1, respectively. The Figure 2.2 shows the performance of call and put option deltas in the form of moving from out-of-the-money (OTM) to at-the-money (ATM) and lastly in-the-money (ITM).

2.7.2 **Gamma**

For the reason that Delta is not fixed and it will raise or drop in different situations, it requires its own measure which is called Gamma. Gamma ($\Gamma$) of an option is the rate of change of corresponding delta with respect to the price of underlying stock (Hull, 2009, p.361). Delta with higher Gamma is more risky, because given the unfavorable changes in the price of underlying stock; Delta with larger Gamma indicates higher adverse change. It can be calculated as follows:

$$\Gamma = \frac{\partial \Delta}{\partial S} = \frac{\partial^2 V}{\partial S^2}$$  \hspace{1cm} (2.12)

where $V$ is the price of portfolio of options and $S$ is the price of underlying stock.

2.7.3 **Theta**

Theta is the measurement of the options’ time value decay. Theta measures the rate at which the option loses its value as it approaches the expiry date. In other words, Theta measures the sensitivity of an option with respect to the passage of the time. Theta is usually negative for call and put options. Using the Black-Scholes formula, Theta for European call and put options on a non-dividend-paying underlying stock can be calculated as follows:

$$\Theta(\text{call}) = - \frac{S_0 N'(d_1) \sigma}{2\sqrt{T}} - rK e^{-rT} N(d_2)$$  \hspace{1cm} (2.13)

where $d_1$ and $d_2$ are measured as in equation (2.1) and

$$N'(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2}$$  \hspace{1cm} (2.14)

$$\Theta(\text{put}) = - \frac{S_0 N'(d_1) \sigma}{2\sqrt{T}} + rK e^{-rT} N(-d_2)$$  \hspace{1cm} (2.15)

2.7.4 **Vega**

However, it is hypothetically assumed that the volatility of underlying stock of a derivative is constant; in practice it changes over the time (Hull, 2009, p.365). Vega measures the sensitivity of an option value with respect to the volatility of underlying stock. Vega is also expressed as the amount of money per underlying share that the option's value will gain or lose
as volatility rises or falls by one percent. In other words, the higher the Vega, the greater the sensitivity of the options’ value to the volatility of underlying stock will be. Vega can be calculated as follows:

\[ \nu = \frac{\partial V}{\partial \sigma} \]  

(2.16)

2.7.5 Rho

Rho (\( \rho \)) measures the sensitivity of an options’ value with respect to the changes in risk-free interest rate (Hull, 2009, p.367). In general, an options’ value is less sensitive to the risk-free interest rate than other factors. Rho can also be expressed as the amount of money that the option will gain or lose, per underlying stock, as risk-free interest rate rises or falls by one percent annually. Generally, it can be expressed as follows:

\[ \rho = \frac{\partial V}{\partial r} \]  

(2.17)

where \( r \) denotes risk-free interest rate.

Over the recent decades, the growth of financial derivatives worldwide has been driven by some factors like increased volatility in financial asset prices, growing integration between national financial markets and international markets, development of risk management tools, and innovations in financial engineering. In addition, subsequent to the recent financial crisis very high volatile movements have been reported in the capital markets over the globe which highlighted the importance of growth in derivatives more than before. Despite the encouraging growth and developments of derivatives for the risk management purposes, they may have some destabilizing effects on the capital markets. Therefore, the regulatory authorities need to be more careful in providing remedial actions to protect the interests of the investors and stakeholders against uncertain fluctuations. In this regard, the empirical investigations in different time settings will provide appropriate information to the policy makers to take right decision.