Chapter 3

Conceptual framework of options
CHAPTER 3
CONCEPTUAL FRAMEWORK OF OPTION

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3.1. Introduction

An option is the right, but not the obligation, to buy or sell underlying assets or securities at a stated date at a stated price. The option writer (seller) grants the right to the option holder (buyer) in exchange for option Premium. The option contract is divided into two main parts namely call option and put option. A call option provides its holder to buy certain securities or assets at a specified price on some future date; whereas put option provides its holder to sell certain securities or assets on some future date at a specified price. Investors adopt combination of both put and call options while entering into option contract.

3.2. Definition of Options:

Options have been defined by different financial experts in different ways:

"An option is the right to buy or sell a specified amount of a financial instrument at a pre-arranged price on, or before, a particular date"

-Keath Red Head.
“An option agreement is a contract in which the writer of the option grants the buyer of the option the right to purchase from or sell to the writer, a designated instrument at specified price (or receive a cash settlement) within a specified period of time”

-Fisher and Jordan.

“An option is a contract between two parties in which one party has the right but not the obligation, to buy or sell some underlying assets”

-D.C. Patwari.

By analysing the above definitions an option is a contract between writer and the holder where in premium is payable by the holder to the writer for acquiring the right to buy or sell.

3.3 The language of Options:

As a recent origin the option contract involves certain jargon which one has to understand to enter option contract. The specific terms used in the option contract are enunciated as under:

**American option:** An option which can be exercised by the option holder on or before the date of maturity. It provides an opportunity to
the holder to exercise the option on or before the maturity when it is “In the money” (ITM).

**AT the Money (ATM):** When the option results in no benefit to the option holder it is called ‘At the Money’ (ATM). An option is said to be ‘At the Money’ if exercise price is equal to the prevailing market price for both call and put options. The holder may not exercise the option if it is ‘At the Money’ (ATM).

**Call and Put option:** The right to purchase a specified number of stocks at a specified price on a specified date is called the call option, while the right to sell a specified number of stocks at specified price on at specified date is called a put option.

**European option:** An option which can be exercised by the option holder on the date of maturity.

**Expiration Day:** It is also known as day of maturity, exercise day, or strike day on which option contract can be exercise if it is ITM and can’t be exercise if it is OTM by the option holder.

**In the Money (ITM):** When the option results in some benefit to the option holder it is called ‘In the Money’ (ITM). In case of call option the option is in the money if exercise price is less than the
prevailing market price whereas in case of put option if exercise price is more than the market price. The holder may exercise the option only, if it is ‘In the Money’ (ITM).

**Index options:** These options have the index as the underlying.

In India Index options are European styled and cash settled. An Index option contract provides the holder the right to buy and sell indices at specified price on some future date.

**Intrinsic value of an option:** The option premium can be broken down into two components viz., intrinsic value and time value. The intrinsic value of a call is the difference between stock price and the strike price, 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 \[0, S_t - X\] which means the intrinsic value of a call is the greater of 0 or \(S_t - X\). Similarly, the intrinsic value of a put is Max \[0, X - S_t\], i.e. the greater of 0 or \(X - S_t\) where \(X\) is the strike price and \(S_t\) is the spot price\(^{37}\).

**Long position:** Going long a stock means buying the stock. A position to buy certain asset or securities on certain future date at a specified price is called long position. While taking long position the
holder has to pay option premium to the writer on the day of entering into the contract at a unit price per share.

**Non linear pay-off:** When the payoffs of the option holder does not equal to the pay-off option writer, it is called non-linear pay-offs. Option offers non-linear pay-off in that loss of the option holder is limited while profits are unlimited. For a writer, the pay-offs are just opposite.

**Option holder:** The buyer of the option is called option holder. An option holder enjoys right but not the obligation to exercise the option to buy or sell certain security or asset. The option holder may be a buyer of the put or call option. The losses of option holder are limited to the amount of option premium but profits are unlimited.

**Option premium:** The consideration for a contract of option is option premium payable by the option holder (buyer) to the writer (seller). It is also referred to as the option price.

**Option writer:** The seller of the option is called option writer. A writer is legally obligatory to perform according to the terms of the option contract. An option writer does not enjoy any right but has the obligation to buy (In case of writing a call) if holder wants to sell or sell (In case of writing a put) if the holder wants to buy certain
security or asset. The option writer may be a buyer of the put or call option. The losses of option holder are unlimited but profits are limited to the extent of option premium.

**Out the Money (ITM):** When the option results in some losses to the option holder it is called ‘Out the Money’ (OTM). In case of call option the option is ‘Out the money’ if exercise price is more than the market price whereas in case of put option it is ‘Out the money’ if exercise price less than the market price. The holder does not exercise the option if it is ‘Out the Money’ (OTM).

**Price volatility:** It is defined as the fluctuation or variability in the prices of security. As a concept volatility is straightforward and intuitive. It measures variability or deviation about a central tendency Gupta (2005)\(^{38}\). To be more precisely, it is a measure of how far the current price of an asset or security deviates from its average past prices. Greater the deviation, greater is the volatility. At a more fundamental level, volatility can indicate the strength or conviction behind a price move. Volatility in the share price significantly influences the call option value. In operational terms, the greater is the possibility of extreme outcomes, the greater is the call option value to its holder, ceteris paribus. In statistical terms if volatility in the stock price is more it’s worth is more to its owner.
**Short position:** Going short a stock means selling the stock. A position to sell certain asset or securities on certain future date at a specified price is called short position. If a person has taken short position he may receive option premium from the option holder for accepting the obligation to sell.

**Stock options:** Stock options are options on individual stocks. They are currently traded on over one-hundred and thirty six stocks in the India. A stock option contract grants the holder the right to buy or sell shares at the specified price on some future date.

**Time to maturity (TTM):** It is also known as time to expiration. It is a time gap between the days of entering into contract till the expiration day. Time to maturity decreases as the time approaches near maturity. For the current study in a month there are four time to maturities such as: 28, 21, 14 and 7 days.

**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. At expiration, an option should have no time value.
3.4 Permitted Lot sizes of Contracts:

Depending on the volume and value of trade for different securities different lot sizes are permitted. The step value of price change of IOC, BPCL and Hindpetro is Rs. 10, whereas for ONGC it is Rs. 5. Six strike prices are provided for ITM and six for OTM and one ATM for IOC. Nine strikes prices are provided for ITM and nine strikes are provided for OTM and one ATM for BPCL. Ten strikes prices provided for ITM and ten strikes are provided for OTM and one ATM for both Hindpetro and ONGC. The permitted lot sizes for the companies are depicted in the last column of Table 3.1.

Table 3.1

Permitted lot sizes of companies under study

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Applicable Step value</th>
<th>No. of Strikes Provided In the money - At the money - Out of the money</th>
<th>No of additional strikes which may be enabled intraday</th>
<th>*Lot Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOC</td>
<td>10</td>
<td>6 -1- 6</td>
<td>6</td>
<td>600</td>
</tr>
<tr>
<td>BPCL</td>
<td>10</td>
<td>9 -1- 9</td>
<td>9</td>
<td>1100</td>
</tr>
<tr>
<td>Hindpetro</td>
<td>10</td>
<td>10 -1- 10</td>
<td>10</td>
<td>1300</td>
</tr>
<tr>
<td>ONGC</td>
<td>5</td>
<td>10 -1- 10</td>
<td>10</td>
<td>300</td>
</tr>
</tbody>
</table>

Source: Survey result from National Stock Exchange, www.nseindia.com

*For entire period of study lot size or contract size is assumed as uniform.
The Table 3.1 is compiled by obtaining data from the official web site of NSE. At the time of computation of net payoffs, lot size plays a prominent role. The net payoff per share is multiplied with the lot size to obtain the total net payoff by way of option contracts.

3.5. Black-Scholes option pricing model:

The Black-Scholes Option Pricing Model is an approach used for computing the value of a stock option. It can be used to obtain values of both call and put options. To be acquainted with the assumptions of the Black-Scholes model, it will be important to know its applications. In their seminal paper (1973)\textsuperscript{40}, Black and Scholes made the undermentioned assumptions on the financial market.

3.5.1 Assumptions of Black and Scholes model:

a) Non-dividend paying Stock: The model assumes that holders of the underlying stocks are paid no dividends during the life of the option. But, in the contemporary world, most companies pay dividends to their shareholders. One needs to overcome this serious limitation by deducting the present value of future dividend from the stock price. For the purpose of the current study it is assumed that the stock pays no dividends so that the entire return from holding the stock comes through the price appreciation.
b) No Transaction Costs or Taxes: Usually, market participants and makers incur certain amount of costs while buying and/or selling option in the form of brokerage commissions, fees and so on. These costs may distort the output derived from the model.

c) Constant Risk-free Interest Rate: It is also assumed that a risk-free interest rate \((r_f)\) is constant. In reality, there is no such risk-free interest rate in the world. Usually, discount rates on Government Treasury Bills are considered as risk-free interest rate for all practical purposes. In this dynamic world, discount rates can never be the same throughout the period. This violates an important assumption of the model. However, for the current research Mumbai Inter Bank Offer rate (MIBOR) is assumed as risk free rate which obtained from the Bond segment of NSE on the date of entering into the contract.

d) European Styled Options: The option is a European option. A European option is exercisable only at the end of maturity. American options allow the option holders to exercise the option at any time within the maturity date. However, this assumption is not of a major concern because only a few options are, in fact, exercised before the last days of their life.
e) Lognormal Distribution of Returns: The model assumes that the future stock price has a lognormal distribution. A variable that has a lognormal distribution can have any value between zero and infinity, while its natural logarithm is normally distributed. Contrasting to normal distribution, it is skewed and its mean, median and mode are all different.

f) Constant volatility: Volatility, a measure of how much a stock can be expected to move in the near-term, is constant over time. This means that the variance of the return is constant over the life of the option contract and is known to market participants. While volatility can be relatively constant in very short term; it is never constant in longer term. Some advanced option valuation models substitute Black-Scholes constant volatility with stochastic process generated estimates.

It is apparent that none of these principles can be entirely satisfied. Transaction costs exist in all markets, all securities come in discrete units, short selling with full use of proceeds is very rare, interest rates vary with time and there is evidence that the price of most stocks do not precisely follow a geometric Brownian process. Even then the model is more popular and widely used because the method is more precise and simple for determination of equilibrium values of options with great speed and ease.
3.5.2 Black and Scholes formula

The Black-Scholes mathematical model explains that the price of heavily traded assets follow a geometric Brownian motion that looks like a smile or smirk with constant drift and volatility. When applied to a stock option, the model incorporates the constant price variation of the stock, the time value of money, the option's strike price and the time to the options expiry. The Black-Scholes model provides a precise formula for the prices of a European call on a non-dividend paying stock is expressed as follows;

\[ c = S_0 N(d_1) - X e^{-rT} N(d_2) \]  \hspace{1cm} (3.1)

Where,

\[ d_1 = \frac{\ln\left( \frac{S_0}{X} \right) + (r + \frac{\sigma^2}{2})T}{\sigma \sqrt{T}} \]  \hspace{1cm} (3.2)

\[ d_2 = d_1 - \sigma \sqrt{T} \]  \hspace{1cm} (3.3)

The interpretation of the symbols is as follows:

c = price of a European call on a non-dividend paying stock

\( S_0 \) = Spot price of the underlying asset

\( X \) = Strike price of the option
e = 2.71828, the base of natural logarithms and Ln is natural logarithm.

r = Risk-free rate. (In this model continuous compounding rate given by \( \ln (1+r) \) is considered. For instance, if interest rate per annum is 10 percent, then \( \ln (1+0.10) \) is equal to 0.0953 is considered, which is equivalent to the continuously compounded equivalent of 10 percent per annum.

T = Time to expiration/maturity expressed in years

\( \sigma \) = is a measure of volatility that measures the annualized standard deviation of continuously compounded returns on the underlying asset. While determining value of annualized sigma daily sigma is multiplied by root of number of trading days per year.

According to Hull (2004)\(^{42} \), by using closing daily prices of few recent months a compromise solution for annualized volatility can be obtained by taking product of daily volatility and squared root of number of trading days which is symbolically represented as follows,

\[
\sigma_{\text{annual}} = \sigma_{\text{daily}} \times \sqrt{\text{No. of trading days}}
\]

It is assumed that on an average there are 252 trading days in a year. It is so because, the standard deviation is measured on returns
of the trading days only since volatility on holidays is zero as no trading takes place on these days.

\[ N(d) = \text{Cumulative standard normal deviation of a variable that is normally distributed with a mean of 0 and a standard deviation of 1.} \]

\[ N(d_1) \text{ is the delta of the option that measures the change in option price for a given change in the price of the underlying asset and } N(d_2) \text{ is the probability of option being ‘In the money’ (ITM).} \]

By solving equation (3.2) and (3.3), the value of \( d_1 \) and \( d_2 \) can be obtained.

Finally, by substituting the value of \( N(d_1) \) and \( N(d_2) \) in equation (3.1) the fair value of the call option can be obtained.

### 3.6 Determinants of Option price:

The price of the option is determined by many methods like binomial method, Black-Scholes option pricing formula, Volatility jump model etc. out of which the Black-Scholes option pricing model is most popular and widely used throughout the world. The current study also focuses on the B-S model. It is based on the assumption that the stock prices as per continuous time and continuous variable stochastic Markov process. Markov process states that the future value of stock price depends only on the present value not on the history of the variable. The Markov property implies that the probability distribution of the stock prices at any particular future time is not dependent on
the path followed by the price in the past. The Markov property of the stock prices is consistent with the weak form of market efficiency. The variables or parameters or factors that determine the call option price are given below:

a) Current price of the underlying asset \( (S_0) \): When a call option on stock is exercised some time in future, the payoff from the option is the amount by which the stock price exceeds the strike price. Hence, the price of a call option increases with the increase of stock price and vice versa. The opposite is true for the put option. Here the payoff on exercise is the amount by which the strike price exceeds the stock price. Hence, put option becomes more valuable as the stock price falls and less valuable as the underlying stock price rise.

b) The strike price \( (X) \): Strike price or exercise price of a call option specifies the price at which the option holder can buy the underlying stock. Hence, a higher (lower) strike price makes a call option less (more) valuable. Strike price, in case of a put option, indicates the price at which the option buyer can sell the stock to the option writer. Hence, for put options, as the strike price increase, they become more valuable and as the strike price decreases, they become less valuable.
c) The time to maturity ($T$): The values of both put and call American options increase with the increase of time to maturity or expiration since long-life option holders receive greater opportunities than the owners of the short-life options. However, it may not hold good for European options because all European options can be exercisable only on the maturity and hence, there exists no definite relationship between time to expiration and option price in case of European options. For the current research in each month option payoffs are calculated for a time to maturity of 7 days, 14 days, 21 days and 28 days.

d) The volatility of the price of the underlying stock ($\sigma$): Volatility of stock price reflects the uncertainty associated with future movements of the stock price. As volatility increases, the chance that the stock will do very glowing or very badly also increases. The value of both calls and puts increases as volatility increases because higher the volatility the greater is the chances of receiving higher profits. Owners of call and put options are not concerned about price falls and increases respectively because their losses are limited only to the option premiums they paid. The past volatility of a security can be estimated as the standard deviation of a stock's returns over a predetermined number of days. Choosing the appropriate number of
days is complicated. Longer period of observation has an averaging effect and as volatility varies with time and very old data may not be relevant for the current situation and cannot be used for predicting the future. In absence of an agreed method to estimate volatility to be used in options pricing models, a simple method of estimating standard deviation using past nine months return was used in the study.

e) The risk free interest rate ($r_f$): The effect of risk-free interest rate on option prices is not clearly defined. An increase in the interest rate increases the expected growth rate of the stock price, but decreases the present value of any cash flow received by the option holder. Because of these two effects the value of put option falls as interest rate increases. However, in case of calls, the first effect increases the value of the call option, while the second effect tends to reduce the value. As effect of former overwhelm the second effect, the price of the call increase with the increase of interest rate, as other variables remaining constant. Generally, when interest rate fall (rise) stock prices increase (fall). Hence, the net effect of change in interest rate and change in stock price may be different from the above results. For the present study MIBOR (Mumbai Inter Bank Offer rate) is assumed as the risk free interest rate which is obtained from Bond segment of NSE.
3.7 Implied volatility of stock prices ($\delta$):

It is perceived volatility of the investor in the light of current option price which is based on Black-Scholes option pricing model. It may also be defined as the forecast of the underlying stock volatility as implied by the option prices. Symbolically, it is expressed as follows:

$$\delta = f (S_o, E, C_o, t, r)$$

Where; $\delta = \text{Implied volatility}$

**Figure 3.1. Implied volatility**

By obtaining the option price quoted in the market and working backward, the market’s opinion about the volatility of the option over the remaining life of the option can be deduced. This is called implied volatility which is the perceived volatility of the investors arrived from

3.8 OPTION STRATEGY AND PAY-OFF:

Implied volatility levels in an option decide the price of an option. Implied volatility can go up or down but typically; fall back to their normal levels. Option technical analyst rely on one of the two things-price and volume as the foundation for analysis. According to them implied volatility reflects itself in the price of the options, so that expensive options have high implied volatility and cheap options have low implied volatility. High implied volatility environment is good for selling options and low implied volatility is good for buying options.

Table 3.2 Volatility based strategy

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Implied volatility</th>
<th>Option strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low</td>
<td>Long call</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>Short call</td>
</tr>
</tbody>
</table>

Table 3.2 depicts that based on implied volatility option strategy is adopted by taking a long position in call option (Buying a call option)
at a strike price where the implied volatility is low and a call is written (selling a call option) at which implied volatility is high as a result of the two positions net option pay-off is positive. The crux of the present study is based on this strategy. A call option is “In the Money” (ITM) if strike price is less than the spot price on maturity else “Out the Money”. When a call is written the writer does not enjoy any rights. Therefore, the holder will exercise the option if strike price is less than the spot price on maturity and option is said to be “In the Money” (ITM) else it is “Out the Money” (OTM). Under any situation a holder will exercise the option only, if it is “In the money”.

3.9 Using Black Scholes model for American Option:

The Black-Scholes model has been designed for the European type options which will be exercised only on expiration date. But, the Indian stock options are of American type, which can be exercised on or before expiration date. Hence, strictly speaking one can’t use the formula in Indian option market. But, thanks for the fact that “It is never optimal to exercise early for an option that pays no dividend”.47 Because of this, if we eliminate all arbitrary opportunities of American options, then as per the above fact, one will not exercise the options early hence can be treated like European options. In view of the above, all risk-free arbitrage opportunities, if any, to be eliminated
from the sample to make use of the B-S model for American type options. Thus, for the sample taken from Indian stock options, Black-Scholes formula can be used theoretically as well as practically.