Term Project

ON

An Empirical Investigation of Black-Scholes Option Pricing Model on NSE NIFTY Index Options

Submitted By:
Ruchika Saluja
2K14/MBA/523

Under the Guidance of:
Dr. Archana Singh

DELHI SCHOOL OF MANAGEMENT
DELHI TECHNOLOGICAL UNIVERSITY
BAWANA ROAD DELHI 110042
January-May, 2016

DECLARATION

I, Ruchika Saluja, student of EMBA 2014-2016 batch of Delhi School of Management, Delhi Technological University, Bawana road, Delhi-42 declare that term project "An Empirical Investigation of Black-Scholes Option Pricing Model on NSE NIFTY Index Options." submitted in partial fulfilment of Executive MBA programme is the original work conducted by me.

The information and data given in the report is authentic to the best of my knowledge.
This Report is not being submitted to any other University for award of any other Degree, Award and Fellowship.

Place: New Delhi
Date:

Ruchika Saluja

CERTIFICATE

This is to certify that Ruchika Saluja, student of Executive MBA, Delhi Technological University, has worked on the project titled "An Empirical Investigation of Black-Scholes Option Pricing Model on NSE NIFTY Index Options." under my guidance submitted towards partial fulfilment of Executive MBA programme.

Place: New Delhi
Date:

Dr Archana Singh

EXECUTIVE SUMMARY

The options are the contracts which serve as a tool for risk hedging and price discovery. Therefore, they lead to better allocation of capital. The efficiency of an options market, i.e. the correctness of option prices indicates that it is working well at its well identified functions. In view of this, the efficiency of options market has been of equal interest to the academics as well as practitioners and a number of studies have been carried out across the globe in different markets.

Index derivatives (e.g., index options and index futures) become a natural choice to the fund managers as most of the equity funds are created .Amongst all index derivatives, index options play an important role in the economy as they provide a better hedging mechanism to the institutional investors (e.g., mutual fund organizations) compared to that of index futures. These contracts, unlike futures, allow fund managers to take advantage of favourable movements in the market along with the protection against the unfavourable movements.

The most popular model for pricing options, both in financial literature as well as in practice has been the Black-Scholes model. In spite of its wide spread use the model appears to be deficient in pricing the options.

The purpose of this study is to test the pricing performance of Black-Scholes model. Since globally Black-Scholes Model is used to price the Options contracts, therefore, the premium of Equity Index Options contracts traded on Nifty index is compared with the theoretical price estimated by using Black-Scholes Model. MIBOR is used as Risk-free rate and standard deviation computed from daily returns of the underlying index is used as volatility to estimate the theoretical prices.

Present study uses daily data for the sample period from January 1, 2016 to March 31, 2016 and daily price quotes of underlying index and premium on options contracts have been downloaded from the website of NSE (www.nseindia.com).

Mean Absolute Errors, Mean Squared Errors, Root Mean Squared Errors and Theil's U statistics are found to be statistically significant, which implies that the Equity Index options contracts are not fairly priced and options premium significantly differ from price suggested by Black-Scholes Model. Heteroscedastic nature of returns and daily volatility, time-varying risk-free rate may be significant reasons for inefficient index options prices because Black-Scholes Model assumes volatility and risk-free rate to be constant over the contract cycle, however, during the study period, prices were highly volatile and interest rate kept on changing. Findings of present study are consistent with that of existing literature which states that nonetheless, Black-Scholes Model is theoretically very sound but is not applicable in real life.

Contents

Introduction

Presence of an organized derivatives market furnish the legitimate traders to hedge non diversifiable risk element contained in their portfolio and help an informed market participants to speculate on the basis risk so that they can secure risk free profit, which is offered as a reward to restore market equilibrium. Reward to restore market equilibrium evolves because of noise trading by uninformed market agents, which inflates information asymmetry in the underlying asset market and it starts trading at disequilibrium price, reflected through jumps in the basis risk. On the other hand, informed trading by market agents is expected to bring fairness in price change of the underlying asset and help it to stabilize, consequently the required rate of return declines. Therefore, an organized options market would be a joint product, where price risk insurance is furnished to hedgers, gambling to speculators and arbitrageurs undertake the responsibility to restore market equilibrium.

Low transaction cost, low initial investment (i.e. margin money and premium) to undertake position(s) in the options market i.e. convenience to take leverage positions (i.e. no restriction to take short positions), very low risk of default (because other party to the contract is clearing house itself), convenience to rollover etc. are prominent features of options market(s) which attract all types of traders (such as informed, uninformed, large as well as small traders) and results into volume explosion in the options market.

Active trading in the options market simultaneously affects the cash market information dissemination efficiency, volatility and liquidity because both markets are linked through arbitrage process and volatility spill over between two is very efficient and quick.

Since, there is an old Wall Street adage "**It depends upon volume to make prices move**", therefore in the wake of the fact that options markets are fairly liquid (as per the Efficient Market Hypothesis (EMH)), options markets (like any other speculative market) are also expected to absorb information immediately as it becomes available thus should be efficient in weak form at least.

Last two decades have witnessed a manifold increase in the volume of financial derivatives market. Trading and pricing of option find an important place in derivatives market. Indeed, Option pricing has attracted the interest of academicians and practitioners alike. Many empirical studies have been conducted on the applicability of Black and Scholes (B-S) (1973) option pricing model in the developed markets.

There are number of pricing model created, developed and studied but Black-Scholes options pricing model is the most widely used formula, with embedded probability, in human history. The model is successful because Black-Scholes model is very predictive,

meaning that it generates option prices that are very close to actual price at which the option trade takes place.

While many studies have highlighted the bias in the B-S model, few models appear to be consistently superior to it. The simplicity and mathematical ease of implementing the B-S model retains it as a strong contender among the competing alternatives for option pricing.

The Black-Scholes model revolutionized financial economics in several ways.

1. It contributed to our understanding of a wide range of contracts with option-like futures. For example, the call future in corporate and municipal bonds is clearly an option, as is the refinancing privilege in mortgages.
2. It allowed us to revise our understanding of traditional financial instruments. For example, because shareholders can turn the company over to creditors if it has negative net worth, corporate debt can be viewed as a put option bought by the shareholders from creditors. Pricing usually means that there is an active and liquid market with many buyers and sellers that generates a continuous flow of price for specific instrument. However, the pricing of option goes beyond supply and demand fundamentals. Market participants follow pricing models that can be used as benchmark.

Black Scholes Model (Black - Scholes Model henceforth) is used as option pricing model in most of the markets of the world. Most of the studies were conducted in the developed markets. In the emerging Indian market, exchange-traded options were introduced in 2001. Since then there have been a few empirical studies to test the B-S model in the Indian derivatives market.

However, the assumptions of Black-Scholes model have been criticized for being

- too simplistic;
- not taking into account the dividends;
- option to early exercise the contract;
- Constant volatility and risk-free rate.

The present study examines the pricing efficiency of S&P CNX NIFTY Index (NIFTY traded at National Stock Exchange of India). NIFTY is included for being the representative of the market. Present study uses daily data for the sample period January 1, 2016 to March 31, 2016 and daily closing price quotes of underlying indices and premium on options contracts have been downloaded from the website of NSE (www.nseindia.com).

Financial Derivatives

The term ‘derivatives, refers to a broad class of financial instruments which mainly include options and futures. These instruments derive their value from the price and other related variables of the underlying asset. They do not have worth of their own and derive their value from the claim they give to their owners to own some other financial assets or security. A simple example of derivative is butter, which is derivative of milk. The price of butter depends upon price of milk, which in turn depends upon the demand and supply of milk. **The general definition of derivatives means to derive something from something else.**

Derivatives are financial contracts on a pre-determined payoff structure, whose value derives from underlying reference assets, such as securities, commodities, market indices, interest rates, or foreign exchange rates. The economic rationale for derivatives assumes gains from efficient price discovery and risk shifting. Derivatives supplement cash markets as unfunded alternatives to trading underlying reference assets by providing hedging and low-cost arbitrage opportunities. They improve market liquidity and complete financial markets by facilitating the unbundling, transformation and diversification of financial risks, which can be customized to the varying risk preference and tolerance of agents, and, thus, improving the capacity of the financial system overall to bear risk and intermediate capital.

Risk diversification improves the fair market pricing and managing of risk; increases stability at all levels, and enhances general welfare. Derivatives help “discover” the fair market price (spot and future) of certain assets or risks in instances of high-transaction costs, poor liquidity due to the dispersion of markets, limited asset supply or the conglomeration of many risks into one whole asset. In particular, derivatives allow a variety of economic agents to raise capital more cheaply in capital markets.

Equity derivatives convey benefits similar to other derivatives, but they also entail sizable risks to be managed. Derivatives on single stocks or equity indices reduce uncertainty about expected corporate performance, strengthen the liquidity and price discovery in underlying equity markets, and lower the cost of equity listings for firms.

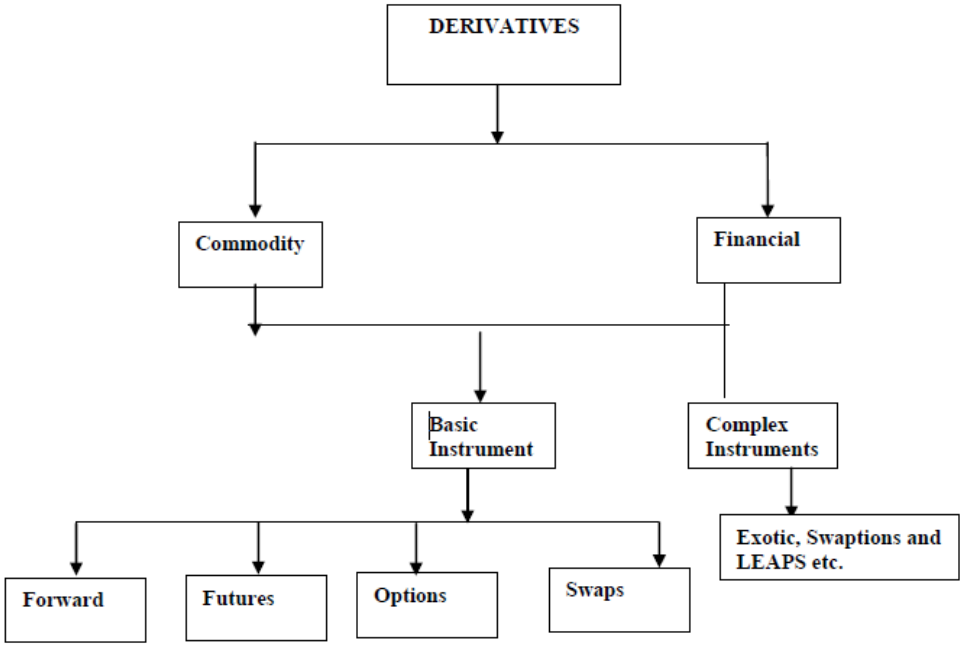
However, as investors revise their expectations about the cash generating ability of one or more listed firms, small price moves in cash markets can have an outsized impact on the financial position of participants in these markets, because derivatives often imply substantial leverage. Moreover, unlike most other derivatives, the effective use of derivative markets for risk transfer and price discovery of equity depends critically on the liquidity as well as efficient pricing and sufficient trading volume in underlying cash markets.

Broadly derivatives can be classified in to two categories

- **Commodity derivatives**
  - In case of commodity derivatives, underlying asset can be commodities like wheat, gold, silver etc.,

- **Financial derivatives**
  - In case of financial derivatives underlying assets are stocks, currencies, bonds and other interest rates bearing securities etc.

Since, the scope of this case study is limited to only financial derivatives so we will confine our discussion to financial derivatives only.



Forward Contract

A forward contract is an agreement between two parties to buy or sell an asset at a specified point of time in the future. In case of a forward contract the price which is paid/ received by the parties is decided at the time of entering into contract. It is the simplest form of derivative contract mostly entered by individuals in day today's life.

One of the parties to a forward contract assumes a long position (buyer) and agrees to buy the underlying asset at a certain future date for a certain price. The other party to the contract known as seller assumes a short position and agrees to sell the asset on the same

date for the same price. The specified price is referred to as the delivery price. The contract terms like delivery price and quantity are mutually agreed upon by the parties to the contract. Forwards contracts are traded over-the- counter and are not dealt with on an exchange unlike futures contract.

Lack of liquidity and counter party default risks are the main drawbacks of a forward contract.

Futures Contract

Futures is a standardized forward contact to buy (long) or sell (short) the underlying asset at a specified price at a specified future date through a specified exchange. Futures contracts are traded on exchanges that work as a buyer or seller for the counterparty. Exchange sets the standardized terms in term of Quality, quantity, Price quotation, Date and Delivery place (in case of commodity).

Futures contracts being traded on organized exchanges impart liquidity to the transaction. The clearinghouse, being the counter party to both sides of a transaction, provides a mechanism that guarantees the honouring of the contract and ensuring very low level of default.

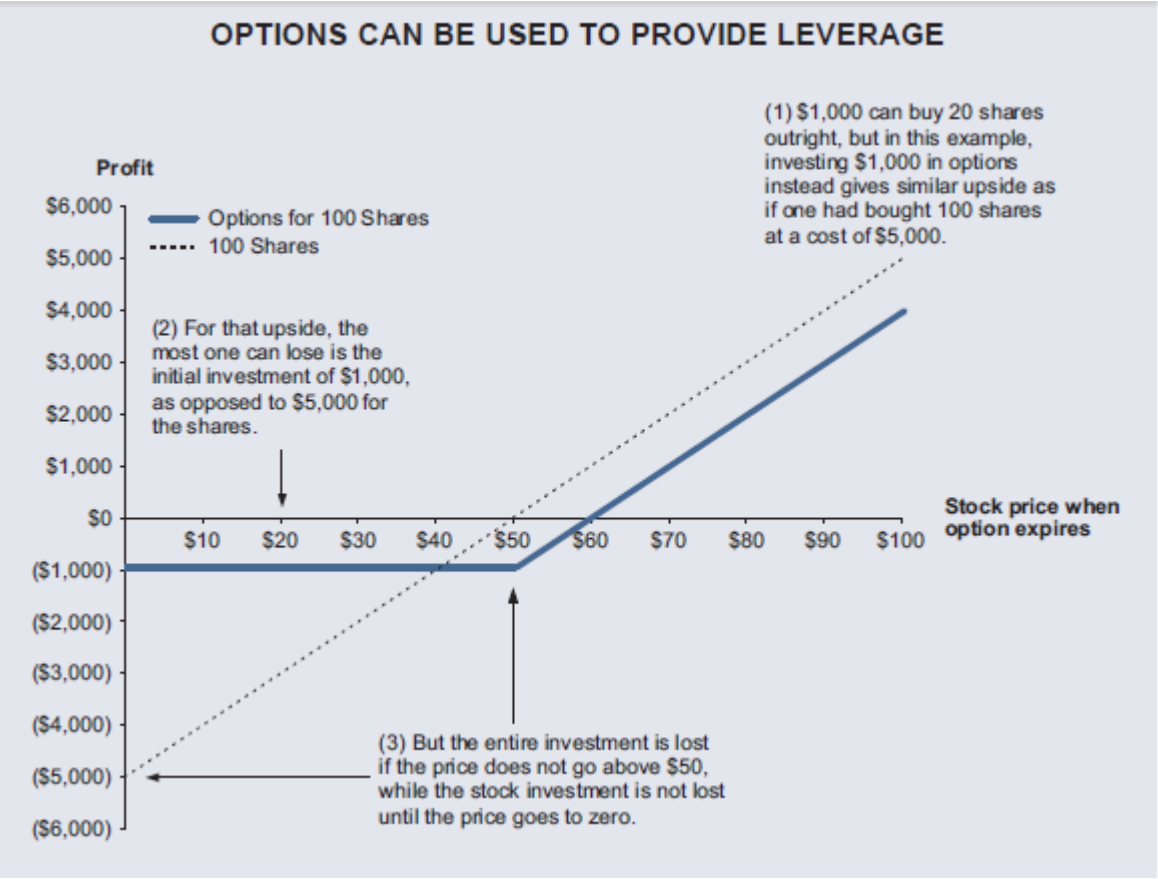
Options Contract

In case of futures contact, both parties are under obligation to perform their respective obligations out of a contract. But an options contract, as the name suggests, is in some sense, an optional contract. An option is the right, but not the obligation, to buy or sell something at a stated date at a stated price. Options are the standardized financial contract that allows the buyer (holder) of the option, i.e. the right at the cost of option premium, not the obligation, to buy (call options) or sell (put options) a specified asset at a set price on or before a specified date through exchanges.

Options contracts are of two types:

- **Call options**
  - A call options gives the holder (buyer/one who is long call), the right to buy specified quantity of the underlying asset at the strike price on or before expiration date. The seller (one who is short call) however, has the obligation to sell the underlying asset if the buyer of the call option decides to exercise his option to buy.

- **Put options**
  - A put options gives the holder (buyer/ one who is long put), the right to sell specified quantity of the underlying asset at the strike price on or before an expiry date. The seller of the put options (one who is short put) however, has the obligation to buy the underlying asset at the strike price if the buyer decides to exercise his option to sell. Right to sell is called a Put Options.



Swaps Contract

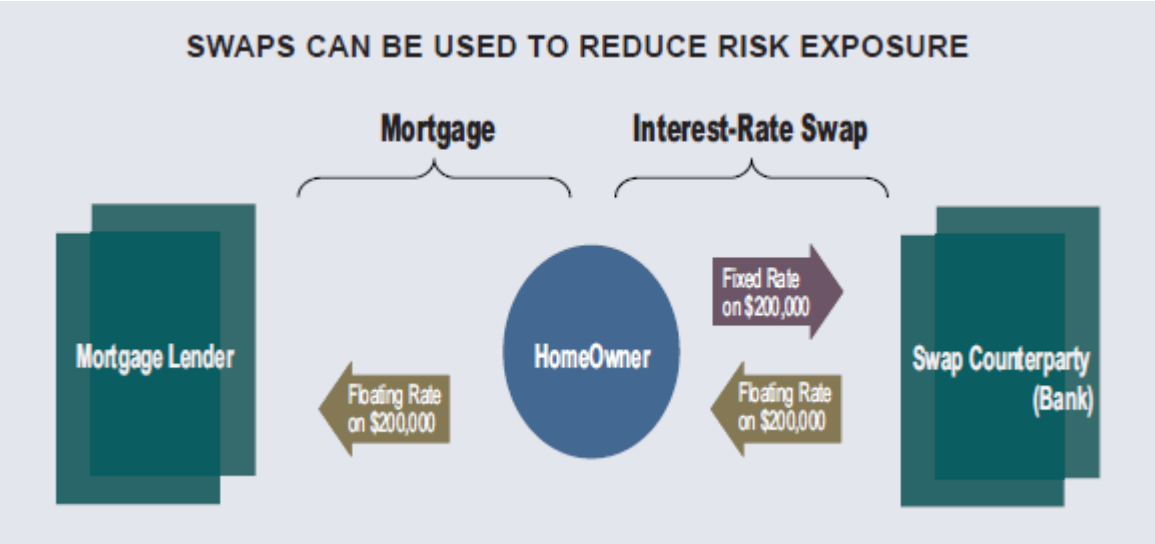
A swap can be defined as a barter or exchange. It is a contract whereby parties agree to exchange obligations that each of them have under their respective underlying contracts or we can say, a swap is an agreement between two or more parties to exchange stream of cash flows over a period of time in the future. The parties that agree to the swap are known as counter parties.

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, and
- **Currency swaps**

- These entail swapping both principal and interest between the parties, with the cash flows in one direction being in a different currency than the cash flows in the opposite direction.

The most popular among these products are financial futures and options. They are available for foreign exchange, interest rates, stock indices, equities and commodities. These products are also known as derivatives.



HISTORY OF DERIVATIVES MARKET

The largest derivative markets in the world are in government bonds, stock market indices and in exchange rates. The year 1973 was the most important in the field of options trading. In this year, the creation Chicago Board Options Exchange and the publication of the most popular formula in finance, the option pricing model (i.e., Black-Scholes Model) of Fischer Black and Myron Scholes revolutionized the investment world.

Derivatives markets in India have been in existence in one form or the other for a long time. In the area of commodities, the Bombay Cotton Trade Association started futures trading way back in 1875. In 1952, the Government of India banned cash settlement and options trading. Derivatives trading shifted to informal forwards markets. In recent years, government policy has shifted in favour of an increased role of market-based pricing and less suspicious derivatives trading. The first step towards introduction of financial derivatives trading in India was the promulgation of the Securities Laws (Amendment) Ordinance, 1995. It provided for withdrawal of prohibition on options in securities. The last decade, beginning the year 2000, saw lifting of ban on futures trading in many commodities.

Derivatives trading over the exchange started in India in June, 2000 with the introduction of index futures trading on the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE) of India. This was followed up in July 2001 by the introduction of the index options, options on individual securities, and futures on individual securities on both the NSE and BSE. The market regulator, Securities and Exchange Board of India (SEBI) has been on both the NSE and BSE taking active steps to increase liquidity in the available contracts to make the market more robust and viable for all kinds of investors.

In recent years, government policy has changed, allowing for an increased role for market-based pricing and less suspicion of derivatives trading. In the exchange-traded market, the biggest success story has been derivatives on equity products. Index futures were introduced in June 2000, followed by index options in June 2001, and options and futures on individual securities in July 2001 and November 2001, respectively. Derivatives on stock indexes and individual stocks have grown rapidly since inception.

Following are the factors driving the growth of financial derivatives:

1. Increased participation of investors in financial market,
2. Increased integration of national financial market with the international markets,
3. Marked improvement in communication facilities and sharp decline in their costs,
4. Development of more sophisticated risk management tools, providing economic participants a wider choice of risk management strategies, and

5. Innovations in the derivatives market, which optimally combine the risks and returns over a large number of financial assets leading to higher returns, reduced risk as well as transactions costs as compared to individual financial assets.

The use of derivatives varies by type of institution. Financial institutions, such as banks, have assets and liabilities of different maturities and in different currencies and are exposed to different risks of default from their borrowers. Thus, they are likely to use derivatives on interest rates and currencies, to manage interest and exchange risk respectively. Financial institutions are regulated differently from non-financial institutions, and this affects their incentives to use derivatives. Indian insurance regulators, for example, are yet to issue guidelines relating to the use of derivatives by insurance companies. In practice, some foreign investors also invest in Indian markets by issuing Participatory Notes to an off-shore investor. FIIs and Domestic institutions are increasing their presence in the equity derivatives market. Retail investors are the major participants in equity derivatives. In terms of the growth of derivatives market, and the variety of derivatives users, the Indian market has equalled or exceeded many other regional markets. While the growth is being spearheaded mainly by foreign institutional investors, retail investors, private sector institutions and large corporations, smaller companies and state-owned institutions are gradually getting into the act. The variety of derivative instruments available for trading is also expanding. Indian commodity derivatives have great growth potential but government policies have resulted in the underlying spot/physical market being fragmented (e.g. due to lack of free movement of commodities and differential taxation within India). Similarly, credit derivatives, the fastest growing segment of the market globally, are absent in India and require regulatory action if they are to develop.

December 14, 1995	NSE asked SEBI for permission to trade index futures
November 18, 1996	L.C. Gupta Committee set up to draft a policy framework for introducing derivatives
May 11, 1998	L.C. Gupta committee submits its report on the policy framework
May 25, 2000	SEBI allows exchanges to trade in index futures
June 12, 2000	Trading on Nifty futures commences on the NSE
June 4, 2001	Trading for Nifty options commences o n the NSE
July 2, 2001	Trading on Stock options commences on the NSE
November 9, 2001	Trading on Stock futures commences on the NSE
August 29, 2008	Currency derivatives trading commences on the NSE
August 31, 2009	Interest rate derivatives trading commences on NSE

Source: NSE Publications

Black-Scholes Model

The Black-Scholes Model for calculating the premium of an option was introduced in 1973 in a paper entitled, "The Pricing of Options and Corporate Liabilities" published in the Journal of Political Economy. The formula developed by three economists – Fischer Black, Myron Scholes and Robert Merton as a way to estimate the price of an option over time and is perhaps the world's most well-known options pricing model. It was developed by Fisher Black and Myron Scholes. Robert Merton later published a follow up paper further expanding the understanding of the model. Merton is actually credited for naming the model "Black-Scholes". Black passed away two years before Scholes and Merton were awarded the 1997 Nobel Prize in Economics for their work in finding a new method to determine the value of derivatives (the Nobel Prize is not given posthumously; however, the Nobel committee acknowledged Black's role in the Black-Scholes model).

The Black-Scholes model is used to calculate the theoretical price of European put and call options, ignoring any dividends paid during the option's lifetime. While the original Black-Scholes model did not take into consideration the effects of dividends paid during the life of the option, the model can be adapted to account for dividends by determining the ex-dividend date value of the underlying stock.

The model makes certain assumptions, including:

I. **Arbitrage**
   a. The market is arbitrage free. Traders can and will, eliminate any arbitrage profits by simultaneously buying (or writing) options and writing (or buying) the option-replicating portfolio whenever profitable opportunities appear.

II. **Friction less and continuous trading**
   a. Trading in both the option and the underlying security is continuous in time, There are no transactions costs or differential taxes, trading takes place continuously, assets are infinitely divisible, unlimited borrowing and short selling are allowed and borrowing and lending rates are equal. Trading in both the option and the underlying security is continuous in time, that is, transactions can occur simultaneously in related markets at any instant.

III. **Leverage**
   a. Black-Scholes model assume that markets are perfectly liquid and it is possible that Traders can borrow or lend in unlimited amounts at the riskless rate of interest. The riskless instantaneous interest rate is constant over time. Stock pays no dividends during the option’s life: it is assumed that stock does not pay any dividend to his stock holder during the life of options.

IV. Log normally distribution returns

a. Stock price (S) are assumed to be random, stock return are log normally distributed with statistically independent price change, and with constant mean and constant variance means that no discontinuous jumps occur in the price of underlying security.

V. European style options

a. The Black-Scholes model assumes European-style options

The Black-Scholes formula takes the following variables into consideration:

- Current underlying price
- Options strike price
- Time until expiration, expressed as a percent of a year
- Implied volatility
- Risk-free interest rates

$$C = SN(d_1) - N(d_2)Ke^{-rt}$$

$P=Ke^{-rt.}N(-d2)-S.N(-d1)$

Where,

$$d_1 = \frac{\ln\left(S/K\right) + \left(r + s^2/2\right)t}{s \cdot \sqrt{t}}$$

$$d_2 = d_1 - s \cdot \sqrt{t}$$

In this formula,

C = Call premium
S = Current stock price
t = Time until option exercise
K = Option striking price
r = Risk-free interest rate
N = Cumulative standard normal distribution
e = Exponential term

s = St. Deviation
ln = Natural Log

The Black-Scholes model for Call option is essentially divided into two parts:

- The first part, SN(d1), multiplies the price by the change in the call premium in relation to a change in the underlying price. This part of the formula shows the expected benefit of purchasing the underlying outright.

- The second part, N(d2)Ke^(-rt), provides the current value of paying the exercise price upon expiration (remember, the Black-Scholes model applies to European options that are exercisable only on expiration day).

The value of the option is calculated by taking the difference between the two parts.

FACTORS AFFECTING OPTION PRICING

Six factors that affect option prices are shown on the top row. As indicated, the underlying price and strike price determine the intrinsic value; the time until expiration and volatility determine the probability of a profitable move; the interest rates determine the cost of money; and dividends can cause an adjustment to share price.

1. **Stock Price**
    a. The most influential factor on an option premium is the current market price of the underlying asset. In general, as the price of the underlying increases, call prices increase and put prices decrease. Conversely, as the price of the underlying decreases, call prices decrease and put prices increase.

    b. If a call option allows you to buy a stock at a certain price in the future than the higher that price goes the more the option will be worth.

If underlying prices ...	Call prices will ...	Put prices will ...
Increase	Increase	Decrease
Decrease	Decrease	Increase

2. **Strike Price**
    a. The strike price determines if the option has any intrinsic value. Intrinsic value is the difference between the strike price of the option and the current price of the underlying. The premium typically increases as the option becomes further in-the-money (where the strike price becomes more favourable in relation to the current underlying price). The premium generally decreases as the option becomes more out-of-the-money (when the strike price is less favourable in relation to the underlying).

b. Options that are in-the-money have a higher value compared to options that are out-of-the-money.

Premiums increase as options become further in-the-money

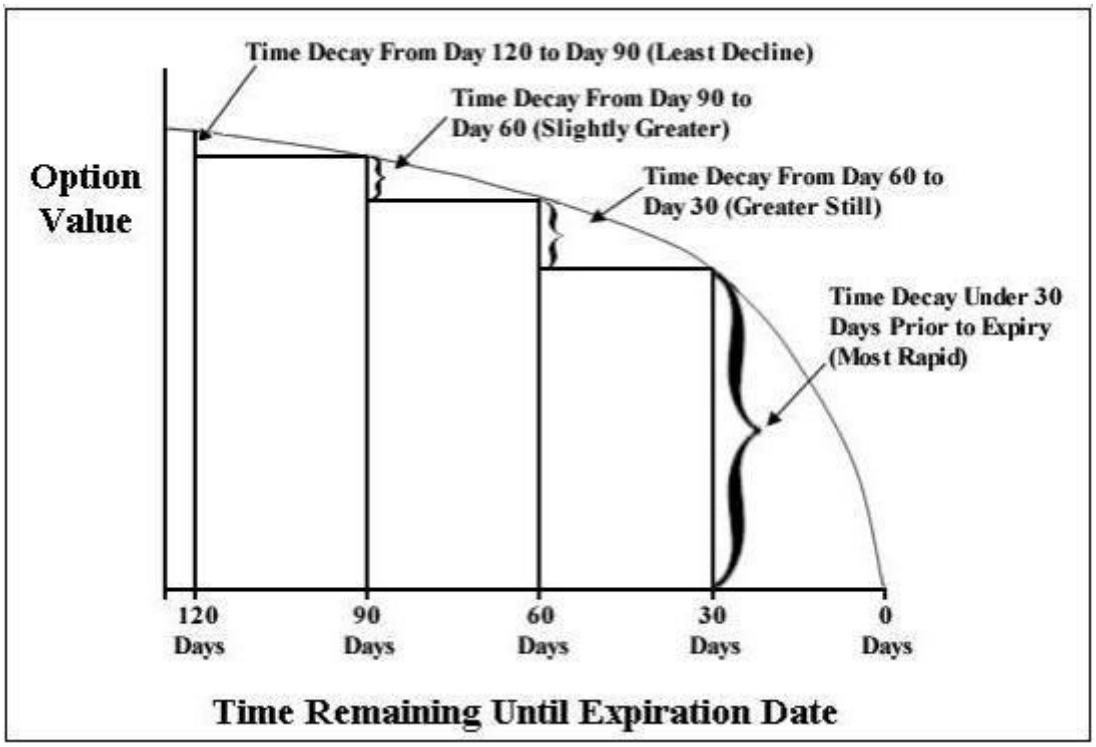
3. Type Of Option

a. This is probably the easiest factor to understand. An option is either a put or a call and the value of the option will change accordingly.

b. A call option gives the holder the right to buy the underlying at a specified price within a specific time period.

c. A put option gives the holder the right to sell the underlying at a specified price within a specific time period.

d. If you are long a call or short a put your option value increases as the market moves higher. If you are long a put or short a call your option value increases as the market moves lower.



4. Time To Expiration

a. Options have a limited life span thus their value is affected by the passing of time. The longer an option has until expiration, the greater the chance that it

will end up in-the-money, or profitable. As expiration approaches, the option's time value decreases. In general, an option loses one-third of its time value during the first half of its life and two-thirds of its value during the second half. The underlying's volatility is a factor in time value; if the underlying is highly volatile, one could reasonably expect a greater degree of price movement before expiration. The opposite holds true where the underlying typically exhibits low volatility; the time value will be lower if the underlying price is not expected to move much.

The longer the time until expiration, the higher the option price
The shorter the time until expiration, the lower the option price

5. **Interest Rates**
    a. Interest rates also have small, but measurable, effects on option prices. In general, as interest rates rise, call premiums will increase and put premiums will decrease. This is because of the costs associated with owning the underlying; the purchase will incur either interest expense (if the money is borrowed) or lost interest income (if existing funds are used to purchase the shares). In either case, the buyer will have interest costs.

If interest rates ...	Call prices will ...	Put prices will ...
Rise	Increase	Decrease
Fall	Decrease	Increase

6. **Dividends**
    a. Options do not receive dividends so their value fluctuates when dividends are released. When a company releases dividends they have an ex-dividend date. If you own the stock on that date you will be awarded the dividend. Also on this date the value of the stock will decrease by the amount of dividend. As dividends increase a put option's value also increases and a call's value decreases.

If dividends ...	Call prices will ...	Put prices will ...
Rise	Decrease	Increase
Fall	Increase	Decrease

7. **Volatility**
    a. Volatility is the degree to which price moves, regardless of direction. It is a measure of the speed and magnitude of the underlying's price changes.

Historical volatility refers to the actual price changes that have been observed over a specified time period. Option traders can evaluate historical volatility to determine possible volatility in the future. Implied volatility, on the other hand, is a forecast of future volatility and acts as an indicator of the current market sentiment. While implied volatility is often difficult to quantify, option premiums will generally be higher if the underlying exhibits higher volatility, because it will have higher expected price fluctuations.

b. Volatility is the only estimated factor in this model. The volatility that is used is forward volatility. Forward volatility is the measure of implied volatility over a period in the future. Implied volatility shows the "implied" movement in a stock's future volatility. Basically it tells you how traders think the stock will move. Implied volatility is always expressed as a percentage, non-directional and on an annual basis.

c. The higher the implied volatility the more people think the stock's price will move. Stocks listed on the Dow Jones are value stocks so a lot of movement is not expected, thus, they have a lower implied volatility. Growth stocks or small caps found on the Russell 2000, conversely, are expected to move around a lot so they carry a higher implied volatility.

The greater the expected volatility, the higher the option value

CNX NIFTY OPTIONS

The National Stock Exchange of India Limited (NSE) commenced trading in derivatives with the launch of index futures on June 12, 2000. The futures contracts are based on the popular benchmark Nifty 50 Index.

The Exchange introduced trading in Index Options (also based on Nifty 50) on June 4, 2001. NSE also became the first exchange to launch trading in options on individual securities from July 2, 2001. Futures on individual securities were introduced on November 9, 2001. Futures and Options on individual securities are available on 173 securities stipulated by SEBI. The Exchange has also introduced trading in Futures and Options contracts based on Nifty IT, Nifty Bank, and Nifty Midcap 50, Nifty Infrastructure, Nifty PSE indices.

Nifty index option contracts are European style and cash settled and are based on the popular market benchmark Nifty 50 index.

Contract Specifications

Security descriptor

The security descriptor for the Nifty 50 options contracts is:

- Market type : N
- Instrument Type : OPTIDX
- Underlying : NIFTY
- Expiry date : Date of contract expiry
- Option Type : CE/ PE
- Strike Price: Strike price for the contract
- Instrument type represents the instrument i.e. Options on Index.
- Underlying symbol denotes the underlying index, which is Nifty 50
- Expiry date identifies the date of expiry of the contract
- Option type identifies whether it is a call or a put option., CE - Call European, PE - Put European.

Underlying Instrument

The underlying index is CNX NIFTY.

Trading cycle

CNX Nifty options contracts have 3 consecutive monthly contracts, additionally 3 quarterly months of the cycle March / June / September / December and 5 following semi-annual months of the cycle June / December would be available, so that at any point in time there

would be options contracts with at least 3 year tenure available. On expiry of the near month contract, new contracts (monthly/quarterly/ half yearly contracts as applicable) are introduced at new strike prices for both call and put options, on the trading day following the expiry of the near month contract.

Expiry day

CNX Nifty options contracts expire on the last Thursday of the expiry month. If the last Thursday is a trading holiday, the contracts expire on the previous trading day.

Trading Parameters

Contract size

The value of the option contracts on Nifty may not be less than Rs. 2 lakhs at the time of introduction. The permitted lot size for futures contracts & options contracts shall be the same for a given underlying or such lot size as may be stipulated by the Exchange from time to time.

Price steps

The price step in respect of CNX Nifty options contracts is Re.0.05.

Base Prices

Base price of the options contracts, on introduction of new contracts, would be the theoretical value of the options contract arrived at based on Black-Scholes model of calculation of options premiums.

The options price for a Call and Put options are computed as per the Black-Scholes formula.

Rate of interest may be the relevant MIBOR rate or such other rate as may be specified.

The base price of the contracts on subsequent trading days, will be the daily close price of the options contracts. The closing price shall be calculated as follows:

- If the contract is traded in the last half an hour, the closing price shall be the last half an hour weighted average price.
- If the contract is not traded in the last half an hour, but traded during any time of the day, then the closing price will be the last traded price (LTP) of the contract.

If the contract is not traded for the day, the base price of the contract for the next trading day shall be the theoretical price of the options contract arrived at based on Black-Scholes model of calculation of options premiums.

Order type/Order book/Order attributes

- Regular lot order
- Stop loss order
- Immediate or cancel
- Spread order

LITERATURE REVIEW

Despite the extant literature on the Black-Scholes model the following is a brief review of empirical developments related to the central theme of this study.

Black and Scholes (1972) first reported that the model overpriced (underpriced) options on high (low) estimated variance stocks. The problem was attributed to measurement errors of variables that are assumed to be constant over the contract cycle.
Black (1975) observed that the model systematically overpriced (underpriced) deep in the money (deep out of the money) options and underpriced options with less than 90 days to maturity. Examining some probable sources of these biases, Black ultimately concluded that "we don't know why some of the options contracts are consistently overpriced according to the formula and other are consistently underpriced".

Merton (1976a and 1976b) tested the robustness of the Black-Scholes model postulating the jump-diffusion process to the proper return generating process, and found that Black-Scholes prices tended to be underpriced both in the money and deep out of the money options and overprice at the money options. They found mispricing is expected to magnify for shorter maturity options, since for longer maturity, mispricing decreases as the distributions tend to converge to each other.

Boyle and Ananthanarayanan (1977) considered the bias of the Black-Scholes price with an estimated variance rate, against the Black-Scholes price with the true variance rate. Using numerical integration to compute the bias, they found that the formula estimate underprices at and around the money options and overprice deeper money options. They also reported that the size of these biases is small even when the sample size for estimating the variance rate is low as 15.

Furthermore, Galai (1977) tested the efficiency of CBOE by using daily data on options traded on the CBOE from 26 April 1973 to 30 November 1973. Using the Black-Scholes model they constructed a hedge portfolio consisting of an underpriced or overpriced option and the underlying stock, which was liquidated one day later. The ex post hedging test produced average returns significantly different from zero at the five percent level of significance, which indicates that his hedge strategy with the Black-Scholes model could locate mispriced options. The findings remained unchanged when the estimated risk free interest rate and the standard deviation of the underlying stock's return were changed. However, when an ad hoc one percent transaction costs was imposed on buying / selling of stock and options, almost all hedge returns were eliminated. However, in the case of the ex ante hedging, the average return were lower than those from the ex post tests. The one day delay in the execution of the hedge had reduced the profitability of Galai's trading rule. The average returns, ignoring transactions costs, were still significantly different from zero.

Hence, Galai concluded that both ex-ante as well as ex-post hedging strategies produced profitable opportunities, which implies that Black-Scholes Model is inefficient in pricing the options contracts.

MacBeth and Merville (1979) further tested Black-Scholes Model using a different approach, by examining different call options on the same stock at the same time and compared the volatilities implied by option price. They found that Black-Scholes underpriced in the money options and overprices out of the money options, the time expiration bias is similar to Black (1975) but the Strike price bias is diametrically opposed to the finding of Black (1975). This was attributed to the nonstationarity of the variance rate overlooked in Black (1975).

Bhattacharya (1983) used transaction data to test the efficiency of CBOE. The transaction data include every reported transaction and every reported bid-ask quote for each option. The sample period for the study was 196 trading days from 24 August 1976 to 12 June 1977. The Black-Scholes model with discrete dividend adjustment was used and they found that their ex ante spreading test required spreads to set up with the next available prices after the mispricing signals were observed. The spreads were held until maturity or until the mispricing were eliminated, which were rebalanced fortnightly with an average of 1.38 revisions over their lifetime. This test produced after transactions costs profits that would imply market inefficiency. However, Bhattacharya noted that his fortnightly revision of spreads could not maintain riskless positions and hence this result must be treated with caution.
However, Blomeyer and Klemkosky (1983) tested the efficiency of CBOE and found that in the ex post test, the hedge position was set up immediately upon observing the mispriced option and was maintained till the next option transaction. They concluded that the option market appear to be efficient to the arbitrageur using the trading rules involving Black-Scholes and roll pricing model.

Rubinstein (1985) compared the Black-Scholes model prices versus five different models (pure jump model, mixed diffusion-jump model, constant elasticity of variance diffusion model, compound diffusion model, displaced diffusion model) which relaxed the assumptions that the stock prices follows a continuous path over time and that the volatility is non stochastic and found no model consistently better than other.

Ramaswamy (1985) has examined the rational restrictions for the value of options on futures contracts, and he has also presented approaches to their valuation. In the study they found that the value added by the American feature is rather small, especially for at-the-money options, despite the fact that premature exercise may be optimal.

Whaley (1982), Stein (1989) and Bakshi et al. (1997) find that option pricing models systematically misprice options with respect to maturity and moneyness. They all find that

short term options are typically underpriced by Black-Scholes relative to long term options. Similarly, deep in the money option and deep out of the money options are underpriced relative to at the money options.

Cavallo and Mammola (2000) investigate the efficiency of Italian index option market through put-call parity conditions. Additionally, find the validity of Black and Scholes option pricing model using volatility hedging strategies. The result of put-call parity conditions seems to be a weak test for market efficiency. However, the test of volatility hedging strategy does not provide any systematic abnormal returns, and are consistent with the market efficiency.

Ackert and Tian (2000 & 2001) examined the pricing efficiency of S&P 500 index options market. They find frequent mispricing in the market and indicate that the market is inefficient because of arbitrage limitations. Their later study in testing the efficiency of S&P 500 index options market and cross market effect of a traded stock basket, Standard and Poor's Depository Receipts (SPDRs), on the link between index and options markets finds the improvement of pricing efficiency within option market, but does not support for enhancement of arbitrage across market by stock basket.

Varma (2003) studied the pricing efficiency of Indian stock index option market. He has taken data from National Stock Exchange from the period June, 2001 to February, 2002. He has observed that Nifty Index Futures trade at a discount to the underlying. He attributed this phenomenon on the short sale restrictions in the cash market. He found that the implied probability distribution is more highly peaked and has thinner tails than the normal distribution. He concluded that the market appears to be underestimating the probability of market movement in both direction, and thereby underpricing volatility severely.

Mishra et al., (2006) investigate the determinants of volatility and the surface of volatility by taking data from National Stock Exchange from the period January 1, 2004 to December 31, 2004. They have found that deep in the money and deep out of money options are having higher volatility than at the money options; the implied volatility of out of the money call options is more than in the calls; implied volatility is higher for the month contracts than near the month contracts; deep in the money and out of money options with shorter maturity have higher volatility than those of with longer maturity; put options have higher volatility than options; and implied volatility of more liquid options is more than that of less liquid options.

Kakati (2006) examined the Black-Scholes model in India by taking the option contract of ten Indian stock for the period of July, 2001 to March, 2003. By using the Mean Error, Percentage mean error, Root mean Square error and Theil's Inequality Coefficient they find that options are severely mispriced by the Black-Scholes model. Moneyness bias, maturity bias and call vs. put bias do occur.

Tiwari and Saurabha (2007) also compared Black-Scholes model with the modified Black-Scholes model given by Corrdo and Sue on the basis of implied volatility, Skewness and Kurtosis by using call prices of Nifty Options (European type) for the period August 1, 2007 to October 24, 2007. The findings suggest that modified model is not very different from that of original Black-Scholes model. Since it does not add unnecessary complexity and still gives significantly better predictions of option prices.

In nutshell, based on the above discussion it may be concluded that for last four decades the debate on the validity, reliability and robustness of Black-Sholes Model in pricing options contracts is going on but has not yet been settled. Moreover, from the above discussion, it can be observed that most of the studies have been conducted in the developed markets of the world and there is dearth of literature examining the validity of Black-Sholes Model in pricing options contracts in the emerging markets like India which is ranked amongst top 5 markets of the global derivatives markets. Therefore, present study is an attempt to plug this literature gap.

RESEARCH METHODOLOGY

In the present study, it is desired that a comprehensive investigation be carried out to examine the pricing efficiency of the index options market using Black-Scholes method in India. Index futures contracts were introduced in India in June 2000, index options, in June 2001 and stock options, in July 2001.Although Black-Scholes is used for indices, it is a matter of concern that whether it is depicting the true picture to investor or not. The price given by Black-Scholes model is true if there is no pricing error between market price of options and theoretical price of options.

Data and scope

- ✓ This study focuses on the European stock options, which were introduced in January 2011. Stock options are traded on the National Stock Exchange of India (NSE) and The Stock Exchange (Mumbai) in India. But, the volumes at NSE are more than 90 per cent of the total volume of options and futures traded in India. Therefore, the study is confined to the options traded at NSE.

- ✓ The present study attempts to assess the efficiency of the S&P CNX Nifty index options. NIFTY is included for being the representative of the market.

- ✓ The period covered in this study is 1 January 2016-31 March 2016(61 trading days). The high-frequency transaction data for the derivative segment and the equity segment is used, and the same is sourced from the NSE.

- ✓ Data employed for examining the Indian index options market has been downloaded from the web site of National Stock Exchange of India (www.nseindia.com) and is secondary in nature.

- ✓ Call and put options contracts of all NIFTY option indexes are included in sample period. In order to estimate the theoretical price according to Black-Scholes model closing price are taken into account.

- ✓ Data for thinly traded options (less than 100 contracts on a given day) was excluded from the study.

- ✓ Standard deviation computed on daily returns of the underlying index is used as volatility to estimate the theoretical prices. This should theoretically be identical for options of all strike prices because the underlying asset is the same in each case. It has been calculated by computing the log normal of the daily closing returns of Nifty.

Time to expiry

As suggested by Hull (2011), trading days (as against the calendar days) are taken as the measure of the time to expiry, as the non-trading days are often ignored by the market. The number of days, thus obtained, is divided by 241 to get the time to expiry (T) used in the Black-Scholes formula.

Risk-free rate

The methodology for the Fixed Income Money Market and Derivative Association of India (FIMMDA)-NSE-Overnight Mumbai Interbank Bid/Offer Rate (Overnight MIBID/MIBOR) benchmark in India has been revised with the introduction of the FBIL-Overnight MIBOR on July 22, 2015. The FBIL-Overnight MIBOR will be based on actual traded rates and will be administered by a new company called the Financial Benchmarks India Private Ltd (FBIL).
The daily MIBOR (Mumbai Inter Bank Offer Rate) rate has been taken as the risk free interest rate.

Performance measures

The Black-Scholes formula is used to calculate the option prices for the index.
Four performance measures are chosen for the comparison of model prices with market prices, in terms of bias and efficiency. The four pricing error are mean absolute error, mean squared error, root mean squared error, Thiel`s U statics. After this number of times Call options Overpriced (%), number of times Call options under-priced (%), number of times put options Overpriced (%), number of times put options underpriced (%) are calculated.

Mean Absolute Error (MAE)

Mean squared error is computed as average of the squared error values. As compared to the mean absolute error values, this measure is very sensitive to large outlier as it places more penalties on large error than mean absolute error.

$$\text{MAE}=\frac{1}{N}\sum_{n=1}^{N}|y_n|$$

$|y_n|$=Absolute pricing error

Mean absolute error (MAE) is used as an absolute measure of efficiency.

Mean Squared Error (MSE)

Mean squared error is computed as average of the squared error values. As compared to the mean absolute error values, this measure is very sensitive to large outlier as it places more penalties on large error than mean absolute error.

$$MSE=\frac{1}{N}\sum_{n=1}^{N} y_n^2$$

y_n^2=square of pricing error

Root Mean Squared Error (RMSE)

It is square root value of mean squared error and conceptually similar to the widely used statistic –standard deviation

$$RMSE=\sqrt{\frac{1}{N}\sum_{n=1}^{N} y_n^2}$$

y_n^2=square root of mean squared error

Root mean squared error (RMSE) provides an absolute measure of efficiency and is more sensitive to large errors.

Thiel's U Statistic

Henri Thiel (1961) developed an inequality coefficient for measuring the degree to which one time series differs from another.

$$U=\frac{\sqrt{\frac{1}{N}\sum_{n=1}^{N}(p_n-q_n)^2}}{\sqrt{\frac{1}{N}\sum_{n=1}^{N} p_n^2}+\sqrt{\frac{1}{N}\sum_{n=1}^{N} q_n^2}}$$

Here two time series is used. One is actual value of options (pn) and other is predicated value of options (qn). Thiel's U will be equal to 1 if a forecast method is found no better than using a naïve forecast. If Thiel's U is less than 1, it indicates that the method is superior to naïve forecast. A value close to zero indicate a good fit, whereas, value greater than 1 indicate that the technique is worse than using a naïve forecast.

Results

Mean Absolute Errors, Mean Squared Errors, Root Mean Squared Errors and Theil's U statistics are found to be statistically significant, which implies that the NSE Index options contracts are not fairly priced and options premium significantly differ from price suggested by Black-Scholes Model.

Present study examines the Black-Scholes model in Indian Index options market

NIFTY Call Options

Mean Absolute Error	Mean Squared Error	Root Mean Squared Error	Thiel's U	No of times call underpriced	No of times call overpriced
174.90	95715.02	309.39	0.34	40.69%	59.31%

Above table reports the descriptive statistics of NIFTY (Nifty) call options contract. MAE, MSE, RMSE and Thiel's u statistics reported in the table are statistically significant, which implies that actual Nifty call options price is significantly different from the theoretical call options price (estimated by using Black- Scholes Model). Moreover, it has been found that the actual options price series is overpriced 59.31% times and underpriced 40.69% times, which again suggests that significant arbitrage opportunities may be present in the market.

NIFTY Put Options

Mean Absolute Error	Mean Squared Error	Root Mean Squared Error	Thiel's U	No of times call underpriced	No of times call overpriced
209.72	193098	439.43	0.55	54%	46%

Moreover, descriptive statistics of Nifty put options contract i.e. MAE, MSE, RMSE and Thiel's u statistics are also statistically significant. This suggests that 'actual' Nifty put options price is significantly different from the 'theoretical' put options price (estimated by using Black-Scholes Model). It has also been found that 46% time and 54% time options are overpriced and underpriced respectively, which again suggest that significant arbitrage opportunities may be present in the market.

The notable finding of the research is that put options market is more inefficient compared to call options market. The revealed state of options pricing in the derivatives market can also be attributed to dearth of liquidity and lack of proper understanding of the market amongst market participant's investors.

Conclusion

Black-Scholes model is the most popular model for options pricing in the world. The study has examined the Black-Scholes model in the Indian conditions. Since the study has examined daily prices of options on only NIFTY index as underlying securities over the different time period, inferences drawn from this study must be tentative.

Results confirm the differences between the market price and model price. However, this may not indicate that the Black-Scholes model is wrong or the market is inefficient. The observed differences may be due to discrepancies between the actual market trading structures, which are assumed by the Black-Scholes model. For instance, Black-Scholes model assumes trading symmetry there by allowing both long purchasing, as well as short selling to determine arbitrage free prices

The finding of this study is somewhat consistent with the several empirical studies viz., Black and Scholes (1972), Boyle and Ananthanarayanan (1977), Galai (1977), Bhattacharya (1980), Andersson, (1995), Kataki (2006) and Mitra (2008) on the pricing accuracy of the Black-Scholes model. So, there is a need to look for alternative model for pricing options contract.

References:

1. Ackert, L. and Tian, Y. S. (2001),"Efficiency in Index Options Market and Trading in Stock Baskets", Journal of Banking and Finance, Vol. 25, pp 1607-1634.
2. Bhattacharya, M. (1983), "Transactions Data Test of Efficiency of Chicago Board Options Exchange", Journal of Financial Economics, Vol. 12, pp 161-185.
3. Black, F. (1975), "Fact and Fantasy in the Use of Options", Financial Analysts Journal, Vol. 31, pp 36-72.
4. Black, F., & Scholes, M.. (1972). The Valuation of Option Contracts and a Test of Market Efficiency. The Journal of Finance, 27(2), 399–417.
5. Black, F. and Scholes, M. (1973), "The Pricing of Options and Corporate Liabilities", Journal of Political Economy, Vol. 81(May/June), pp 637-654.
6. Boyle P. and Ananthanarayanan A. (1977), "The Impact of Variance Estimation in Option Valuation Models", Journal of Financial Economics, Vol.5 (3), pp 375- 387.
7. Cavallo, L, and Mammola, P. (2000), "Empirical Tests of Efficiency of the Italian Index Options Market", Journal of Empirical Finance, Vol.7, pp 173-193.
8. Kakati, R. P. (2006), "Effectiveness of the Black-Scholes Model for Pricing Options in Indian Option Market", Journal of Derivatives Market, Vol. III (1), pp 1-15.
9. Galai, D. (1977), "Test of Market Efficiency of the Chicago Board Options Exchange", Journal of Business, Vol. 50(2), pp 167-197.
10. MacBeth, J. And Merville, L. (1980), "Test of Black-Scholes and Cox Call Valuation Model", Journal of Finance, Vol. 35(2), pp 285-303.
11. Mishra, D., Kannan, R. and Mishra, D. S. (2006), "Implied Volatility Surface: A Study of NSE NIFTY Options", International Research Journal of Finance and Economics, Vol. 6, pp 7-21.
12. Ramaswamy, K (1985), "The Valuation of Options on Futures Contracts", Journal of Finance, Vol. 40, pp 1319-1340.
13. Rubinstein, M. (1985), "Nonparametric Test of Alternative Option Pricing Models Using A Reported Trades and Quotes on Thirty Most Active CBOE Option
14. Shivam Singh Vipul . , (2015),"Performance of Black-Scholes model with TSRV estimates", Managerial Finance, Vol. 41 Iss 8 pp. 857 - 870
15. Stein J. (1989), "Overreactions in the Options Market", Journal of Finance, Vol. 44, pp 1011-1024.
16. Tiwari, M. and R. Saurabha (2007), "Empirical study of the Effect of Including Skewness and Kurtosis in Black-Scholes Option pricing Formula on S&P CNX Nifty Index Options", http://mpra.ub.uni-muenchen.de/6329/1/ MPRA_paper_6329.pdf., 2007.
17. Varma, J. R. (2003), "Mispricing of Volatility in the Indian Index Options Market", http://www.iimahd.ernet.in/~jrvarma/papers/WP2002-04-01.pdf.

Websites

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2722323
www.greatlakes.edu.in/pdf/DebijanMukherjee.pdf
https://casi.sas.upenn.edu/sites/casi.../Derivatives%20-%20Vashishtha.pdf
https://rbi.org.in/scripts/AnnualReportPublications.aspx?Id=1023
http://www2.isda.org/
http://doi.org/10.2307/2978484
http://dx.doi.org/10.1108/MF-06-2014-0177
https://www.ccilindia.com/Research/Statistics/Pages/FIMMDA_CCIL_MIBOR.aspx
www.nseindia.com/content/press/faqfo.pdf
http://theoptionprophet.com/blog/7-factors-that-affect-an-option-s-price
http://www.investopedia.com/university/options-pricing/black-scholes-model.asp

ANNEXURE

ANNEXURE 1: Calculation of Volatility

Date	Closing Price	Log Normal Returns
1/4/2016	7791.3	
1/5/2016	7784.65	-0.000853868
1/6/2016	7741	-0.005622955
1/7/2016	7568.3	-0.022562432
1/8/2016	7601.35	0.00435743
1/11/2016	7563.85	-0.004945543
1/12/2016	7510.3	-0.007104947
1/13/2016	7562.4	0.006913201
1/14/2016	7536.8	-0.003390924
1/15/2016	7437.8	-0.013222583
1/18/2016	7351	-0.011738722
1/19/2016	7435.1	0.011375685
1/20/2016	7309.3	-0.01706456
1/21/2016	7276.8	-0.004456305
1/22/2016	7422.45	0.019818039
1/25/2016	7436.15	0.001844011
1/27/2016	7437.75	0.000215155
1/28/2016	7424.65	-0.001762851
1/29/2016	7563.55	0.018535099
2/1/2016	7555.95	-0.001005273
2/2/2016	7455.55	-0.013376663
2/3/2016	7361.8	-0.012654254
2/4/2016	7404	0.005715953
2/5/2016	7489.1	0.011428248
2/8/2016	7387.25	-0.013693102
2/9/2016	7298.2	-0.012127772
2/10/2016	7215.7	-0.011368534
2/11/2016	6976.35	-0.033733363
2/12/2016	6980.95	0.000659167
2/15/2016	7162.95	0.025736896
2/16/2016	7048.25	-0.016142575
2/17/2016	7108.45	0.008504886
2/18/2016	7191.75	0.011650291
2/19/2016	7210.75	0.002638432
2/22/2016	7234.55	0.003295165
2/23/2016	7109.55	-0.01742921
2/24/2016	7018.7	-0.01286088

2/25/2016	6970.6	-0.006876725
2/26/2016	7029.75	0.008449825
2/29/2016	6987.05	-0.006092736
3/1/2016	7222.3	0.033115027
3/2/2016	7368.85	0.020088235
3/3/2016	7475.6	0.014382727
3/4/2016	7485.35	0.001303393
3/8/2016	7485.3	-6.72E-06
3/9/2016	7531.8	0.00619296
3/10/2016	7486.15	-0.006079398
3/11/2016	7510.2	0.003207489
3/14/2016	7538.75	0.003794263
3/15/2016	7460.6	-0.010420533
3/16/2016	7498.75	0.005100487
3/17/2016	7512.55	0.001838589
3/18/2016	7604.35	0.012145535
3/21/2016	7704.25	0.01305166
3/22/2016	7714.9	0.001381387
3/23/2016	7716.5	0.000207382
3/28/2016	7615.1	-0.013227762
3/29/2016	7597	-0.002379699
3/30/2016	7735.2	0.018027933
3/31/2016	7738.4	0.00041357
4/1/2016	7713.05	-0.003281261

Standard Deviation	0.012248
Daily volatility	1.22%
No of trading days	241
Annual Volatility	18.94%

ANNEXURE 2: MIBOR RATES

Date	MIBOR
1/1/2016	6.96
4/1/2016	6.9
5/1/2016	6.8
6/1/2016	6.8
7/1/2016	6.86
8/1/2016	7.02
11/1/2016	7.03
12/1/2016	7
13/01/2016	6.98
14/01/2016	7
15/01/2016	7
18/01/2016	6.99
19/01/2016	7.04
20/01/2016	7.01
21/01/2016	6.91
22/01/2016	6.9
25/01/2016	6.98
27/01/2016	7.01
28/01/2016	7.08
29/01/2016	7
1/2/2016	7.02
2/2/2016	6.95
3/2/2016	6.85
4/2/2016	6.76
5/2/2016	6.79
8/2/2016	6.97
9/2/2016	7.11
10/2/2016	7.05
11/2/2016	7.07
12/2/2016	7.01
15/02/2016	6.95
16/02/2016	7
17/02/2016	6.95
18/02/2016	6.89
22/02/2016	6.93
23/02/2016	6.9
24/02/2016	6.9
25/02/2016	6.96
26/02/2016	6.94
29/02/2016	6.96

3/3/2016	6.91
4/3/2016	6.85
8/3/2016	6.95
9/3/2016	7.01
10/3/2016	7.04
11/3/2016	7
14/03/2016	6.97
15/03/2016	7.01
16/03/2016	7.05
17/03/2016	7.31
18/03/2016	7.13
21/03/2016	7.03
22/03/2016	7.14
23/03/2016	7.32
28/03/2016	7.32
29/03/2016	7.26
30/03/2016	7.38
31/03/2016	9

ANNEXURE 3: NIFTY Call Option Data (Strike Price 8200)

Date	Expiry	Strike Price	Day Close	Underlying Value	MIBOR	Volatility	Time	Call Price	Absolute Difference
1-Jan-16	28-Jan-16	8200	36.15	7963.2	6.96	18.94	0.11	128.59	92.44
1-Jan-16	25-Feb-16	8200	81.2	7963.2	6.96	18.94	0.23	238.67	157.47
1-Jan-16	31-Mar-16	8200	141.35	7963.2	6.96	18.94	0.37	355.05	213.70
4-Jan-16	28-Jan-16	8200	14.9	7791.3	6.9	18.94	0.10	63.47	48.57
4-Jan-16	25-Feb-16	8200	43.8	7791.3	6.9	18.94	0.22	157.93	114.13
4-Jan-16	31-Mar-16	8200	93.25	7791.3	6.9	18.94	0.36	264.19	170.94
5-Jan-16	28-Jan-16	8200	12.55	7784.65	6.8	18.94	0.10	58.26	45.71
5-Jan-16	25-Feb-16	8200	41.85	7784.65	6.8	18.94	0.21	151.83	109.98
5-Jan-16	31-Mar-16	8200	91.95	7784.65	6.8	18.94	0.36	257.36	165.41
6-Jan-16	28-Jan-16	8200	7.15	7741	6.8	18.94	0.09	45.79	38.64
6-Jan-16	25-Feb-16	8200	30.35	7741	6.8	18.94	0.21	134.05	103.70
6-Jan-16	31-Mar-16	8200	76.45	7741	6.8	18.94	0.35	236.42	159.97
7-Jan-16	28-Jan-16	8200	3.3	7568.3	6.86	18.94	0.09	18.87	15.57
7-Jan-16	25-Feb-16	8200	16.95	7568.3	6.86	18.94	0.20	83.81	66.86
7-Jan-16	31-Mar-16	8200	48.25	7568.3	6.86	18.94	0.35	171.20	122.95
8-Jan-16	28-Jan-16	8200	3.1	7601.35	7.02	18.94	0.08	20.28	17.18
8-Jan-16	25-Feb-16	8200	16.5	7601.35	7.02	18.94	0.20	89.70	73.20
8-Jan-16	31-Mar-16	8200	47.45	7601.35	7.02	18.94	0.34	181.03	133.58
11-Jan-16	28-Jan-16	8200	2.85	7563.85	7.03	18.94	0.07	11.40	8.55
11-Jan-16	25-Feb-16	8200	16.4	7563.85	7.03	18.94	0.19	73.43	57.03
11-Jan-16	31-Mar-16	8200	48.75	7563.85	7.03	18.94	0.33	161.13	112.38
12-Jan-16	28-Jan-16	8200	2.45	7510.3	7	18.94	0.07	6.90	4.45
12-Jan-16	25-Feb-16	8200	12.5	7510.3	7	18.94	0.18	60.19	47.69
12-Jan-16	31-Mar-16	8200	38.85	7510.3	7	18.94	0.33	142.11	103.26
13-Jan-16	28-Jan-16	8200	2.35	7562.4	6.98	18.94	0.06	8.21	5.86
13-Jan-16	25-Feb-16	8200	14.25	7562.4	6.98	18.94	0.18	68.07	53.82
13-Jan-16	31-Mar-16	8200	44.45	7562.4	6.98	18.94	0.32	155.32	110.87
14-Jan-16	28-Jan-16	8200	1.8	7536.8	7	18.94	0.06	5.67	3.87
14-Jan-16	25-Feb-16	8200	11.6	7536.8	7	18.94	0.17	60.62	49.02
14-Jan-16	31-Mar-16	8200	40.4	7536.8	7	18.94	0.32	145.16	104.76
15-Jan-16	28-Jan-16	8200	1.25	7437.8	7	18.94	0.05	2.03	0.78
15-Jan-16	25-Feb-16	8200	8.4	7437.8	7	18.94	0.17	41.89	33.49
15-Jan-16	31-Mar-16	8200	30.05	7437.8	7	18.94	0.32	115.37	85.32
18-Jan-16	28-Jan-16	8200	1.15	7351	6.99	18.94	0.04	0.26	0.89
18-Jan-16	25-Feb-16	8200	6.3	7351	6.99	18.94	0.16	26.05	19.75
18-Jan-16	31-Mar-16	8200	22.5	7351	6.99	18.94	0.30	88.72	66.22
19-Jan-16	28-Jan-16	8200	0.8	7435.1	7.04	18.94	0.04	0.41	0.39
19-Jan-16	25-Feb-16	8200	5.6	7435.1	7.04	18.94	0.15	34.09	28.49
19-Jan-16	31-Mar-16	8200	21.25	7435.1	7.04	18.94	0.30	106.16	84.91

20-Jan-16	28-Jan-16	8200	1.15	7309.3	7.01	18.94	0.03	0.04	1.11
20-Jan-16	25-Feb-16	8200	4.75	7309.3	7.01	18.94	0.15	19.43	14.68
20-Jan-16	31-Mar-16	8200	14.4	7309.3	7.01	18.94	0.29	76.52	62.12
21-Jan-16	28-Jan-16	8200	1.15	7276.8	6.91	18.94	0.03	0.01	1.14
21-Jan-16	25-Feb-16	8200	4.75	7276.8	6.91	18.94	0.15	15.67	10.92
21-Jan-16	31-Mar-16	8200	13.55	7276.8	6.91	18.94	0.29	68.33	54.78
22-Jan-16	28-Jan-16	8200	0.85	7422.45	6.9	18.94	0.02	0.03	0.82
22-Jan-16	25-Feb-16	8200	6.85	7422.45	6.9	18.94	0.14	27.14	20.29
22-Jan-16	31-Mar-16	8200	19.3	7422.45	6.9	18.94	0.29	96.02	76.72
25-Jan-16	28-Jan-16	8200	0.45	7436.15	6.98	18.94	0.01	0.00	0.45
25-Jan-16	25-Feb-16	8200	3.9	7436.15	6.98	18.94	0.13	23.66	19.76
25-Jan-16	31-Mar-16	8200	17.6	7436.15	6.98	18.94	0.27	93.12	75.52
27-Jan-16	25-Feb-16	8200	3.2	7437.75	7.01	18.94	0.12	20.59	17.39
27-Jan-16	31-Mar-16	8200	17.15	7437.75	7.01	18.94	0.27	89.30	72.15
28-Jan-16	25-Feb-16	8200	1.7	7424.65	7.08	18.94	0.12	17.94	16.24
28-Jan-16	31-Mar-16	8200	15.4	7424.65	7.08	18.94	0.26	84.57	69.17
29-Jan-16	25-Feb-16	8200	2.5	7563.55	7	18.94	0.11	30.83	28.33
29-Jan-16	31-Mar-16	8200	24.05	7563.55	7	18.94	0.26	115.73	91.68
29-Jan-16	28-Apr-16	8200	44.8	7563.55	7	18.94	0.37	185.64	140.84
1-Feb-16	25-Feb-16	8200	2.6	7555.95	7.02	18.94	0.10	23.63	21.03
1-Feb-16	31-Mar-16	8200	20.35	7555.95	7.02	18.94	0.24	106.30	85.95
1-Feb-16	28-Apr-16	8200	37.55	7555.95	7.02	18.94	0.36	175.86	138.31
2-Feb-16	25-Feb-16	8200	1.8	7455.55	6.95	18.94	0.10	12.96	11.16
2-Feb-16	31-Mar-16	8200	13.35	7455.55	6.95	18.94	0.24	79.99	66.64
2-Feb-16	28-Apr-16	8200	25.3	7455.55	6.95	18.94	0.36	142.05	116.75
3-Feb-16	25-Feb-16	8200	1.55	7361.8	6.85	18.94	0.09	6.73	5.18
3-Feb-16	31-Mar-16	8200	8.7	7361.8	6.85	18.94	0.24	59.70	51.00
3-Feb-16	28-Apr-16	8200	17.45	7361.8	6.85	18.94	0.35	114.36	96.91
4-Feb-16	25-Feb-16	8200	1.45	7404	6.76	18.94	0.09	7.54	6.09
4-Feb-16	31-Mar-16	8200	9.4	7404	6.76	18.94	0.23	65.01	55.61
4-Feb-16	28-Apr-16	8200	19.85	7404	6.76	18.94	0.35	122.40	102.55
5-Feb-16	25-Feb-16	8200	1.5	7489.1	6.79	18.94	0.08	10.91	9.41
5-Feb-16	31-Mar-16	8200	17.3	7489.1	6.79	18.94	0.23	80.00	62.70
5-Feb-16	28-Apr-16	8200	32.1	7489.1	6.79	18.94	0.34	143.80	111.70
8-Feb-16	25-Feb-16	8200	1.2	7387.25	6.97	18.94	0.07	3.52	2.32
8-Feb-16	31-Mar-16	8200	13.45	7387.25	6.97	18.94	0.22	54.94	41.49
8-Feb-16	28-Apr-16	8200	22.95	7387.25	6.97	18.94	0.33	111.08	88.13
9-Feb-16	25-Feb-16	8200	1.1	7298.2	7.11	18.94	0.07	1.42	0.32
9-Feb-16	31-Mar-16	8200	10.15	7298.2	7.11	18.94	0.21	40.32	30.17
9-Feb-16	28-Apr-16	8200	18.05	7298.2	7.11	18.94	0.33	89.56	71.51
10-Feb-16	25-Feb-16	8200	1.25	7215.7	7.05	18.94	0.06	0.51	0.74
10-Feb-16	31-Mar-16	8200	8.2	7215.7	7.05	18.94	0.21	29.17	20.97
10-Feb-16	28-Apr-16	8200	14.1	7215.7	7.05	18.94	0.32	71.52	57.42
11-Feb-16	25-Feb-16	8200	1.3	6976.35	7.07	18.94	0.06	0.02	1.28

11-Feb-16	31-Mar-16	8200	6.75	6976.35	7.07	18.94	0.20	11.05	4.30
11-Feb-16	28-Apr-16	8200	12	6976.35	7.07	18.94	0.32	36.53	24.53
12-Feb-16	25-Feb-16	8200	1.45	6980.95	7.01	18.94	0.05	0.01	1.44
12-Feb-16	31-Mar-16	8200	5.8	6980.95	7.01	18.94	0.20	10.55	4.75
12-Feb-16	28-Apr-16	8200	10.05	6980.95	7.01	18.94	0.32	35.78	25.73
15-Feb-16	25-Feb-16	8200	0.9	7162.95	6.95	18.94	0.04	0.02	0.88
15-Feb-16	31-Mar-16	8200	6.55	7162.95	6.95	18.94	0.19	18.52	11.97
15-Feb-16	28-Apr-16	8200	10	7162.95	6.95	18.94	0.30	54.72	44.72
16-Feb-16	25-Feb-16	8200	0.8	7048.25	7	18.94	0.04	0.00	0.80
16-Feb-16	31-Mar-16	8200	5.45	7048.25	7	18.94	0.18	10.84	5.39
16-Feb-16	28-Apr-16	8200	8.35	7048.25	7	18.94	0.30	38.55	30.20
17-Feb-16	25-Feb-16	8200	0.85	7108.45	6.95	18.94	0.03	0.00	0.85
17-Feb-16	31-Mar-16	8200	6.3	7108.45	6.95	18.94	0.18	13.12	6.82
17-Feb-16	28-Apr-16	8200	8.25	7108.45	6.95	18.94	0.29	44.41	36.16
18-Feb-16	25-Feb-16	8200	0.75	7191.75	6.89	18.94	0.03	0.00	0.75
18-Feb-16	31-Mar-16	8200	7.2	7191.75	6.89	18.94	0.17	17.38	10.18
18-Feb-16	28-Apr-16	8200	8	7191.75	6.89	18.94	0.29	54.35	46.35
19-Feb-16	25-Feb-16	8200	0.5	7210.75	6.89	18.94	0.02	0.00	0.50
19-Feb-16	31-Mar-16	8200	6.65	7210.75	6.89	18.94	0.17	17.67	11.02
19-Feb-16	28-Apr-16	8200	9.9	7210.75	6.89	18.94	0.29	55.69	45.79
22-Feb-16	25-Feb-16	8200	0.2	7234.55	6.93	18.94	0.01	0.00	0.20
22-Feb-16	31-Mar-16	8200	5.8	7234.55	6.93	18.94	0.16	16.11	10.31
22-Feb-16	28-Apr-16	8200	8	7234.55	6.93	18.94	0.27	54.75	46.75
23-Feb-16	25-Feb-16	8200	0.35	7109.55	6.9	18.94	0.01	0.00	0.35
23-Feb-16	31-Mar-16	8200	4.35	7109.55	6.9	18.94	0.15	8.45	4.10
23-Feb-16	28-Apr-16	8200	7	7109.55	6.9	18.94	0.27	36.71	29.71
24-Feb-16	31-Mar-16	8200	3.1	7018.7	6.9	18.94	0.15	4.89	1.79
24-Feb-16	28-Apr-16	8200	5.65	7018.7	6.9	18.94	0.27	26.53	20.88
25-Feb-16	31-Mar-16	8200	1.9	6970.6	6.96	18.94	0.15	3.41	1.51
25-Feb-16	28-Apr-16	8200	3.5	6970.6	6.96	18.94	0.26	21.76	18.26
26-Feb-16	31-Mar-16	8200	1.75	7029.75	6.94	18.94	0.14	4.24	2.49
26-Feb-16	28-Apr-16	8200	3.65	7029.75	6.94	18.94	0.26	25.51	21.86
26-Feb-16	26-May-16	8200	58.15	7029.75	6.94	18.94	0.37	58.70	0.55
29-Feb-16	31-Mar-16	8200	1.3	6987.05	6.96	18.94	0.13	2.33	1.03
29-Feb-16	28-Apr-16	8200	3.55	6987.05	6.96	18.94	0.24	19.39	15.84
29-Feb-16	26-May-16	8200	58.15	6987.05	6.96	18.94	0.36	49.07	9.08
1-Mar-16	31-Mar-16	8200	1.45	7222.3	6.96	18.94	0.12	7.87	6.42
1-Mar-16	28-Apr-16	8200	3.25	7222.3	6.96	18.94	0.24	40.90	37.65
1-Mar-16	26-May-16	8200	58.15	7222.3	6.96	18.94	0.36	85.87	27.72
2-Mar-16	31-Mar-16	8200	2.35	7368.85	6.96	18.94	0.12	14.93	12.58
2-Mar-16	28-Apr-16	8200	6.55	7368.85	6.96	18.94	0.24	61.23	54.68
2-Mar-16	26-May-16	8200	58.15	7368.85	6.96	18.94	0.35	116.77	58.62
3-Mar-16	31-Mar-16	8200	2.95	7475.6	6.91	18.94	0.12	22.51	19.56
3-Mar-16	28-Apr-16	8200	8.35	7475.6	6.91	18.94	0.23	79.74	71.39

3-Mar-16	26-May-16	8200	18.6	7475.6	6.91	18.94	0.35	143.01	124.41
4-Mar-16	31-Mar-16	8200	2.65	7485.35	6.85	18.94	0.11	21.70	19.05
4-Mar-16	28-Apr-16	8200	10.25	7485.35	6.85	18.94	0.23	79.40	69.15
4-Mar-16	26-May-16	8200	22.1	7485.35	6.85	18.94	0.34	143.13	121.03
8-Mar-16	31-Mar-16	8200	2.35	7485.3	6.95	18.94	0.10	15.15	12.80
8-Mar-16	28-Apr-16	8200	9.6	7485.3	6.95	18.94	0.21	70.82	61.22
8-Mar-16	26-May-16	8200	23	7485.3	6.95	18.94	0.33	134.59	111.59
9-Mar-16	31-Mar-16	8200	2.25	7531.8	7.01	18.94	0.09	17.41	15.16
9-Mar-16	28-Apr-16	8200	13.6	7531.8	7.01	18.94	0.21	78.51	64.91
9-Mar-16	26-May-16	8200	30.9	7531.8	7.01	18.94	0.32	146.15	115.25
10-Mar-16	31-Mar-16	8200	1.95	7486.15	7.04	18.94	0.09	12.24	10.29
10-Mar-16	28-Apr-16	8200	12.35	7486.15	7.04	18.94	0.20	66.82	54.47
10-Mar-16	26-May-16	8200	26.6	7486.15	7.04	18.94	0.32	130.78	104.18
11-Mar-16	31-Mar-16	8200	2.1	7510.2	7	18.94	0.08	12.39	10.29
11-Mar-16	28-Apr-16	8200	12.35	7510.2	7	18.94	0.20	69.25	56.90
11-Mar-16	26-May-16	8200	26.55	7510.2	7	18.94	0.32	134.97	108.42
14-Mar-16	31-Mar-16	8200	1.6	7538.75	6.97	18.94	0.07	9.75	8.15
14-Mar-16	28-Apr-16	8200	12.15	7538.75	6.97	18.94	0.19	67.99	55.84
14-Mar-16	26-May-16	8200	29.3	7538.75	6.97	18.94	0.30	135.79	106.49
15-Mar-16	31-Mar-16	8200	1.3	7460.6	7.01	18.94	0.07	4.90	3.60
15-Mar-16	28-Apr-16	8200	10.55	7460.6	7.01	18.94	0.18	51.43	40.88
15-Mar-16	26-May-16	8200	22.45	7460.6	7.01	18.94	0.30	112.37	89.92
16-Mar-16	31-Mar-16	8200	1.25	7498.75	7.05	18.94	0.06	5.29	4.04
16-Mar-16	28-Apr-16	8200	12.75	7498.75	7.05	18.94	0.18	55.97	43.22
16-Mar-16	26-May-16	8200	23.5	7498.75	7.05	18.94	0.29	120.29	96.79
17-Mar-16	31-Mar-16	8200	1.05	7512.55	7.31	18.94	0.06	4.79	3.74
17-Mar-16	28-Apr-16	8200	10.45	7512.55	7.31	18.94	0.17	56.82	46.37
17-Mar-16	26-May-16	8200	22.3	7512.55	7.31	18.94	0.29	123.12	100.82
18-Mar-16	31-Mar-16	8200	1.25	7604.35	7.13	18.94	0.05	7.56	6.31
18-Mar-16	28-Apr-16	8200	14.05	7604.35	7.13	18.94	0.17	72.37	58.32
18-Mar-16	26-May-16	8200	30.35	7604.35	7.13	18.94	0.29	146.40	116.05
21-Mar-16	31-Mar-16	8200	1.35	7704.25	7.03	18.94	0.04	8.17	6.82
21-Mar-16	28-Apr-16	8200	18.9	7704.25	7.03	18.94	0.16	87.55	68.65
21-Mar-16	26-May-16	8200	46.95	7704.25	7.03	18.94	0.27	170.48	123.53
22-Mar-16	31-Mar-16	8200	0.85	7714.9	7.14	18.94	0.04	6.86	6.01
22-Mar-16	28-Apr-16	8200	19.45	7714.9	7.14	18.94	0.15	87.60	68.15
22-Mar-16	26-May-16	8200	51.55	7714.9	7.14	18.94	0.27	172.08	120.53
23-Mar-16	31-Mar-16	8200	0.65	7716.5	7.32	18.94	0.03	5.13	4.48
23-Mar-16	28-Apr-16	8200	19.35	7716.5	7.32	18.94	0.15	85.43	66.08
23-Mar-16	26-May-16	8200	52.05	7716.5	7.32	18.94	0.27	170.93	118.88
28-Mar-16	31-Mar-16	8200	0.45	7615.1	7.32	18.94	0.01	0.01	0.44
28-Mar-16	28-Apr-16	8200	12.45	7615.1	7.32	18.94	0.13	48.83	36.38
28-Mar-16	26-May-16	8200	38.85	7615.1	7.32	18.94	0.24	124.04	85.19
29-Mar-16	31-Mar-16	8200	0.35	7597	7.26	18.94	0.01	0.00	0.35

29-Mar-16	28-Apr-16	8200	10.35	7597	7.26	18.94	0.12	43.09	32.74
29-Mar-16	26-May-16	8200	36	7597	7.26	18.94	0.24	115.91	79.91
30-Mar-16	28-Apr-16	8200	15.65	7735.2	7.38	18.94	0.12	67.96	52.31
30-Mar-16	26-May-16	8200	53.05	7735.2	7.38	18.94	0.24	156.73	103.68
31-Mar-16	28-Apr-16	8200	14.55	7738.4	9	18.94	0.12	68.78	54.23
31-Mar-16	26-May-16	8200	49.95	7738.4	9	18.94	0.23	164.39	114.44

ANNEXURE 4: NIFTY Put Option Data (Strike Price 8200)

Date	Expiry	Strike Price	Day Close	Underlying Value	MIBOR	Volatility	Time	Put Price	Absolute Difference
1-Jan-16	28-Jan-16	8200	246.45	7963.2	6.96	18.94	0.11	1414.26	229.71
1-Jan-16	25-Feb-16	8200	269.75	7963.2	6.96	18.94	0.23	0.00	0.10
1-Jan-16	31-Mar-16	8200	310	7963.2	6.96	18.94	0.37	1206.54	31.16
4-Jan-16	28-Jan-16	8200	398.1	7791.3	6.9	18.94	0.10	1594.12	409.57
4-Jan-16	25-Feb-16	8200	403.6	7791.3	6.9	18.94	0.22	0.00	0.75
4-Jan-16	31-Mar-16	8200	407.3	7791.3	6.9	18.94	0.36	1365.10	127.40
5-Jan-16	28-Jan-16	8200	403.9	7784.65	6.8	18.94	0.10	1604.31	419.76
5-Jan-16	25-Feb-16	8200	411.15	7784.65	6.8	18.94	0.21	1343.29	135.64
5-Jan-16	31-Mar-16	8200	407.3	7784.65	6.8	18.94	0.36	29.16	7.26
6-Jan-16	28-Jan-16	8200	448.95	7741	6.8	18.94	0.09	1600.90	15.10
6-Jan-16	25-Feb-16	8200	444.5	7741	6.8	18.94	0.21	1387.41	179.76
6-Jan-16	31-Mar-16	8200	430	7741	6.8	18.94	0.35	31.85	7.35
7-Jan-16	28-Jan-16	8200	613.7	7568.3	6.86	18.94	0.09	1825.39	640.84
7-Jan-16	25-Feb-16	8200	594.05	7568.3	6.86	18.94	0.20	0.00	1.70
7-Jan-16	31-Mar-16	8200	600	7568.3	6.86	18.94	0.35	1625.64	861.29
8-Jan-16	28-Jan-16	8200	590.1	7601.35	7.02	18.94	0.08	1793.76	609.21
8-Jan-16	25-Feb-16	8200	581	7601.35	7.02	18.94	0.20	0.99	3.26
8-Jan-16	31-Mar-16	8200	574.05	7601.35	7.02	18.94	0.34	1591.35	827.00
11-Jan-16	28-Jan-16	8200	609.2	7563.85	7.03	18.94	0.07	1540.90	627.90
11-Jan-16	25-Feb-16	8200	590.8	7563.85	7.03	18.94	0.19	0.70	3.25
11-Jan-16	31-Mar-16	8200	594.3	7563.85	7.03	18.94	0.33	1633.04	868.69
12-Jan-16	28-Jan-16	8200	660.9	7510.3	7	18.94	0.07	1895.89	711.34
12-Jan-16	25-Feb-16	8200	638.85	7510.3	7	18.94	0.18	0.11	2.54
12-Jan-16	31-Mar-16	8200	641.8	7510.3	7	18.94	0.33	1640.12	402.42
13-Jan-16	28-Jan-16	8200	615.6	7562.4	6.98	18.94	0.06	1846.63	662.08
13-Jan-16	25-Feb-16	8200	606	7562.4	6.98	18.94	0.18	1771.53	425.83
13-Jan-16	31-Mar-16	8200	622	7562.4	6.98	18.94	0.32	1640.15	875.80
14-Jan-16	28-Jan-16	8200	655.8	7536.8	7	18.94	0.06	1576.07	663.07
14-Jan-16	25-Feb-16	8200	641.2	7536.8	7	18.94	0.17	1553.61	393.31
14-Jan-16	31-Mar-16	8200	632.55	7536.8	7	18.94	0.32	1618.93	381.23
15-Jan-16	28-Jan-16	8200	748.5	7437.8	7	18.94	0.05	2.32	1.03
15-Jan-16	25-Feb-16	8200	729.5	7437.8	7	18.94	0.17	1851.35	249.00
15-Jan-16	31-Mar-16	8200	632.55	7437.8	7	18.94	0.32	1716.70	479.00
18-Jan-16	28-Jan-16	8200	819.5	7351	6.99	18.94	0.04	736.96	420.96
18-Jan-16	25-Feb-16	8200	805.05	7351	6.99	18.94	0.16	1847.32	592.07
18-Jan-16	31-Mar-16	8200	632.55	7351	6.99	18.94	0.30	3418.57	91.43
19-Jan-16	28-Jan-16	8200	755.75	7435.1	7.04	18.94	0.04	86.61	7.09
19-Jan-16	25-Feb-16	8200	742.6	7435.1	7.04	18.94	0.15	1864.07	261.72

19-Jan-16	31-Mar-16	8200	632.55	7435.1	7.04	18.94	0.30	0.17	5.83
20-Jan-16	28-Jan-16	8200	881.85	7309.3	7.01	18.94	0.03	91.03	0.77
20-Jan-16	25-Feb-16	8200	864.15	7309.3	7.01	18.94	0.15	1893.96	638.71
20-Jan-16	31-Mar-16	8200	632.55	7309.3	7.01	18.94	0.29	0.28	6.42
21-Jan-16	28-Jan-16	8200	910	7276.8	6.91	18.94	0.03	2154.25	969.70
21-Jan-16	25-Feb-16	8200	888.55	7276.8	6.91	18.94	0.15	1930.43	675.18
21-Jan-16	31-Mar-16	8200	632.55	7276.8	6.91	18.94	0.29	5.61	4.81
22-Jan-16	28-Jan-16	8200	767.25	7422.45	6.9	18.94	0.02	2011.33	826.78
22-Jan-16	25-Feb-16	8200	751.05	7422.45	6.9	18.94	0.14	1886.61	50.34
22-Jan-16	31-Mar-16	8200	740.85	7422.45	6.9	18.94	0.29	3.17	2.37
25-Jan-16	28-Jan-16	8200	758.65	7436.15	6.98	18.94	0.01	1705.90	792.90
25-Jan-16	25-Feb-16	8200	747.7	7436.15	6.98	18.94	0.13	1830.37	527.27
25-Jan-16	31-Mar-16	8200	740.85	7436.15	6.98	18.94	0.27	2.60	1.80
27-Jan-16	28-Jan-16	8200	761.5	7437.75	7.01	18.94	0.00	2009.50	824.95
27-Jan-16	25-Feb-16	8200	744.85	7437.75	7.01	18.94	0.12	1833.77	530.67
27-Jan-16	31-Mar-16	8200	756.7	7437.75	7.08	18.94	0.27	2.31	1.51
28-Jan-16	25-Feb-16	8200	737	7424.65	7.08	18.94	0.12	1848.79	545.69
28-Jan-16	31-Mar-16	8200	727	7424.65	7	18.94	0.26	2.33	1.53
29-Jan-16	25-Feb-16	8200	623.65	7563.55	7	18.94	0.11	1663.93	44.77
29-Jan-16	31-Mar-16	8200	727	7563.55	7.02	18.94	0.26	3141.95	1449.95
29-Jan-16	28-Apr-16	8200	696.95	7563.55	7.02	18.94	0.37	13.19	5.54
1-Feb-16	25-Feb-16	8200	627.5	7555.95	7.02	18.94	0.10	1580.06	33.04
1-Feb-16	31-Mar-16	8200	620	7555.95	6.95	18.94	0.24	2666.98	1256.83
1-Feb-16	28-Apr-16	8200	696.95	7555.95	6.95	18.94	0.36	811.93	362.83
2-Feb-16	25-Feb-16	8200	713.4	7455.55	6.95	18.94	0.10	1683.66	21.39
2-Feb-16	31-Mar-16	8200	635	7455.55	6.85	18.94	0.24	3558.68	1850.68
2-Feb-16	28-Apr-16	8200	696.95	7455.55	6.85	18.94	0.36	856.50	51.85
3-Feb-16	25-Feb-16	8200	812.65	7361.8	6.85	18.94	0.09	1830.54	622.89
3-Feb-16	31-Mar-16	8200	757.7	7361.8	6.76	18.94	0.24	3658.21	1950.21
3-Feb-16	28-Apr-16	8200	696.95	7361.8	6.76	18.94	0.35	985.38	536.28
4-Feb-16	25-Feb-16	8200	758.55	7404	6.76	18.94	0.09	1741.98	57.92
4-Feb-16	31-Mar-16	8200	788	7404	6.76	18.94	0.23	3523.01	1782.36
4-Feb-16	28-Apr-16	8200	696.95	7404	6.76	18.94	0.35	0.39	2.36
5-Feb-16	25-Feb-16	8200	669.05	7489.1	6.79	18.94	0.08	1708.93	501.28
5-Feb-16	31-Mar-16	8200	690	7489.1	6.79	18.94	0.23	3538.69	1830.69
5-Feb-16	28-Apr-16	8200	696.95	7489.1	6.79	18.94	0.34	0.23	2.52
8-Feb-16	25-Feb-16	8200	809.95	7387.25	6.97	18.94	0.07	1767.63	26.47
8-Feb-16	31-Mar-16	8200	779.6	7387.25	6.97	18.94	0.22	3547.07	1806.42
8-Feb-16	28-Apr-16	8200	696.95	7387.25	6.97	18.94	0.33	0.40	0.20
9-Feb-16	25-Feb-16	8200	865.35	7298.2	7.11	18.94	0.07	1908.24	700.59
9-Feb-16	31-Mar-16	8200	844.7	7298.2	7.11	18.94	0.21	1814.89	672.84
9-Feb-16	28-Apr-16	8200	696.95	7298.2	7.11	18.94	0.33	650.98	20.57

10-Feb-16	25-Feb-16	8200	942.8	7215.7	7.05	18.94	0.06	7.00	5.20
10-Feb-16	31-Mar-16	8200	923.5	7215.7	7.05	18.94	0.21	1993.80	786.15
10-Feb-16	28-Apr-16	8200	696.95	7215.7	7.05	18.94	0.32	1219.82	695.87
11-Feb-16	25-Feb-16	8200	1203.1	6976.35	7.07	18.94	0.06	5.89	4.84
11-Feb-16	31-Mar-16	8200	1035	6976.35	7.07	18.94	0.20	2141.80	999.75
11-Feb-16	28-Apr-16	8200	696.95	6976.35	7.07	18.94	0.32	2.43	2.23
12-Feb-16	25-Feb-16	8200	1207.85	6980.95	7.01	18.94	0.05	2234.14	1026.49
12-Feb-16	31-Mar-16	8200	1184.1	6980.95	7.01	18.94	0.20	2140.94	998.89
12-Feb-16	28-Apr-16	8200	696.95	6980.95	7.01	18.94	0.32	48.16	40.51
15-Feb-16	25-Feb-16	8200	1035.6	7162.95	6.95	18.94	0.04	2060.41	852.76
15-Feb-16	31-Mar-16	8200	1000	7162.95	6.95	18.94	0.19	1968.07	826.02
15-Feb-16	28-Apr-16	8200	696.95	7162.95	6.95	18.94	0.30	27.96	20.31
16-Feb-16	25-Feb-16	8200	1138.7	7048.25	7	18.94	0.04	2177.60	969.95
16-Feb-16	31-Mar-16	8200	1128.4	7048.25	7	18.94	0.18	2084.41	942.36
16-Feb-16	28-Apr-16	8200	696.95	7048.25	7	18.94	0.30	44.09	34.59
17-Feb-16	25-Feb-16	8200	1067.5	7108.45	6.95	18.94	0.03	1820.93	892.38
17-Feb-16	31-Mar-16	8200	1050.2	7108.45	6.95	18.94	0.18	2027.71	885.66
17-Feb-16	28-Apr-16	8200	696.95	7108.45	6.95	18.94	0.29	4.30	3.15
18-Feb-16	25-Feb-16	8200	998.9	7191.75	6.89	18.94	0.03	1740.36	811.81
18-Feb-16	31-Mar-16	8200	980	7191.75	6.89	18.94	0.17	1898.72	1240.92
18-Feb-16	28-Apr-16	8200	696.95	7191.75	6.89	18.94	0.29	3.03	1.88
19-Feb-16	25-Feb-16	8200	986.3	7210.75	6.89	18.94	0.02	1674.00	43.50
19-Feb-16	31-Mar-16	8200	958.9	7210.75	6.89	18.94	0.17	1931.67	789.62
19-Feb-16	28-Apr-16	8200	696.95	7210.75	6.89	18.94	0.29	2.69	1.54
22-Feb-16	25-Feb-16	8200	960.4	7234.55	6.93	18.94	0.01	1657.78	6.32
22-Feb-16	31-Mar-16	8200	927.65	7234.55	6.93	18.94	0.16	1865.66	1207.86
22-Feb-16	28-Apr-16	8200	696.95	7234.55	6.93	18.94	0.27	2.72	1.92
23-Feb-16	25-Feb-16	8200	1089.55	7109.55	6.9	18.94	0.01	1785.36	9.29
23-Feb-16	31-Mar-16	8200	1059.4	7109.55	6.9	18.94	0.15	2043.03	900.98
23-Feb-16	28-Apr-16	8200	696.95	7109.55	6.9	18.94	0.27	3.33	2.18
24-Feb-16	25-Feb-16	8200	1176.05	7018.7	6.9	18.94	0.00	1878.75	7.45
24-Feb-16	31-Mar-16	8200	1142.45	7018.7	6.9	18.94	0.15	0.08	3.92
24-Feb-16	28-Apr-16	8200	696.95	7018.7	6.96	18.94	0.27	2.74	1.69
25-Feb-16	31-Mar-16	8200	1177.85	6970.6	6.96	18.94	0.15	2186.38	1044.33
25-Feb-16	28-Apr-16	8200	696.95	6970.6	6.96	18.94	0.26	8.32	7.27
26-Feb-16	31-Mar-16	8200	1128.4	7029.75	6.94	18.94	0.14	1684.71	35.79
26-Feb-16	28-Apr-16	8200	696.95	7029.75	6.94	18.94	0.26	53.44	10.46
26-Feb-16	26-May-16	8200	1120.2	7029.75	6.94	18.94	0.37	98.68	39.87
29-Feb-16	31-Mar-16	8200	1168.25	6987.05	6.96	18.94	0.13	1635.55	35.20
29-Feb-16	28-Apr-16	8200	696.95	6987.05	6.96	18.94	0.24	6.68	5.63
29-Feb-16	26-May-16	8200	1120.2	6987.05	6.96	18.94	0.36	146.87	39.13
1-Mar-16	31-Mar-16	8200	959.6	7222.3	6.96	18.94	0.12	1898.37	240.53

1-Mar-16	28-Apr-16	8200	948.2	7222.3	6.96	18.94	0.24	12.79	9.56
1-Mar-16	26-May-16	8200	1120.2	7222.3	6.96	18.94	0.36	926.50	189.15
2-Mar-16	31-Mar-16	8200	833.55	7368.85	6.96	18.94	0.12	1952.78	64.82
2-Mar-16	28-Apr-16	8200	948.2	7368.85	6.96	18.94	0.24	3.54	0.54
2-Mar-16	26-May-16	8200	1120.2	7368.85	6.96	18.94	0.35	975.46	24.54
3-Mar-16	31-Mar-16	8200	740.1	7475.6	6.91	18.94	0.12	1849.28	81.32
3-Mar-16	28-Apr-16	8200	766.05	7475.6	6.91	18.94	0.23	2.16	0.84
3-Mar-16	26-May-16	8200	1120.2	7475.6	6.91	18.94	0.35	24.35	10.70
4-Mar-16	31-Mar-16	8200	730.05	7485.35	6.85	18.94	0.11	1793.22	555.52
4-Mar-16	28-Apr-16	8200	697.4	7485.35	6.85	18.94	0.23	1.95	1.05
4-Mar-16	26-May-16	8200	1120.2	7485.35	6.85	18.94	0.34	14.10	64.95
8-Mar-16	31-Mar-16	8200	736.6	7485.3	6.95	18.94	0.10	1802.90	565.20
8-Mar-16	28-Apr-16	8200	690	7485.3	6.95	18.94	0.21	1.11	6.14
8-Mar-16	26-May-16	8200	1120.2	7485.3	6.95	18.94	0.33	12.64	66.41
9-Mar-16	31-Mar-16	8200	658.65	7531.8	7.01	18.94	0.09	1758.57	520.87
9-Mar-16	28-Apr-16	8200	690	7531.8	7.01	18.94	0.21	0.82	5.18
9-Mar-16	26-May-16	8200	1120.2	7531.8	7.01	18.94	0.32	8.80	13.70
10-Mar-16	31-Mar-16	8200	707.35	7486.15	7.04	18.94	0.09	1806.67	568.97
10-Mar-16	28-Apr-16	8200	662.25	7486.15	7.04	18.94	0.20	0.94	4.56
10-Mar-16	26-May-16	8200	1120.2	7486.15	7.04	18.94	0.32	11.86	67.19
11-Mar-16	31-Mar-16	8200	680.05	7510.2	7	18.94	0.08	1735.94	83.56
11-Mar-16	28-Apr-16	8200	660	7510.2	7	18.94	0.20	0.77	3.73
11-Mar-16	26-May-16	8200	1120.2	7510.2	7	18.94	0.32	3.86	37.14
14-Mar-16	31-Mar-16	8200	647.25	7538.75	6.97	18.94	0.07	1715.64	103.86
14-Mar-16	28-Apr-16	8200	617	7538.75	6.97	18.94	0.19	0.50	3.85
14-Mar-16	26-May-16	8200	1120.2	7538.75	6.97	18.94	0.30	8.99	70.06
15-Mar-16	31-Mar-16	8200	707.4	7460.6	7.01	18.94	0.07	1845.99	608.29
15-Mar-16	28-Apr-16	8200	670.75	7460.6	7.01	18.94	0.18	101.77	36.77
15-Mar-16	26-May-16	8200	1120.2	7460.6	7.01	18.94	0.30	0.28	7.47
16-Mar-16	31-Mar-16	8200	662.85	7498.75	7.05	18.94	0.06	1810.31	572.61
16-Mar-16	28-Apr-16	8200	638.45	7498.75	7.05	18.94	0.18	0.50	3.05
16-Mar-16	26-May-16	8200	1120.2	7498.75	7.05	18.94	0.29	9.53	69.52
17-Mar-16	31-Mar-16	8200	665.15	7512.55	7.31	18.94	0.06	1748.04	28.04
17-Mar-16	28-Apr-16	8200	635.25	7512.55	7.31	18.94	0.17	0.41	2.49
17-Mar-16	26-May-16	8200	1120.2	7512.55	7.31	18.94	0.29	8.65	70.40
18-Mar-16	31-Mar-16	8200	589.9	7604.35	7.13	18.94	0.05	1659.95	30.15
18-Mar-16	28-Apr-16	8200	562.25	7604.35	7.13	18.94	0.17	0.32	2.68
18-Mar-16	26-May-16	8200	1120.2	7604.35	7.13	18.94	0.29	5.03	17.47
21-Mar-16	31-Mar-16	8200	477.55	7704.25	7.03	18.94	0.04	1568.66	47.34
21-Mar-16	28-Apr-16	8200	457.5	7704.25	7.03	18.94	0.16	0.12	2.88
21-Mar-16	26-May-16	8200	1120.2	7704.25	7.03	18.94	0.27	3.92	75.13
22-Mar-16	31-Mar-16	8200	468.35	7714.9	7.14	18.94	0.04	1610.20	372.50

22-Mar-16	28-Apr-16	8200	445	7714.9	7.14	18.94	0.15	6.63	3.73
22-Mar-16	26-May-16	8200	1120.2	7714.9	7.14	18.94	0.27	1.03	39.97
23-Mar-16	31-Mar-16	8200	459.8	7716.5	7.32	18.94	0.03	1610.81	373.11
23-Mar-16	28-Apr-16	8200	430	7716.5	7.32	18.94	0.15	4.99	2.99
23-Mar-16	26-May-16	8200	1120.2	7716.5	7.32	18.94	0.27	0.95	40.05
28-Mar-16	31-Mar-16	8200	549.05	7615.1	7.32	18.94	0.01	1676.43	76.43
28-Mar-16	28-Apr-16	8200	519.1	7615.1	7.32	18.94	0.13	1.19	0.41
28-Mar-16	26-May-16	8200	1120.2	7615.1	7.32	18.94	0.24	1.06	39.94
29-Mar-16	31-Mar-16	8200	574.8	7597	7.26	18.94	0.01	1697.40	21.90
29-Mar-16	28-Apr-16	8200	535.35	7597	7.26	18.94	0.12	0.12	0.48
29-Mar-16	26-May-16	8200	1120.2	7597	7.26	18.94	0.24	1.42	45.73
30-Mar-16	31-Mar-16	8200	453.35	7735.2	7.38	18.94	0.00	1611.94	374.24
30-Mar-16	28-Apr-16	8200	422.55	7735.2	7.38	18.94	0.12	0.00	0.40
30-Mar-16	26-May-16	8200	1120.2	7735.2	7.38	18.94	0.24	0.53	40.47
31-Mar-16	28-Apr-16	8200	421.35	7738.4	9	18.94	0.12	1073.49	25.71
31-Mar-16	26-May-16	8200	1120.2	7738.4	9	18.94	0.23	0.57	46.58