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## STUDY OF OPTION PRICE DEVIATION USING BLACK SCHOLES OPTION PRICING MODEL FOR EQUITY OPTIONS IN INDIA

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### ABSTRACT

*Trading in derivatives has become more volatile and faster in the derivative segments. It has become more important to price the derivative contract for effective trading in the market. In the area of Option Pricing, so many new pricing models have been developed by several researchers but still Black Scholes Model is one of the most popular tools to price the fair value of option contracts. The structure of Black Scholes Model is fixed which is also used to predict the volatility in the options. The Objective of the research paper is to compute the fair value of different equity option contracts and to compare with their actual values. For this, we have used the Black Scholes Model to compute the fair value of various equity option contracts. Further, we have compared the pricing deviation of Black Scholes model of the equity option contracts by using MSE (Mean Squared Error Method).*

### KEYWORDS

derivatives, option, volatility, black-scholes model, mean squared error.

### INTRODUCTION

Derivative trading is becoming more volatile with increasing trading volumes on the stock exchanges. On one hand, hedging is one of the reasons for increasing trading volumes, whereas the speculation is also becoming more popular now days among the traders. It has become very important for the traders to price the fair value of option with high accuracy to take right trading decisions on right time. Still, the Black Scholes Model is one of the most popular models for pricing option contract in India. But, it is also limited to some certain conditions.

Basically, derivative is an instrument or security, the value of which is derived from the value of any security (for example a share, interest rate, currency etc.) usually called as underlying asset. Option contract is type of derivatives in which the buyer have limited risk that is maximum up to the premium amount that they have already paid at the time of buying the option contract. On the other hand, the risk of seller is unlimited (or very high). A call option seeks for bullishness in the market and that's why the premium of call option goes up as the market goes up. On the contrary, the put option price increases only when the market moves in the negative direction.

For pricing of option contract many models are suggested by various economists and researchers. But mostly, the black scholes model is used for pricing of option contracts.

### BLACK SCHOLES MODEL FOR OPTION PRICING

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:

- The options are European and can only be exercised at expiration
- Efficient markets (i.e., market movements cannot be predicted)
- No commissions
- The risk-free rate and volatility of the underlying are known and constant
- Follows a lognormal distribution; that is, returns on the underlying are normally distributed.

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

$$C = SN(d_1) - N(d_2)Ke^{-rt} \quad d_1 = \frac{\ln(S/K) + (r + s^2/2)t}{s\sqrt{t}}$$

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

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



The model is essentially divided into two parts: the first part,  $SN(d_1)$ , 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,  $N(d_2)Ke^{-rt}$ , 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, as shown in the equation. The put option can be calculated by using the following formula:

$$P = -S N(-d_1) + N(-d_2) K e^{-rt}$$

The following steps are applied for the determining the fair option prices and implies volatility of stock options:

**Step I:** First, we calculate the historical volatility using the daily log returns by using moving average method.

Daily Return =  $\ln(\text{today's closing price/yesterday's closing price})$

Daily standard deviation (SD) =  $(\text{Variance of daily returns})^{0.5}$

Historical Volatility =  $\text{Daily SD} \times (250)^{0.5}$

(Here we consider 250 trading days in a year)

**Step II:** We get all required value in the Black formula from the NSE website and use them in the Black scholes model and we get the fair value of call and put options of various strike prices.

**Step III:** Now, we can compare the fair option premium with the actual value of option premium and get the mean squared error (MSE) by finding the square of differences of fair and actual values and then dividing them with the no. of data. The higher MSE shows the less accurate fair values of option contract.

## LITERATURE REVIEW

Frino et al. (1999) carried out cross sectional tests of the model using the historical data. There are conclusion was that the Black Scholes Model cannot be rejected. They carried out a time series analysis of mispricing in order to determine whether that could be attributed to a market learning effect over time. They controlled the effect of dividend and possibility of early exercise and used to limit the possibility of incompatible risk free interest rate proxies having a confounding effect on results.

Gencay and Salih (2003) put light on the fact that the Black Scholes Pricing errors are larger in the deeper out of the money options, and mispricing worsens with increased volatility. Their result indicated that the Black Scholes model is not proper pricing tool in high volatility with considerably lower errors for out-of-the-money call and put options. They also mentioned that this could be invaluable information for practitioners as option pricing is a major challenge during high volatility periods.

Choi et al. (2011) estimated implied volatility using the inverse function of Black Scholes Model and Least Square Support Vector Machine (LSSVM) model and found that LSSVM is more accurate than Black Scholes model since LSSVM's MSE value is lesser than Black Scholes model's MSE value. They used Hang Seng index option to verify the performances of these models.

Ray (2012) studied the Black Scholes Model of option pricing and made a more detailed analysis of the assumptions of the model and the mathematical derivation process of the model and also analysed the inherent loopholes in the theory.

Khan et al. (2013) incorporated modification in Black-Scholes option pricing model formula by adding some new variables on the basis of given assumption related to risk-free interest rate, and also showed the calculation process of new risk-free interest rate on the basis of modified variable. This paper also identified the various situations in empirical testing of modified and original Black-Scholes formula with respect to the market value on the basis of assumed and calculated risk-free interest rate.

Arora K. & Sharma M. (2013) determined the volatility and studied that how the implied volatility levels of an option contract of a stock is related to the pricing of that option and also determined whether a stock option is underpriced or overpriced. For this the sample data was collected from the stock options traded on the NSE. They used the basic statistical approach to determine the volatility of a stock and used this historical volatility in the Black-Scholes model in order to determine the implied volatility and then compared the historical volatility with the implied volatility to find whether an option is fairly priced or not.

Panduranga V. (2013) studied the relevance of Black-Scholes model in Indian Derivative market with specific reference to select cement stock options. Results of their study comprising of paired sample T-test revealed that there is no significant difference between the expected option price calculated through Black-Scholes Model and market price of options. The study inferred that model is relevant for cement stocks.

## OBJECTIVES

1. To determine the fair value (or theoretical value) of an option contract.
2. To determine the Mean Squared Error of fair and actual value of an option contract.

## RESEARCH METHODOLOGY

**SAMPLING:** For this study the ten companies are selected from NIFTY. The one-year historical closing price data of these four companies and the index NIFTY is taken from Nov. 2012 to July 2013 for the period of one year and 780 samples of stock options are taken from 8<sup>th</sup> July 2013 to 24<sup>th</sup> July 2013.

**DATA SOURCE:** The data of closing prices of shares and the actual option premiums are collected from the website [www.nseindia.com](http://www.nseindia.com).

## DATA ANALYSIS

We have computed the fair values (Mentioned in Table 1, 2, 3 & 4) of option contract by using the above mentioned black scholes formula. Further, in Table 5 the MSE of call and put option is mentioned. The Higher MSE shows that there is more deviation in the fair values than the actual values and they are less accurate and vice versa. We can see that Infosys option's MSE is very high for both call (1444.55) and put (1475.74) and its average annual volatility is also high (0.4376). We can also notice from table 5 that the MSE of call and put are different for different stocks irrespective of their average annual volatility.

## CONCLUSION

The brief conclusion from this study is that the accuracy of Black Scholes Model may vary with respect to stock option contracts (depending upon the stock price and volatility and volumes). It has been observed that stock option with less volume and high volatility of underlying stock has more deviation and less accuracy than high volumes options contracts with less volatility.

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## TABLES

TABLE 1: FAIR VALUE AND ACTUAL VALUE OF CALL OPTIONS

S.No.	Date	HDFC		HDFC BANK		ICICI BANK		INFOSYS		ITC	
		Fair	Actual	Fair	Actual	Fair	Actual	Fair	Actual	Fair	Actual
1	08-Jul-13	34.81	39.85	26.84	31.25	56.96		43.34	104.55	5.54	7.00
2	09-Jul-13	38.75	43.00	34.66	31.25	61.74		50.82	115.45	5.67	6.65
3	10-Jul-13	36.35	38.00	25.25	31.25	64.82		49.04	110.25	4.59	5.35
4	11-Jul-13	58.91	48.00	45.98	47.00	82.04		56.35	145.50	8.49	9.20
5	12-Jul-13	55.32	46.15	57.82	47.00	83.96		232.64	217.30	6.46	6.55
6	15-Jul-13	51.58	50.00	56.97	50.50	83.47		173.78	159.40	6.81	7.10
7	16-Jul-13	24.11	28.25	40.40	50.50	32.49	40.00	159.45	142.35	11.93	13.10
8	17-Jul-13	24.06	24.00	25.57	24.75	16.87	24.70	173.54	155.75	19.17	18.70
9	18-Jul-13	32.81	36.75	45.22	37.00	18.04	25.30	213.41	207.15	19.32	19.50
10	19-Jul-13	13.48	16.20	40.98	37.00	6.15	11.05	254.32	247.00	19.58	19.70
11	22-Jul-13	31.37	33.00	42.48	48.85	7.55	12.45	278.66	273.00	19.02	20.35
12	23-Jul-13	27.54	30.10	43.89	51.55	14.10	16.90	303.09	309.35	25.89	26.00
13	24-Jul-13	6.55	8.90	20.11	21.00	0.13	2.00	309.17	313.50	25.87	27.05
14	08-Jul-13	22.26	27.90	13.84	18.50	41.98	52.50	21.65	65.75	2.27	3.40
15	09-Jul-13	25.17	29.60	19.45	23.50	45.96	55.35	25.66	76.20	2.28	3.15
16	10-Jul-13	23.12	25.25	12.43	16.90	48.50	53.75	24.13	76.20	1.69	2.35
17	11-Jul-13	41.89	41.55	28.48	31.95	64.07	70.55	27.91	106.85	3.73	4.20
18	12-Jul-13	38.50	40.00	38.95	39.10	65.68	68.00	158.22	126.35	2.48	2.70
19	15-Jul-13	34.55	34.00	37.73	39.10	64.65	69.00	106.34	70.70	2.40	3.05
20	16-Jul-13	12.58	16.05	22.67	29.00	19.94	27.50	93.70	56.70	5.23	6.45
21	17-Jul-13	12.20	14.35	11.09	12.55	8.65	16.75	102.62	65.75	10.45	11.65
22	18-Jul-13	18.14	20.30	26.41	25.85	9.08	16.75	132.50	110.35	10.40	11.90
23	19-Jul-13	5.21	7.75	22.37	21.00	2.24	6.10	165.33	147.65	10.44	11.45
24	22-Jul-13	14.72	16.45	22.81	20.40	2.07	5.60	181.22	172.15	9.38	11.55
25	23-Jul-13	10.94	12.75	23.97	24.25	4.17	7.10	203.58	208.35	15.91	16.70
26	24-Jul-13	0.43	2.25	3.28	5.60	0.00	0.75	209.20	211.95	15.87	17.25
27	08-Jul-13	13.03	18.00	5.80	10.15	29.41	41.05	9.87	41.30	0.75	1.75
28	09-Jul-13	14.94	18.90	8.97	12.95	32.51	42.55	11.77	49.15	0.74	1.25
29	10-Jul-13	13.35	15.90	4.84	8.45	34.43	42.85	10.70	50.55	0.49	0.90
30	11-Jul-13	27.48	28.25	14.79	16.05	47.75	53.75	12.39	76.40	1.30	1.70
31	12-Jul-13	24.51	25.30	22.59	23.40	48.96	53.15	99.52	59.95	0.72	1.05
32	15-Jul-13	20.66	21.65	20.86	22.85	47.25	52.30	58.13	23.20	0.59	1.05
33	16-Jul-13	5.51	8.95	9.65	14.35	11.00	17.95	48.40	15.80	1.63	2.40
34	17-Jul-13	5.08	7.45	3.23	5.05	3.86	10.25	52.75	17.25	4.24	5.75
35	18-Jul-13	8.24	10.20	11.51	11.50	3.91	9.65	71.27	37.15	4.03	6.20
36	19-Jul-13	1.51	3.20	8.48	9.60	0.66	3.30	93.00	56.60	3.85	5.90
37	22-Jul-13	4.51	6.35	7.01	9.10	0.37	2.10	95.34	74.30	2.44	5.40
38	23-Jul-13	2.25	3.70	6.85	8.35	0.69	2.35	109.64	108.20	6.42	8.70
39	24-Jul-13	0.00	0.45	0.02	0.60	0.00	0.35	110.61	111.05	6.04	8.20

TABLE 2: FAIR VALUE AND ACTUAL VALUE OF CALL OPTIONS

S.No.	Date	L&T		ONGC		RELIANCE		TATAMOTORS		TCS	
		Fair	Actual	Fair	Actual	Fair	Actual	Fair	Actual	Fair	Actual
1	08-Jul-13	46.69		17.35	24.65	14.97	19.25	13.29	15.35	34.90	62.20
2	09-Jul-13	59.68		15.81	17.15	17.94	22.10	13.93	15.90	32.64	60.75
3	10-Jul-13	51.04		11.28	12.15	9.63	13.35	10.32	11.95	35.64	63.40
4	11-Jul-13	83.74	68.10	17.46	18.50	14.42	16.75	10.57	12.00	74.11	92.10
5	12-Jul-13	107.15	99.20	11.09	12.10	24.39	27.10	15.66	16.70	115.05	117.00
6	15-Jul-13	113.31	99.20	9.91	11.35	26.56	31.25	11.75	13.65	145.02	140.10
7	16-Jul-13	81.99	99.20	12.26	13.45	28.43	35.15	13.83	14.95	152.22	154.00
8	17-Jul-13	78.01	99.20	12.80	13.20	39.16	42.25	8.86	10.45	181.02	168.60
9	18-Jul-13	91.21	99.20	25.20	24.70	40.51	45.60	9.62	11.25	162.61	165.85
10	19-Jul-13	79.98	99.20	27.36	27.80	45.80	48.95	15.66	16.95	244.69	232.00
11	22-Jul-13	20.12	19.00	17.59	27.80	30.43	32.25	18.10	18.25	247.44	244.50
12	23-Jul-13	16.33	13.10	22.27	27.80	30.24	32.35	18.93	19.15	250.43	247.70
13	24-Jul-13	1.54	1.15	18.46	27.80	29.58	31.15	17.36	17.70	283.12	279.90
14	08-Jul-13	22.31		10.59	12.40	8.31	12.25	7.70	9.80	4.25	25.30
15	09-Jul-13	31.01		9.31	10.95	10.16	13.80	8.07	10.10	3.48	24.05
16	10-Jul-13	24.55		5.98	7.70	4.78	7.80	5.46	7.15	3.76	23.10
17	11-Jul-13	57.79		10.39	11.05	7.59	9.65	5.54	7.05	14.73	41.95
18	12-Jul-13	77.06	42.95	5.68	6.60	14.17	17.80	9.02	10.05	34.82	53.05
19	15-Jul-13	80.69	42.95	4.57	5.95	14.98	20.50	5.85	7.60	53.07	64.20
20	16-Jul-13	53.48	42.95	5.96	6.90	16.01	23.30	7.13	8.50	57.74	73.65
21	17-Jul-13	49.49	42.95	6.15	6.95	23.88	28.55	3.75	5.20	82.75	85.90
22	18-Jul-13	59.47	42.95	15.93	15.90	24.55	30.50	4.01	5.50	65.27	76.55
23	19-Jul-13	49.24	42.95	17.77	17.95	28.52	33.70	7.85	8.90	144.86	133.50
24	22-Jul-13	6.14	4.70	8.45	8.90	14.28	16.25	8.90	10.25	147.52	140.00
25	23-Jul-13	3.56	1.85	12.39	12.15	13.09	14.65	9.29	10.25	150.48	146.00
26	24-Jul-13	0.04	0.25	8.55	9.75	11.13	13.85	7.53	8.35	183.14	179.90
27	08-Jul-13	8.43		5.75	7.55	4.21	7.40	3.98	5.80	0.17	8.05
28	09-Jul-13	12.85		4.83	6.50	5.23	8.20	4.15	5.95	0.11	6.60
29	10-Jul-13	9.14		2.73	4.35	2.13	4.20	2.52	4.00	0.11	5.95
30	11-Jul-13	37.65		5.38	6.10	3.58	5.10	2.51	3.95	0.91	15.60
31	12-Jul-13	52.40	34.20	2.46	3.35	7.40	10.60	4.50	5.60	3.77	17.60
32	15-Jul-13	53.61	37.35	1.68	2.85	7.38	12.65	2.38	3.85	6.49	19.80
33	16-Jul-13	31.91	22.25	2.28	3.20	7.78	14.55	2.97	4.15	6.77	24.40
34	17-Jul-13	28.34	20.45	2.27	3.05	12.60	17.35	1.21	2.30	14.05	31.75
35	18-Jul-13	34.81	26.20	8.31	8.35	12.68	18.80	1.22	2.25	7.12	22.75
36	19-Jul-13	26.53	19.50	9.50	9.75	15.01	21.45	2.92	3.55	50.14	41.20
37	22-Jul-13	1.28	1.00	2.41	3.00	4.49	6.35	2.67	3.95	49.12	45.90
38	23-Jul-13	0.42	0.35	4.16	5.15	3.19	4.10	2.39	3.40	51.03	48.40
39	24-Jul-13	0.00	0.20	1.35	2.25	1.43	3.50	0.99	2.30	83.16	80.45

TABLE 3: FAIR VALUE AND ACTUAL VALUE OF PUT OPTIONS

S.No.	Date	HDFC		HDFC BANK		ICICI BANK		INFOSYS		ITC	
		Fair	Actual	Fair	Actual	Fair	Actual	Fair	Actual	Fair	Actual
1	08-Jul-13	8.00	11.40	3.97	8.35	5.85	13.00	165.57	217.40	7.62	8.85
2	09-Jul-13	6.09	9.25	2.08	5.80	4.41	10.05	143.56	214.10	7.07	8.10
3	10-Jul-13	6.41	9.40	3.81	7.60	3.48	9.20	139.40	194.15	7.96	8.80
4	11-Jul-13	1.84	3.20	0.73	2.85	1.48	4.75	120.07	206.05	4.08	4.85
5	12-Jul-13	1.91	3.40	0.22	1.70	1.13	4.05	21.08	7.60	4.92	5.65
6	15-Jul-13	1.45	2.90	0.09	1.25	0.56	2.90	25.41	7.15	3.50	4.55
7	16-Jul-13	6.60	8.80	0.42	2.15	7.36	12.70	25.55	6.15	1.23	2.10
8	17-Jul-13	5.65	7.90	1.53	3.85	15.13	22.30	18.16	3.15	0.25	1.20
9	18-Jul-13	2.62	3.35	0.12	0.70	12.28	17.35	8.70	1.20	0.16	0.90
10	19-Jul-13	9.31	11.45	0.13	0.75	25.73	28.70	3.47	0.70	0.10	0.70
11	22-Jul-13	0.58	1.55	0.00	0.35	12.54	16.50	0.21	0.30	0.01	0.50
12	23-Jul-13	0.37	0.95	0.00	0.45	4.08	6.20	0.01	0.25	0.00	0.30
13	24-Jul-13	3.14	4.50	0.02	0.50	28.15	26.70	0.00	0.10	0.00	0.25
14	08-Jul-13	15.36	19.10	10.89	15.40	10.77	18.65	243.46	272.00	14.31	15.90
15	09-Jul-13	12.44	15.65	6.79	11.00	8.55	15.05	218.01	281.05	13.65	14.00
16	10-Jul-13	13.10	16.80	10.92	15.20	7.08	14.15	214.12	259.00	15.03	14.50
17	11-Jul-13	4.74	6.30	3.17	6.25	3.44	7.90	191.30	268.30	9.29	10.00
18	12-Jul-13	5.02	5.90	1.28	3.45	2.79	6.00	46.34	19.10	10.91	11.75
19	15-Jul-13	4.37	5.40	0.80	2.90	1.68	4.55	57.73	22.65	9.06	11.00
20	16-Jul-13	15.02	16.65	2.64	5.75	14.77	20.15	59.58	23.45	4.52	5.35
21	17-Jul-13	13.76	15.60	7.01	10.10	26.87	31.50	47.04	14.55	1.51	3.30
22	18-Jul-13	7.92	7.65	1.28	2.25	23.29	27.40	27.61	5.25	1.23	2.70
23	19-Jul-13	21.01	22.95	1.49	2.15	41.80	41.90	14.33	2.00	0.95	2.20
24	22-Jul-13	3.91	5.30	0.32	1.40	27.04	29.30	2.69	0.80	0.35	1.85
25	23-Jul-13	3.76	4.60	0.08	0.90	14.14	15.50	0.45	0.70	0.01	0.80
26	24-Jul-13	17.01	16.90	3.19	4.10	48.01	46.00	0.01	0.30	0.00	0.65
27	08-Jul-13	26.05	29.50	22.77	30.75	18.12	26.65	331.27	414.00	22.75	46.40
28	09-Jul-13	22.13	24.65	16.24	20.65	15.02	22.35	303.73	336.00	22.06	21.00
29	10-Jul-13	23.27	27.45	23.25	27.30	12.93	20.35	300.32	335.00	23.79	21.00
30	11-Jul-13	10.27	11.50	9.40	13.40	7.05	12.55	275.42	332.40	16.82	16.00
31	12-Jul-13	10.97	11.15	4.86	8.05	6.01	9.90	87.32	47.75	19.12	16.00
32	15-Jul-13	10.44	12.55	3.89	7.50	4.24	8.20	109.28	68.00	17.22	16.00
33	16-Jul-13	27.90	28.75	9.58	13.50	25.79	30.05	114.06	72.00	10.88	11.00
34	17-Jul-13	26.59	29.15	19.11	23.25	42.04	45.65	96.97	68.00	5.28	7.20
35	18-Jul-13	17.98	16.70	6.35	7.25	38.08	39.00	66.21	30.40	4.85	6.50
36	19-Jul-13	37.27	37.50	7.57	7.60	60.19	58.80	41.86	11.65	4.34	6.05
37	22-Jul-13	13.70	14.50	4.51	6.25	45.33	44.20	16.74	3.90	3.40	5.50
38	23-Jul-13	15.06	15.75	2.94	4.10	30.65	27.50	6.46	1.25	0.52	2.55
39	24-Jul-13	36.58	35.00	19.92	19.80	68.00	66.00	1.40	0.45	0.16	2.15

TABLE 4: FAIR VALUE AND ACTUAL VALUE OF PUT OPTIONS

S.No.	Date	L&T		ONGC		RELIANCE		TATAMOTORS		TCS	
		Fair	Actual	Fair	Actual	Fair	Actual	Fair	Actual	Fair	Actual
1	08-Jul-13	8.42		2.50	3.45	24.76	27.30	4.41	7.00	22.91	56.95
2	09-Jul-13	4.74		2.71	3.70	20.07	24.50	3.81	6.75	22.71	57.40
3	10-Jul-13	6.01		4.25	5.20	30.75	36.90	5.32	8.65	18.97	49.60
4	11-Jul-13	16.50	8.00	1.88	2.40	21.68	25.95	4.78	6.90	5.15	36.25
5	12-Jul-13	9.42	3.95	3.77	4.70	11.95	16.85	2.33	4.30	1.11	16.40
6	15-Jul-13	5.20	2.50	3.21	4.10	7.79	14.60	2.67	4.85	0.12	6.95
7	16-Jul-13	9.20	4.40	1.98	2.30	6.10	11.70	1.71	3.70	0.04	5.90
8	17-Jul-13	8.44	4.80	1.53	2.00	2.68	8.20	3.10	4.70	0.00	4.35
9	18-Jul-13	4.71	2.85	0.14	0.40	1.91	6.15	2.27	3.60	0.00	3.20
10	19-Jul-13	4.95	3.15	0.05	0.25	0.94	5.10	0.63	1.65	0.00	0.55
11	22-Jul-13	18.11	16.50	0.06	0.40	0.80	2.20	0.06	0.90	0.00	0.40
12	23-Jul-13	14.88	9.75	0.00	0.30	0.31	1.20	0.01	0.40	0.00	0.35
13	24-Jul-13	34.01	31.20	0.00	0.05	0.03	1.20	0.00	0.25	0.00	0.20
14	08-Jul-13	23.87		5.69	6.90	38.01	39.60	8.78	11.15	91.84	100.00
15	09-Jul-13	15.92		6.18	7.20	32.21	36.80	7.92	10.95	93.16	100.00
16	10-Jul-13	19.37		8.90	9.95	45.82	49.90	10.43	13.80	86.73	100.00
17	11-Jul-13	30.41		4.77	5.15	34.78	37.90	9.72	11.45	45.43	80.05
18	12-Jul-13	19.21	8.50	8.33	9.05	21.66	25.80	5.66	7.75	20.56	50.60
19	15-Jul-13	12.48	6.00	7.86	8.75	16.16	22.90	6.74	8.90	7.92	29.50
20	16-Jul-13	20.61	13.00	5.65	5.90	13.64	19.05	4.99	7.05	5.34	25.50
21	17-Jul-13	19.84	14.00	4.86	5.25	7.35	13.70	7.97	9.35	1.54	21.15
22	18-Jul-13	12.90	7.90	0.84	1.20	5.92	11.05	6.65	7.60	2.49	17.70
23	19-Jul-13	14.15	8.45	0.45	0.65	3.64	9.30	2.81	3.70	0.02	0.95
24	22-Jul-13	44.10	41.15	0.91	1.40	4.63	5.15	0.85	2.10	0.00	0.50
25	23-Jul-13	42.10	37.25	0.12	0.45	3.15	3.55	0.36	1.25	0.00	0.35
26	24-Jul-13	72.51	70.20	0.09	0.50	1.59	3.20	0.16	0.70	0.00	0.20
27	08-Jul-13	49.82		10.81	11.95	53.83	56.25	15.02	16.95	187.34	270.50
28	09-Jul-13	37.60		11.66	12.85	47.21	50.00	13.96	16.50	189.39	270.50
29	10-Jul-13	43.81		15.62	16.00	63.10	78.50	17.45	20.55	182.70	270.50
30	11-Jul-13	50.13		9.74	10.10	50.70	78.50	16.65	18.55	131.27	270.50
31	12-Jul-13	34.43	20.90	15.08	16.20	34.83	39.15	11.11	12.55	89.19	110.25
32	15-Jul-13	25.31	13.65	14.94	15.35	28.51	36.65	13.24	14.70	61.10	83.75
33	16-Jul-13	38.94	28.30	11.96	11.95	25.36	29.85	10.80	12.70	54.15	74.00
34	17-Jul-13	38.61	28.25	10.96	11.05	16.04	22.55	15.41	16.15	32.63	65.30
35	18-Jul-13	28.18	16.95	3.21	3.40	14.02	18.85	13.84	14.35	44.17	63.70
36	19-Jul-13	31.39	21.35	2.16	2.30	10.10	16.50	7.86	8.25	5.16	8.35
37	22-Jul-13	79.20	76.40	4.87	5.20	14.84	14.25	4.61	5.60	1.52	3.50
38	23-Jul-13	78.94	74.00	1.88	2.35	13.23	11.60	3.46	4.25	0.50	1.95
39	24-Jul-13	112.46	104.35	2.89	3.00	11.88	11.60	3.62	4.25	0.00	0.45

TABLE 5: MEAN SQUARED ERRORS OF CALL AND PUT OPTIONS

S.No.	Stock Name	MSE CALL	MSE PUT	Average Annual Vol.
1	HDFC	12.35	4.20	0.269855
2	HDFC Bank	18.68	8.71	0.226123
3	ICICI Bank	38.24	21.54	0.272315
4	INFOSYS	1444.55	1475.74	0.437646
5	ITC	1.49	16.13	0.217269
6	L&T	201.12	49.91	0.512876
7	ONGC	8.06	0.41	0.309566
8	RELIANCE	16.44	44.51	0.262205
9	TATAMOTORS	1.97	3.40	0.329852
10	TCS	198.80	1330.63	0.223859

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