

PRICING EFFICIENCY OF EQUITY INDEX OPTION CONTRACTS: EVIDENCE FROM NATIONAL STOCK EXCHANGE OF INDIA

Uma Shankar*, Kapil Gupta**

Abstract *The present study examines the pricing efficiency of equity index options traded at National Stock Exchange of India by comparing the premium of options contracts traded on NIFTY, BANKNIFTY, CNXIT, NIFTYJUNIOR, and CNX100 indices with their respective theoretical price estimated by using Black-Scholes Model. 91-day T-Bill rate is used as risk-free rate and standard deviation computed on daily returns of the underlying index is used as volatility to estimate the theoretical prices. Pricing efficiency has been tested both for daily closing prices per se as well as for the In-the-Money, At-the-Money, and Out-of-the-Money options contracts.*

Mean Absolute Errors (MAE), Mean Squared Errors (MSE), Root Mean Squared Errors (RMSE), and Theil's U statistics suggest that the premium of equity index options contracts do not follow Black-Scholes Model.

Keyword: *Option premium, Liquidity, Volatility, Arbitrage, Put-call-parity*

INTRODUCTION

Last two and a half decades have witnessed manifold increase in the volume of financial derivatives market. Trading and pricing of option contracts find an important place in derivatives market. A number of option pricing model have been proposed, developed and studied but Black-Scholes (BS) options pricing model with embedded probability is the most widely used formula (Rubinsten, 1994). Black-Scholes model is used as option pricing model in most of the markets of the world, however, the assumptions of this model have been criticised for being too simplistic, not taking into account the dividends, option to early exercise the contract, constant volatility, and risk-free rate. Black and Scholes (1972) themselves reported that the model overpriced (underpriced) options on high (low) estimated variance stocks, which was attributed to measurement errors of variables that are assumed to be constant over the contract cycle. Moreover, 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 (1975) concluded that 'we don't know why some of the options contracts are consistently overpriced according to the formula and others are consistently underpriced'.

Furthermore, 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 as low as 15.

Nonetheless, Black-Scholes model is path breaking model in the literature of options pricing however, the validity of the model has been tested in various markets and literature observes mixed evidence. Predominantly literature suggests that since the assumptions of this model are too simple and unrealistic therefore, this model is not fit for options pricing. Hence, a number of variants of Black-Scholes model have been proposed but still the debate has yet not settled and this model commands huge respect in the literature of options pricing. The following section discusses in detail the developments in the literature of option pricing, which covers both testing the validity of Black-Scholes model in various markets of the world as well as different variants of Black-Scholes model proposed in the literature.

* Assistant Statistic Officer at Lalganj Ajamgarh, Planning Department, Uttar Pradesh, India.
Email: shankar.option@gmail.com

** Assistant Professor, Punjab Institute of Management (PIM), I. K. Gujral Punjab Technical University Main Campus, Jalandhar-Kapurthala Highway, Kapurthala, India. Email: kapilfutures@gmail.com.

REVIEW OF LITERATURE

Previous three decades have observed significant development and testing of various asset pricing theories and models, however, development of options pricing model is path breaking development in this discipline. Black-Scholes model though is one of the most popular option pricing models but literature observes that this model lacks application because some of its assumptions like constant risk-free rate, company does not pay dividend etc. does not hold true. For example; MacBeth and Merville (1979) 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 Model underpriced in the money options and overprices out of the money options, the time expiration bias which is consistent with Black (1975) but the strike price bias is diametrically inconsistent with finding of Black (1975). These observations were attributed to the nonstationarity of the variance rate overlooked in Black (1975). Emanuel and MacBeth (1982) also reexamined the validity of constancy of the CEV and parameters as assumed by MacBeath and Merville (1980) and they observed that (i) superior performance of CEV wanes as the interval of prediction (of the variance rate) increases; (ii) depending on the parameter value of CEV, the Black-Scholes will consistently either overprice (underprice) or underprice (overprice) in the money (out of money) options.

Moreover, Bhattacharya (1980) by using daily returns of 62 stocks which were traded on CBOE for the period of May 1976 to October 1977 also found that the formula bias is significant for at the money options with less than one day to expiration. Philips and Smith (1980) suggested that the transaction cost would eliminate pricing inefficiency observed by Galai (1977) and Chiras and Manaster (1978). As a result, the joint test of the validity and the market efficiency seem to remain indecisive. Parkinson (1980) uses extreme values to calculate the stock return and standard deviations of stock price range data in the 20 weeks time both undervalue market prices of put although the Geske and Johnson (GJ) model is significantly closer to market prices than the Black-Scholes Model. In addition, they find that GJ model capture a larger portion of the pricing bias of the Black-Scholes Model for in-the-money puts than out-of-the-money puts, which may be because the GJ model captures the early exercise premium that is argued to be more prevalent in in-the-money than out-of-the-money puts.

Furthermore, Geske, Roll, and Shastri (1984) showed that at an original time both in-the-money and out-of money options contain volatility bias and they conclude time and money bias may be related to improper boundary conditions, where the volatility bias problem may be the result of statistical error in estimation. Kerruish (1985) further by using the

Black-Scholes model with two method of adjusting for dividends, various estimators of the standard deviation of the underlying stock's return, and two method of dealing with the bid-ask spread. They found that the overall return from spreading were not significant greater than zero and concluded that the London Traded Option Market (LTOM) was efficient during the period (July, 1981 – July, 1982).

Gemmill and Dickins (1986) also used ex post test and a spreading strategy to test the efficiency of the LTOM. They found statistically significant profits in excess of the risk-free interest rate, indicating that the Black-Scholes model was able to identify overpriced and underpriced call options. However, these profits turned into losses when an estimated bid-ask spread was applied. Furthermore, Whaley (1982), Stein (1989) and Bakshi, Cao, and Chen (1997) find that option pricing models systematically misprice options contracts with respect to time to maturity and moneyness. They find that short term options are typically underpriced by using Black-Scholes relative to the long term options. Similarly, deep in the money option and deep out of the money options are underpriced relative to at the money options. Whaley (1986) also has made comparison of traded prices and estimated model prices for options in Chicago mercantile Exchange (CME) and found that deviation between actual market price and theoretical model price are not significantly different. They also found that the model underpriced in-the-money options.

In addition, Zivney (1991) estimates the value of early exercise from deviation of observed American put-call parity from an otherwise identical European put-call parity using transaction data of Standard & Poor (S&P) 100 index option contracts. They find that the value of early exercise of calls increases with time to expiration, the risk-free rate of interest, the stock price and decreases with the exercise price. He also finds that the value of early exercise for put options is greater than call options. Raj and Thurston (1998) have examined the effectiveness of Black model on intraday basis and found that model underprice both in-the-money and out-of-money considerably, but predicts the price of at-the-money options contracts very accurately. Guo (1999) observed that the Black-Scholes model is not vulnerable to its assumption on the underlying process, because the fundamental partial differential equation (PDE) can be derived by the possibility of continuously rebalancing a delta-gama-neutral position, without assuming anything about the underlying process.

Furthermore, Cavallo and Mammola (2000) investigated 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) further 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.

Fuh, Wang, and Cheng (2002) have developed close form formula with Markov switching options pricing model by using approximation formula for three or more state hidden Markov model and their results of approximation formula showed that pricing error was very small except in extreme cases. Yakoob (2002) has also analyzed the option valuation models by using option contracts on the S&P Index and found that the Black-Scholes model provides for greater accuracy in pricing than two other models under consideration. Varma (2003) studied the pricing efficiency of Indian stock index option market and found that the implied probability distribution is more highly peaked and has thinner tails than the normal distribution, resulting into underestimating the probability of market movement in both direction, and thereby, underpricing volatility severely.

Daglish (2003) has compared the Out-of-sample option pricing performance and hedging performance by using parametric and nonparametric approaches. He has taken the data in panel form SPI Futures option (An American option Struck) and All Australian Indexes. He has taken data from January 1992 to December 1999. By using the broader spectrum techniques, Spline-based nonparametric technique, Standard Kernel technique and Heston Stochastic Volatility model, they found superior performance by nonparametric technique for in-sample pricing and parametric method showed better ability to explain future price and showed superior hedging performance.

Grose and Dritsakis (2003) studied the performance of London's options market using the Black-Scholes model during the period January 1995 to December 1999 and found that Black-Scholes Model can locate possible mispricing of options contracts and specifically over and valued options. Out-of-the-money options were overvalued and, implied volatility gave more reliable results than historically volatility. Mishra, Kannan, and Mishra (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 and find that deep in the money and deep out of the 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 money call options; implied volatility is higher for far month contracts than near the month contracts; deep in the money and out of the 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) further examined the Black-Scholes model in India by taking the option contract of ten Indian stocks 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 and they find that options are severely mispriced as compared to 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 Corrado 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. 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. Mitra (2008) has addressed the issue of negative cost of carry in NIFTY derivative. By using Black formula and Black-Scholes formula and NIFTY call options traded at National Stock Exchange from the period October 1, 2005 to September 30, 2006, they observed that Black formula provides better result than Black-Scholes formula for NIFTY options.

Necula (2009) further gives a derivative framework in which derivative contract is supposedly driven by a Fractional Brownian Motion (FBM) with Hurst parameter greater than 0.5. Some results especially the behaviour to a Girsanov transform regarding the quasi-conditional expectation are obtained. The researcher has obtained risk-neutral expectation formula and fundamental evaluation equation in case of the fractional Black-Scholes market.

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-Scholes 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-Scholes 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

Assessments of model's validity can be done in two ways:

(i) the model's predictions can be confronted with historical data to determine whether the predictions are accurate or not within some statistical standard of confidence; (ii) the assumptions made in developing the model can be assessed to determine if they are consistent with observed behaviour or historical data. In the present study first approach is followed to study the relevance of Black-Scholes method in India. Black-Scholes model was firstly used by NSE in June 2001 and on the same very date Index options was introduced on NSE based on S&P CNX NIFTY Index based on Black-Scholes model after this NSE has applied this model to all indices. Although Black-Scholes is used for indices but it is a matter of concern that whether it accurately estimates the option premium. The premium estimated by using Black-Scholes model is true if there is no pricing error between market price of options and theoretical price of options.

Moreover, after BS model, Black (1976) suggested an alternative options pricing model by assuming that investor creates a riskless hedge between options and the futures or forward contracts. Black model is more or less similar with BS model; the only difference is that futures price is used in place of spot price. Black's model is not as popular as BS model but BS model also does not produce the bias free price. Black (1975) was the first who observed the biasness in the BS options pricing model. Manaster and Rendleman (1982), observed that out of money put options are generally overpriced in the market (also see MacBeth & Merville, 1979; Kakati, 2006; Mitra, 2008; Sehgal & Vijayakumar, 2009).

As far as methodology is concerned, the theoretical options prices are compared with actual options pricing and then four pricing errors are calculated for each day for all five indices which is used in this study. These pricing errors are mean absolute error, mean squared error, root mean squared error, Theil's U statistics. After this number of times Call options Overpriced (%), no. of times Call options underpriced (%), no. of times put options Overpriced (%), no. of times put options underpriced (%) are calculated. At the end one sampled t value is calculated for checking the significance of pricing errors.

Mean Error (ME)

It is calculated by adding all pricing error values and dividing total pricing error by number of observations.

$$\text{Mean Error (ME)} = \frac{1}{N} \sum_{n=1}^N y_n$$

y_n = Pricing error = Actual Option Premium (p_n) – Estimated Option Premium (q_n)

This measure is acceptable when all error data have the same

sign (either all positive or negative). A low value of ME may conceal forecasting inaccuracy due to the offsetting effect of large positive and negative forecast error and make this measure unacceptable.

Mean Absolute Error (MAE)

Mean absolute error is computed as average of the absolute error values.

$$\text{Mean Absolute Error (MAE)} = \frac{1}{N} \sum_{n=1}^N |y_n|$$

$|y_n|$ = Absolute pricing error = $|(p_n) - (q_n)|$

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.

$$\text{Mean Squared Error (MSE)} = \frac{1}{N} \sum_{n=1}^N y_n^2$$

y_n^2 = Square of pricing error = $[(p_n) - (q_n)]^2$

Root Mean Squared Error (RMSE)

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

$$\text{Root Mean Squared Error (RMSE)} = \sqrt{\frac{1}{N} \sum_{n=1}^N y_n^2}$$

y_n^2 = Square of pricing error = $[(p_n) - (q_n)]^2$

Theil's U Statistic

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

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

Here two time series are used; one is actual value of options (p_n) and other is estimated value of options (q_n). Theil's U will be equal to 0 if estimated price is not different from actual price. If Theil's U is different from 0, it indicates that the estimation model (Black-Scholes Model or Black's Model) overestimates / underestimates the option premium.

Sample Design

Data employed for examining the Indian index options market have been downloaded from the Equity and Futures and Options (F&O henceforth) segments on the website of National Stock Exchange of India (www.nseindia.com) and is secondary in nature. Universe of the study is an option contracts traded in India, while sample size includes five indices NIFTY, CNXIT, BANKNIFTY, NIFTYJUNIOR and CNX100. Call and put options contracts of all these five indices are included in the sample. In order to estimate the theoretical price according to Black model, near month futures closing price is used instead of spot price. For Put-Call-Parity (PCP) also the same sample design is taken.

Sample Period

Sample period for five indices are as follow:

- S&PCNXNIFTY options: June 4, 2001- December 31, 2008;
- CNXIT options: January 1, 2004- December 31, 2008;
- BANKNIFTY options: January 2, 2006- December 31, 2008;
- NIFTYJUNIOR options: June 1, 2007- December 31, 2008;
- CNX100 options: January1, 2008- December 31, 2008.

In the present study, sample period has been taken since the date of commencement of options trading on above five indices till December 31, 2008. Securities Exchange Board of India (SEBI) has permitted for trading in new derivatives instruments after 2008 and has also introduced significant reforms in the Indian derivatives market which have resulted in structural shift in the business growth and trading volume in derivative market from futures contracts to options contracts (please see figure 1). Therefore, the sample period of the study has been restricted to December 31, 2008. The study employs daily closing price of 'near month' options contracts. The daily closing price series of 'mid month' and 'far month' options contracts were also available but due to their low trading activity level, both series observed irregular trading, therefore, present study do not examine the market efficiency of index options (i.e. mid and far) month options contracts. Same sample period is taken for put-call-parity.

RESULTS AND ANALYSIS

The present study examines the fitness of BS model in Indian Index options market. Table 1(A) reports the descriptive statistics of S&P CNX NIFTY (NIFTY) call options contract. MAE (10.96), MSE (594.28), RMSE (24.38) and Theil's

U statistics (0.04) 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 63.65% times and underpriced 36.65% times, which again suggests that significant arbitrage opportunities may be present in the market.

Furthermore, year wise analysis reported in Table 1(A) is similar to that of full sample period except in 2001 and 2002 in which the options contracts are 66.5% times and 54.62% times underpriced respectively. This deviation in result may be because of the newness of the segment. In addition, on the basis of moneyness, series has been decomposed into 'in the money' options (IMO) and 'out of money' options (OMO). The statistical findings of both (IMO) and (OMO) are more or less similar to the aggregate of S&P CNX NIFTY (NIFTY) 'near month' call options contract with the exception of the year 2004, in which 56.39% times of IMO contract are underpriced.

Moreover, descriptive statistics of NIFTY put options contract i.e. MAE (19.97), MSE (3917.65), RMSE (62.59) and Theil's U statistics (0.09) reported in Table 2(A) 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 61.32% time and 38.68% time options are overpriced and underpriced respectively, which again suggest that significant arbitrage opportunities may be present in the market.

In addition, the year wise statistical findings are reported in Table 2(A) where the results are more or less similar to the findings of the full sample period, except the year 2001, in which 60.25% times put options contracts are underpriced. It again may be because of the newness of segment. Furthermore, the series has been decomposed on the basis of Moneyness in IMO and OMO (see Table 2(B)). Statistical findings of both IMO contracts and OMO contracts are more or less similar to the findings of aggregate of NIFTY put options contracts with exception in the year 2001 when 62.71% time and 55.00% time both in IMO and OMO contracts are underpriced, t-statistic in the year 2001 in, in the money option contract and 2002 in, out of money options contracts are insignificant at 1% significant level.

For CNXIT, BANKNIFTY, NIFTYJUNIOR and CNX100 index options contracts similar deviations between estimated and actual option premium have been observed and the estimated errors alongwith their significance levels have been reported in Table 3 (A) through Table 10(B) respectively as reported in the appendix. These observations strongly suggest that option premium for index option contracts does not follow Black-Scholes model. However,

this does 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 BS model. For instance, Black-Scholes model assumes trading asymmetry there by allowing both long buying, as well as short selling to determine arbitrage free prices.

Results of Black Model in Indian Index Options Market

Following the development in the literature on options pricing, the present study also uses Black's model for option pricing in India. As per this model, close price of futures contract have been used to estimate the theoretical options price. Nonetheless, the model inputs have been changed but results are more or less same. For example, consistent with the findings of Black-Scholes model, NIFTY call options contracts are overpriced for 59.38% times and it is also supported by t statistics, which is significant at 1% significance level. In addition MAE (13.40), MSE (712.44), RMSE (26.69) and Theil's U statistics (0.04) reported in Table 11(A) are statistically significant. Furthermore, the series is decomposed on the basis of moneyness in IMO contracts and OMO contracts. Results reported in Table 11(B) are also similar to the descriptive statistics of Black-Scholes model (Table 1(B)).

Moreover, Table 12(A) presents the descriptive statistics of NIFTY put i.e. MAE (14.09), MSE (2859.99), RMSE (53.48) and Theil's U statistics (0.08) which is statistically significant, implying that actual NIFTY put options price is significantly different from the theoretical call options price. This is further evident from the estimated t statistics (13.27, significant at 1% level) of difference between actual and theoretical put options price. Moreover, it has been found that 57.92% time options are overpriced and 42.08% time options are underpriced respectively, which again suggest that significant arbitrage opportunities may be present in the market and these findings are consistent with the results of the Black-Scholes model.

Likewise, aggregate analysis of NIFTY put options contract, year-wise analysis has also been reported in Table 12(A). The statistical results of all the years are similar to that of full sample period further these descriptive statistics are depicting more or less consistent with the descriptive statistics BS model in Table 2(A) except in the year 2005 and 2006 in which 59.33%time and 50.23% time in the options contracts are underpriced respectively. Furthermore, the series is rotten on the basis of Moneyness in Table 12(B), IMO and OMO which depict the similar result as the result depicted by the whole series. Moreover these results are more or less consistent with the descriptive statistics BS

model in Table 2(B) except in the year 2005 and 2006 in which 59.33%time and 50.23% time in the options contracts are underpriced.

Furthermore, similar results have been found for CNXIT, BANKNIFTY, NIFTYJUNIOR and CNX100, which suggest that similar to Black and Scholes Model, the option premium of index options contracts trading in the Indian capital market does not follow Black's model for option pricing. The estimated results for the same have been reported in Table 11(A) through Table 20(B). On the basis of above observations, it can be concluded that option premium in Indian capital market is not consistent with the estimated option price by using Black-Scholes or Black model. Whether this mispricing is exploitable to earn risk-free profit by the traders can be further examined by testing put-call parity in the Indian capital market.

Put-Call-Parity (PCP) Relationship

The put-call-parity theorem states that the payoff from a portfolio consisting of one share of underlying stock and the right to sell that share (at date T for exercise price E) is equivalent to a portfolio consisting of a riskless zero-coupon bond (that pays E at date T) and the right to buy one share of the underlying stock (at date T for exercise price E). Therefore, the expected payoffs at maturity from both portfolios are equal (Knall (2002) and Brunetti and Torricelli (2003))¹. It means that PCP is no arbitrage relationship that must hold between the prices of European call and a European put written on the same underlying and having the same strike and time to expiration (Brunetti & Torricelli (2003)).

Table 21(A) through Table 25(B) reports the findings of put-call parity relationship in Indian index options market for five indices understudy. The findings suggest that the mispricings are significantly exploitable and handsome amount of arbitrage profits can be generated. Both long as well as short strategies are expected to generate huge amount of profits depending upon the size and direction of mispricings. These findings are consistent with the previous findings in the study and reconfirms that the Indian index option contracts are not efficient.

CONCLUSION

The study has examined the fitness of Black-Scholes

¹ For detailed discussion on put-call party please see Klemkosky and Resnick (1979), Brenner and Galai (1979 and 1986), Bhattacharya (1983), Billingsley and Chance (1985), Chance (1988), Frankfurter and Leung (1991), Nisbet (1992), Kamara and Miller (1995), Cavallo and Mammola (2000), Mittnik and Rieken (2000) and Ackert and Tian (2000 and 2001).

model and Black model in the Indian equity index options contracts. The theoretical prices by using these models have been compared with the daily closing prices of index option premium of five index options contracts under study. 't' statistics for both models is found to be significant at 1% significance level, however, this does not indicate that the ineffectiveness of BS model or the Indian index options market is inefficient. Rather the observed differences may be due to discrepancies between the actual market trading structures, which are assumed by the BS model. Findings of the study are consistent with the observations in the existing literature viz., Black and Scholes (1972), Boyle and Ananthanarayanan (1977), Galai (1977), Bhattacharya (1980), Anderson (1995), Katagi (2006) and Mitra (2008).

The study has also tested the efficiency of Indian index option market by checking the most famous no-arbitrage relationship in options market i.e. Put-Call parity. The analysis has been conducted through year wise and range wise and it has been found that in year-wise, NIFTY, BANKNIFTY, short strategy is more profitable than the long strategy, while in NIFTYJUNIOR both strategies are profitable but in case of CNX100 long strategy is more profitable than short strategy. In range wise analysis, only few cases over the whole sample display profit bigger than Rs.500 for five indices under study. The degree of inefficiency detected appears to be the result of overpriced calls and puts.

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APPENDIX

Table 1(A): Measure of Moneyness Biases for NIFTY Call Options with BS Model

Period	Call (Including In the Money, Out of money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full	10.96	594.28	24.38	0.041	63.65	36.35	23.58*
2001	5.09	59.92	7.74	0.051	33.5	66.50	10.13*
2002	4.29	44.23	6.65	0.056	45.38	54.62	-7.72*
2003	4.33	109.16	10.44	0.035	74.18	25.82	9.68*
2004	7.98	195.32	13.98	0.054	53.72	46.28	19.60*
2005	7.41	288.79	16.99	0.048	55.21	44.79	-30.33*
2006	13.67	708.04	26.61	0.0002	69.26	30.74	-15.66*
2007	13.99	1042.90	32.29	0.0344	65.46	34.54	-22.42*
2008	14.84	920.92	30.35	0.060	72.59	27.41	-28.21*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 1 (B): Measure of Moneyness Biases for NIFTY Call Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	10.89	718.81	26.81	0.036	62.62	38.38	4.41*	11.06	390.93	19.77	0.272	70.95	29.05	50.65*
2001	7.04	95.56	9.78	0.046	34.87	65.13	-17.63*	3.31	27.21	5.22	0.318	37.29	62.71	-17.59*
2002	5.54	71.05	8.43	0.045	45.75	54.25	-8.82*	3.09	18.54	4.31	0.266	50.29	49.71	-5.08*
2003	4.60	133.61	11.56	0.034	74.81	25.19	3.02*	5.48	78.19	8.84	0.277	73.86	26.14	21.10*
2004	9.01	256.57	16.02	0.049	43.61	56.39	-16.98*	6.38	99.31	9.97	0.281	73.17	26.83	11.88*
2005	8.25	396.23	19.91	0.046	56.08	43.92	-19.05*	5.71	70.37	8.39	0.221	55.47	44.53	-5.08*
2006	11.07	608.93	24.68	0.034	66.00	34.00	8.29*	19.07	914.33	30.24	0.386	80.79	19.21	40.46*
2007	13.43	1323.59	36.38	0.032	65.50	34.50	7.24*	15.25	420.36	20.50	0.194	65.87	34.13	26.515*
2008	25.25	2058.41	45.37	0.051	67.67	32.33	12.30*	10.20	414.20	20.35	0.242	82.06	17.94	22.10*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 2(A): Measure of Moneyness Biases for NIFTY Put Options with BS Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Time Put Overpriced (%)	No. of Time Put Underpriced (%)	t-test Result
Full	19.97	3917.65	62.59	0.09	61.32	38.68	3.96*
2001	3.43	43.52	6.60	0.04	39.75	60.25	-5.27*
2002	4.74	54.98	7.41	0.07	62.31	37.69	-30.85*
2003	3.56	39.10	6.25	0.10	73.07	26.93	-18.89*
2004	10.12	384.95	19.62	0.09	58.34	41.66	-17.17*
2005	20.94	3485.28	59.04	0.38	62.59	37.41	-45.99*
2006	15.96	955.16	30.91	0.07	61.80	38.20	-37.51*
2007	18.21	1186.44	34.44	0.11	60.06	39.94	-1.88*
2008	60.84	24160.03	155.43	0.09	63.09	36.91	-30.74*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 2 (B): Measure of Moneyness Biases for NIFTY Put Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	34.36	8703.55	93.29	0.088	61.03	38.97	8.96*	11.11	976.66	31.25	0.491	61.49	38.51	-58.87*
2001	4.73	71.19	8.44	0.043	37.29	62.71	-1.85***	2.02	13.37	3.66	0.236	45.00	55.00	5.96*
2002	7.34	97.88	9.89	0.071	51.99	48.01	4.69*	2.08	11.27	3.36	0.245	53.16	46.84	-1.79***
2003	7.71	112.19	10.59	0.089	62.98	37.02	11.48*	2.20	15.23	3.90	0.308	76.36	23.64	-42.14*
2004	16.45	799.63	28.28	0.082	71.16	28.84	17.40*	6.03	117.66	10.85	0.338	50.08	49.92	-8.09*
2005	21.45	2136.45	46.22	0.194	54.44	45.56	-10.09*	20.69	4154.81	64.46	0.822	66.64	33.36	-25.08*
2006	29.47	2114.46	45.98	0.057	71.30	28.70	33.43*	9.41	393.59	19.84	0.392	57.20	42.80	-34.64*
2007	32.92	2719.20	52.14	0.096	63.01	36.99	16.60*	11.72	509.83	22.58	0.320	58.76	41.24	-44.57*
2008	75.42	33680.7	183.52	0.091	52.70	47.30	-2.64*	27.10	2145.68	46.32	0.370	87.10	12.90	-32.29*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 3 (A): Measure of Moneyness Biases for CNXIT Call Options with BS Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full	76.08	26691.11	163.37	0.13	61.64	38.36	101.75*
2004	220.37	82021.26	286.39	0.11	14.29	85.71	69.43*
2005	146.09	67309.98	259.44	0.41	63.25	36.75	-58.94*
2006	17.36	915.57	30.26	0.04	71.32	28.68	-67.13*
2007	18.01	730.72	27.03	0.057	69.81	30.19	-65.14*
2008	22.76	1388.21	37.26	0.06	89.89	10.11	82.94*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 3 (B): Measure of Moneyness Biases for CNXIT Call Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	60.14	79.68	29190.09	0.170	60.43	39.57	103.71*	70.33	56416.19	237.52	0.356	63.56	36.44	35.93*
2004	246.78	92953.49	304.88	0.101	12.97	87.03	103.71*	158.51	109030.1	330.20	0.837	17.36	82.64	37.76*
2005	106.45	50591.31	224.92	0.326	74.11	25.89	45.77*	245.01	1830.03	42.78	0.334	36.14	63.86	60.57*
2006	12.62	591.04	24.31	0.025	68.89	31.11	-59.98*	30.71	861.52	29.35	0.217	78.18	21.82	-53.14*
2007	15.33	569.91	23.87	0.034	67.71	32.29	-37.16*	20.19	1114.68	33.39	0.336	71.52	28.48	-56.76*
2008	27.62	1898.31	43.57	0.043	98.02	01.98	-39.46*	20.16	1114.68	33.39	0.336	85.53	14.47	-52.83*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 4 (A): Measure of Moneyness Biases for CNXIT Put Options with BS Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full	75.69	26828.27	163.79	0.17	49.85	50.15	-102.29*
2004	221.45	82545.18	287.31	0.15	11.06	88.94	-69.57*
2005	146.02	67435.18	259.68	0.63	53.83	46.17	57.06*
2006	17.20	884.64	29.74	0.07	54.79	45.21	51.79*
2007	16.85	607.78	24.65	0.04	58.40	41.60	28.29*
2008	23.71	3226.68	56.80	0.05	72.33	27.67	85.39*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 4 (B): Measure of Moneyness Biases for CNXIT Put Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	70.14	23156.13	152.17	0.100	56.29	43.71	38.12*	79.17	29127.32	170.67	0.612	45.82	54.18	78.31*
2004	159.61	56776.74	238.28	0.072	16.24	83.76	33.84*	247.57	93426.16	305.66	0.585	8.87	91.13	104.27*
2005	245.13	109256.9	330.54	0.525	35.94	64.06	60.62*	106.31	50677.79	225.12	0.856	61.00	39.00	45.81*
2006	31.05	1871.05	43.26	0.053	76.21	23.79	-52.75*	12.26	532.19	23.07	0.317	47.13	52.87	-32.65*
2007	18.61	705.57	26.56	0.036	63.83	36.17	-54.50*	14.68	487.40	22.08	0.191	51.72	48.28	-26.46*
2008	22.69	4195.64	64.77	0.042	63.11	36.89	-15.40*	25.60	1418.4	37.66	0.335	89.54	10.46	-47.15*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 5 (A): Measure of Moneyness Biases for BANKNIFTY Call Options with BS Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full	25.14	2144.31	46.31	0.03	89.82	10.18	89.12*
2006	14.59	753.16	27.44	0.05	87.34	12.66	166.99*
2007	22.48	1380.52	37.15	0.02	91.07	8.93	84.48*
2008	49.69	6190.07	78.68	0.07	91.90	8.10	51.61*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 5(B): Measure of Moneyness Biases for BANKNIFTY Call Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	19.56	1754.49	41.89	0.02	78.66	21.34	230.42*	33.49	2727.52	52.23	0.27	77.19	22.81	215.86*
2006	10.47	520.16	22.81	0.02	48.41	51.59	16.14*	22.17	1181.61	34.37	0.29	32.22	67.78	9.86*
2007	17.31	1074.24	32.78	0.01	100	0.00	916.94*	33.78	2050.07	45.28	0.21	100.00	0.00	522.53*
2008	60.08	8736.07	93.47	0.05	100	0.00	247.98*	44.32	4873.73	69.81	0.32	100.00	0.00	407.48*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 6 (A): Measure of Moneyness Biases for BANKNIFTY Put Options with BS Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full	23.39	2446.89	49.47	0.04	72.43	27.57	-88.59*
2006	13.76	639.23	25.28	0.04	66.95	33.05	-99.91*
2007	19.87	1203.17	34.69	0.06	74.79	25.21	-61.52*
2008	48.01	8211.87	90.62	0.034	81.60	18.40	-119.40*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 6 (B): Measure of Moneyness Biases for BANKNIFTY Put Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	32.26	4159.00	64.49	0.03	80.12	19.98	-79.93*	17.48	1305.38	36.13	0.26	67.29	32.71	-96.52*
2006	21.42	1127.48	33.58	0.03	78.46	21.54	-72.32*	9.62	375.30	19.37	0.23	60.72	39.28	-57.23*
2007	29.80	1711.16	41.37	0.04	87.99	12.01	-85.44*	15.33	970.80	31.16	0.23	66.01	33.99	-64.71*
2008	45.19	9413.69	97.02	0.03	84.36	15.64	-38.82*	53.47	5887.36	76.73	0.30	95.49	04.51	-64.64*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 7 (A): Measure of Moneyness Biases for NIFTYJUNIOR Call Options with BS Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full	42.34	5930.85	77.01	0.05	87.95	12.05	86.12*
2007	33.91	3071.86	55.42	0.03	87.27	12.73	81.11*
2008	50.13	8574.81	92.60	0.08	88.58	11.42	111.78*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 7 (B): Measure of Moneyness Biases for NIFTYJUNIOR Call Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	37.89	4974.57	70.53	0.03	90.98	09.02	-76.52*	47.16	6967.63	83.47	0.35	84.67	15.23	-81.95*
2007	27.55	2415.67	49.15	0.02	88.19	11.81	-67.62*	54.64	5207.92	72.17	0.27	84.28	15.72	-57.49*
2008	62.80	11136.27	105.53	0.05	97.68	02.32	-48.28*	44.86	7509.17	86.66	0.38	84.79	15.21	-65.57*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 8 (A): Measure of Moneyness Biases for NIFTYJUNIOR Put Options with BS Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full	41.81	7919.00	88.99	0.04	71.45	28.55	-78.69*
2007	32.40	2916.64	54.01	0.10	71.45	28.55	-51.94*
2008	50.57	12569.60	112.11	0.035	71.45	28.55	78.25*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 8 (B): Measure of Moneyness Biases for NIFTYJUNIOR Put Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	48.88	11648.51	107.92	0.03	66.78	33.22	-46.80*	35.32	4488.79	66.99	0.34	75.74	24.26	-74.13*
2007	53.15	4973.85	70.52	0.07	80.89	19.11	-53.90*	26.03	2284.67	47.79	0.33	68.54	31.46	-60.74*
2008	47.56	13713.98	117.10	0.03	62.41	37.59	-34.32*	57.80	9821.16	99.10	0.35	93.15	06.85	-49.89*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 9 (A): Measure of Moneyness Biases for CNX100 Call Options with BS Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full/2008	35.23	5116.66	71.53	0.14	78.20	21.80	-12.82*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 9 (B): Measure of Moneyness Biases for CNX100 Call Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full/2008	61.60	12308.18	110.94	0.12	79.47	20.53	4.29*	22.21	1564.62	39.56	0.36	77.59	22.41	-42.03*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 10 (A): Measure of Moneyness Biases for CNX100 Put Options with BS Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full/2008	24.40	3607.05	4.71	0.003	70.81	29.19	-28.93*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 10 (B): Measure of Moneyness Biases for CNX100 Put Options with BS Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full/ 2008	70.15	23156.13	152.17	0.10	79.63	20.37	16.73*	79.17	29127.32	170.67	0.61	99.99	0.01	39.07*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 11 (A): Measure of Moneyness Biases for NIFTY Call Options with Black Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full	13.40	712.44	26.69	0.04	59.38	40.62	11.764*
2001	4.46	46.69	6.83	0.05	36.14	63.86	6.419*
2002	4.35	44.39	6.66	0.06	40.63	59.37	-3.795*
2003	4.89	109.95	10.49	0.03	55.89	44.11	2.189*
2004	8.71	219.96	14.83	0.06	52.61	47.39	-3.205*
2005	8.41	288.80	16.99	0.049	57.68	42.32	45.419*
2006	18.40	960.37	30.99	0.05	63.63	36.37	26.738*
2007	18.07	1232.85	35.12	0.04	61.15	38.85	19.873*
2008	15.49	996.02	31.56	0.06	69.47	30.53	50.302*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 11(B): Measure of Moneyness Biases for NIFTY Call Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	14.25	853.21	29.21	0.04	51.75	48.25	-23.46*	12.04	489.94	22.13	0.29	71.40	28.60	-60.62*
2001	6.07	72.45	8.51	0.04	34.08	65.92	5.09*	3.03	23.90	4.89	0.30	37.92	62.08	15.15*
2002	5.65	71.15	8.43	0.05	37.50	62.50	4.78*	3.11	18.69	4.32	0.26	45.10	54.90	4.71*
2003	5.43	136.31	11.67	0.03	50.62	49.38	0.42	3.11	24.26	4.92	0.24	73.06	26.94	-20.96*
2004	10.01	291.98	17.09	0.05	37.73	62.27	11.27*	6.76	111.99	10.58	0.29	74.96	25.04	-17.98*
2005	9.96	405.63	20.14	0.05	55.46	44.54	-1.63***	5.46	66.89	8.18	0.21	61.89	38.11	-5.82*
2006	16.79	841.49	29.01	0.04	54.49	45.51	-24.11*	21.59	1196.85	34.59	0.42	81.81	18.19	-44.59*
2007	18.59	1551.81	39.39	0.03	56.66	43.34	-14.95*	16.95	559.51	23.65	0.22	70.65	29.35	-36.69*
2008	26.46	2207.30	46.98	0.05	53.97	46.03	-8.74*	10.62	457.80	21.39	0.25	76.33	23.67	-22.67*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 12 (A): Measure of Moneyness Biases for NIFTY Put Options with Black Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full	14.09	2859.99	53.48	0.08	57.92	42.08	13.27*
2001	3.94	46.06	6.79	0.05	34.78	65.22	-5.05*
2002	2.99	22.72	4.77	0.048	51.47	48.53	-47.95*
2003	3.08	29.01	5.39	0.09	79.16	20.84	-1.72***
2004	7.64	183.77	13.56	0.06	51.01	48.99	-13.45*
2005	20.03	3483.55	59.02	0.37	54.89	45.11	-26.04*
2006	12.50	517.94	22.76	0.05	53.49	46.51	-30.22*
2007	12.30	475.09	21.80	0.07	55.50	44.50	-4.71*
2008	34.42	17780.93	133.34	0.08	73.64	26.36	-21.87*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 12 (B): Measure of Moneyness Biases for NIFTY Put Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	20.99	6051.31	77.79	0.07	54.62	45.38	10.26*	9.71	835.54	28.91	0.47	60.01	39.99	10.71*
2001	5.70	75.82	8.71	0.044	35.26	64.74	-7.07*	1.94	12.39	3.52	0.23	34.25	65.75	3.29*
2002	4.16	37.15	6.09	0.04	55.79	44.21	-23.83*	1.79	7.69	2.77	0.21	46.97	53.03	-46.96*
2003	5.54	68.61	8.28	0.07	81.43	18.57	-0.62	2.33	16.87	4.11	0.31	78.48	21.52	-2.64*
2004	11.49	366.42	19.14	0.05	52.78	47.22	16.17*	5.08	62.04	7.87	0.26	49.86	50.14	-23.85*
2005	19.35	2074.04	45.54	0.19	40.67	59.33	-9.92*	20.39	4225.81	65.01	0.82	62.37	37.63	-31.88*
2006	21.56	1044.78	32.32	0.04	49.77	50.23	-7.52*	7.94	253.16	15.91	0.33	55.37	44.63	-38.76*
2007	18.71	843.51	29.04	0.05	52.36	47.64	0.10	9.25	299.39	17.30	0.26	57.02	42.98	-41.15*
2008	39.28	25047.4	158.26	0.08	66.29	33.71	-0.36	23.36	1281.02	35.79	0.30	90.31	9.69	-52.24*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 13 (A): Measure of Moneyness Biases for CNXIT Call Options with Black Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full	84.79	29208.09	170.90	0.14	52.44	47.56	103.56*
2004	251.86	95445.76	308.94	0.18	11.13	88.87	68.74*
2005	148.97	67379.48	259.58	0.41	44.37	55.63	-51.62*
2006	22.36	1172.61	34.24	0.04	60.77	39.23	-58.39*
2007	21.86	969.88	31.14	0.07	64.27	35.73	-61.13*
2008	25.13	1570.29	39.67	0.07	82.23	17.77	83.69*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 13 (B): Measure of Moneyness Biases for CNXIT Call Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	92.10	32849.6	181.24	0.12	45.66	54.34	79.09*	73.08	23387.74	152.93	0.48	63.28	36.72	33.73*
2004	286.02	109624.63	331.09	0.11	7.97	92.03	109.87*	171.60	62129.57	249.26	0.38	19.56	81.44	30.77*
2005	111.26	51342.84	226.59	0.33	47.91	52.09	45.10*	242.54	107170.9	327.37	0.83	35.61	64.39	60.06*
2006	18.71	847.96	29.12	0.03	54.53	45.46	-27.45*	32.69	2092.607	45.74	0.36	78.23	21.77	-52.16*
2007	21.25	879.67	29.66	0.04	55.66	44.34	-26.86*	22.36	1042.72	32.29	0.24	71.23	28.77	-55.18*
2008	33.31	2262.50	47.56	0.05	78.97	21.03	-35.74*	20.76	1199.53	34.63	0.34	83.53	16.02	-51.30*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 14 (A): Measure of Moneyness Biases for CNXIT Put Options with Black Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full	75.69	26573.26	163.01	0.17	50.52	49.48	-102.78*
2004	219.44	81183.06	284.93	0.15	15.33	84.67	-69.73*
2005	146.47	67514.84	259.83	0.63	49.66	50.34	47.21*
2006	17.09	818.89	28.62	0.07	51.94	48.06	48.04*
2007	16.43	518.62	22.77	0.04	60.64	39.36	27.37*
2008	27.31	3303.97	57.48	0.05	81.26	18.74	-87.43*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 14 (B): Measure of Moneyness Biases for CNXIT Put Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	72.10	23030.11	151.75	0.10	58.08	41.92	41.14*	77.93	28788.85	169.67	0.60	45.80	54.20	78.56*
2004	164.39	56630.59	237.97	0.07	31.64	68.36	34.29*	242.59	91512.69	302.51	0.57	8.47	91.53	104.49*
2005	244.70	108498.8	329.39	0.52	30.24	69.76	60.71*	106.83	50982.12	225.79	0.86	57.49	42.51	45.89*
2006	31.83	1755.029	41.89	0.05	61.54	38.46	-33.95*	11.84	485.42	22.03	0.30	48.52	51.48	-34.02*
2007	18.90	604.9222	24.59	0.03	67.35	32.65	-40.33*	13.37	411.76	20.29	0.18	52.34	47.66	-26.67*
2008	28.40	4340.39	65.88	0.04	75.35	24.65	-14.11*	25.26	1367.55	36.98	0.33	92.30	7.70	-47.91*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 15 (A): Measure of Moneyness Biases for BANKNIFTY Call Options with Black Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full	28.96	2252.12	47.46	0.03	66.72	32.28	105.87*
2006	19.66	987.49	31.42	0.03	62.03	37.97	60.19*
2007	26.30	1419.85	37.68	0.02	62.65	37.35	55.07*
2008	51.19	6199.89	78.74	0.07	83.30	16.70	75.95*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 15 (B): Measure of Moneyness Biases for BANKNIFTY Call Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	25.97	1919.97	43.82	0.03	52.15	47.85	-40.57*	33.50	2756.94	52.51	0.28	88.88	11.12	-126.28*
2006	17.52	747.92	27.35	0.02	50.13	49.87	-23.69*	23.64	1432.91	37.85	0.32	84.15	15.85	-69.88*
2007	23.82	1228.99	35.06	0.02	48.56	51.44	-14.27*	31.90	1849.87	43.01	0.20	94.42	5.58	-93.38*
2008	63.96	8749.64	93.54	0.05	73.43	26.56	-34.53*	44.56	4876.05	69.83	0.32	88.42	11.58	-74.85*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 16 (A): Measure of Moneyness Biases for BANKNIFTY Put Options with Black Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full	25.75	2630.15	51.28	0.04	68.84	31.16	106.11*
2006	14.91	612.00	24.739	0.03	61.06	38.94	60.09*
2007	22.35	1471.97	38.37	0.07	72.30	27.70	101.33*
2008	52.35	8615.50	92.82	0.04	76.39	23.61	63.31*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 16 (B): Measure of Moneyness Biases for BANKNIFTY Put Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	37.28	4516.23	67.20	0.03	69.43	30.57	-60.84*	18.18	1392.64	37.32	0.27	68.45	31.55	-101.37*
2006	25.16	1118.50	33.44	0.028	60.29	39.71	-29.05*	9.43	341.31	18.47	0.22	61.47	38.53	-62.92*
2007	35.10	2238.80	47.32	0.05	82.54	17.46	-79.42*	16.69	1131.64	33.64	0.24	67.75	32.25	-69.72*
2008	51.07	9910.41	99.55	0.03	66.36	33.64	-30.39*	54.81	6121.46	78.24	0.31	95.72	4.28	-65.52*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 17 (A): Measure of Moneyness Biases for NIFTYJUNIOR Call Options with Black Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full	59.86	11462.17	107.06	0.06	73.40	26.60	42.52*
2007	59.70	11569.89	107.56	0.05	69.28	30.72	39.56*
2008	59.99	11362.55	106.60	0.09	77.20	22.80	25.84*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 17 (B): Measure of Moneyness Biases for NIFTYJUNIOR Call Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	53.98	7481.28	86.49	0.04	63.50	36.50	-42.52*	65.55	15378.24	124.01	0.49	96.70	3.30	77.54*
2007	38.82	3092.08	55.60	0.02	62.41	37.59	-39.56*	112.84	33146.21	182.06	0.58	96.14	3.86	-51.24*
2008	88.39	17438.86	132.05	0.06	65.96	34.04	-25.83*	48.05	8804.28	93.83	0.40	96.91	3.09	-63.19*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 18 (A): Measure of Moneyness Biases for NIFTYJUNIOR Put Options with Black Model

Period	Put (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full	188.47	517204.8	719.17	0.28	69.85	30.15	23.95*
2007	302.32	1050793	1025.08	0.76	68.60	31.40	30.13*
2008	82.63	21138.88	145.39	0.04	71.01	28.99	37.43*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 18 (B): Measure of Moneyness Biases for NIFTYJUNIOR Put Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full	338.85	1027760	1013.78	0.28	61.53	38.47	29.07*	37.40	4946.01	70.32	0.36	78.20	21.80	-75.83*
2007	1002.7	3720060	1928.74	0.77	59.34	40.66	35.94*	27.26	2521.20	50.21	0.34	72.24	27.76	-63.50*
2008	91.72	25535.52	159.79	0.04	62.34	37.66	-22.37*	60.49	10467.4	102.31	0.37	91.77	8.23	-49.98*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 19 (A): Measure of Moneyness Biases for CNX100 Call Options with Black Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Call Overpriced (%)	No. of Times Call Underpriced (%)	t-test Result
Full/2008	152.19	98376.59	313.65	0.44	47.03	52.97	34.40*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 19 (B): Measure of Moneyness Biases for CNX100 Call Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full/2008	304.98	214646.7	463.30	0.44	73.14	26.86	-41.42*	25.26	25.26	46.14	0.41	63.54	36.46	-16.60*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 20 (A): Measure of Moneyness Biases for CNX100 Put Options with Black Model

Period	Call (Including In the Money, Out of Money)						
	MAE	MSE	RMSE	Theil's U Statistic	No. of Times Put Overpriced (%)	No. of Times Put Underpriced (%)	t-test Result
Full/2008	169.85	86640.88	294.35	0.22	74.85	25.15	44.06*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 20 (B): Measure of Moneyness Biases for CNX100 Put Options with Black Model

Period	In the Money							Out of the Money						
	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result	MAE	MSE	RMSE	Theil's U Statistics	Overpriced (%)	Underpriced (%)	t-test Result
Full/2008	177.53	81423.34	285.34	0.17	63.99	36.01	26.23*	161.61	93792.21	306.25	0.82	88.14	11.86	37.06*

* significant at 1% significance level, ** significant at 5% significance level and *** significant at 10% significance level

MAE = Mean absolute error; MSE = Mean squared error and RMSE = Root mean squared error

Table 21 (A): Descriptive Statistics for Long and Short Strategies Profit for NIFTY Year-wise

Year	Long						Short					
	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count
2001	33.86	0.00	218.97	48.35	2.13	523	21.89	0.00	212.48	37.73	2.23	1107
2002	26.43	0.00	159.12	31.20	6.38	1569	20.76	0.00	155.84	32.04	3.83	1906
2003	14.70	0.00	141.02	19.35	8.78	2160	89.37	0.00	415.71	105.93	8.34	4147
2004	59.34	0.00	450.62	88.69	12.93	3182	57.81	0.02	448.01	78.74	11.06	5497
2005	55.40	0.01	369.26	67.26	9.90	2436	88.31	0.00	506.32	106.34	15.14	7527
2006	263.13	0.00	1148.12	271.07	21.67	5330	207.93	0.00	765.71	178.06	27.85	13846
2007	151.76	0.01	1152.96	154.74	19.27	4740	246.63	0.00	1545.33	284.13	23.00	11430
2008	401.13	0.06	2970.38	624.99	18.94	4659	86.73	0.00	2165.07	108.94	8.55	4250
Total	179.08	0.00	2970.37	338.81	100	24600	148.43	0.00	2165.07	193.78	100	49710

Table 21 (B): Descriptive Statistics for Long and Short Strategies Profit for NIFTY Range-wise

Range	Long						Short					
	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count
(0,500)	89.53	0.00	498.97	118.37	89.59	22040	117.67	0.00	499.89	130.22	95.07	47261
(500,1000)	673.64	500.19	999.70	128.26	7.5	1845	645.09	500.04	999.57	137.20	4.08	2027
(1000,1500)	1200.03	1000.49	1498.31	141.68	1.67	410	1192.63	1000.00	1456.45	123.40	0.81	404
(1500,2000)	1691.18	1503.88	1999.52	128.86	0.40	98	1515.36	1500.83	1545.32	16.38	0.03	17
(2000,2500)	2222.37	2001.55	2495.88	138.42	0.24	60	2165.07	2165.07	2165.07	2165.07	0.00	1
(2500,3000)	2709.21	2504.35	2970.38	138.29	0.60	147	NA	NA	NA	NA	NA	NA
Total	179.08	0.00	2970.38	338.81	100	24600	148.44	0.000	2165.07	193.79	100	49710

NA=Not Applicable

Table 22 (A): Descriptive Statistics for Long and Short Strategies Profit for CNXIT Year-wise

Year	Long						Short					
	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count
2004	1043.41	0.02	4943.24	1127.23	14.04	3991	835.79	0.17	6383.93	1224.64	19.61	7741
2005	122.61	0.08	481.81	106.38	13.19	3752	205.97	0.04	778.57	152.25	20.98	8285
2006	289.56	0.14	1392.61	286.67	20.11	5718	355.52	0.19	1192.78	253.22	37.33	14738
2007	329.66	0.00	1049.55	215.81	33.29	9468	219.88	0.02	767.79	165.27	16.88	6662
2008	645.05	0.49	1940.36	430.02	19.37	5510	321.76	0.01	1147.4	246.63	5.20	2051
Total	455.55	0.00	4943.24	573.17	100	28439	393.67	0.01	6383.93	618.27	100	39477

Table 22 (B): Descriptive Statistics for Long and Short Strategies Profit for CNXIT Range-wise

Long							Short					
Range	Mean	Mini- mum	Maxi- mum	Standard Deviation	%	Total Count	Mean	Mini- mum	Maxi- mum	Standard Deviation	%	Total Count
(0,500)	194.73	0.00	499.90	144.27	70.07	19927	207.68	0.01	499.984	132.59	80.36	31723
(500,1000)	693.48	500.13	999.87	134.61	134.61	5537	671.24	500.04	999.67	129.87	14.03	5540
(1000,1500)	1200.59	1000.06	1497.79	143.57	5.69	1619	1199.03	1000.02	1499.31	139.42	2.20	868
(1500,2000)	1709.98	1500.41	1996.50	150.08	2.06	587	1723.20	1500.18	1997.64	153.83	0.85	332
(2000,2500)	2206.34	2000.10	2499.73	138.72	0.89	252	2238.13	2001.32	2494.82	137.82	0.77	303
(2500,3000)	2746.39	2500.27	2979.12	137.01	0.68	193	2711.22	2501.40	2955.53	134.94	0.25	98
(3000,3500)	3244.00	3026.72	3481.86	116.05	0.40	115	3261.72	3022.28	3492.07	151.63	0.27	108
(3500,4000)	3706.09	3505.53	3956.48	146.87	0.43	123	3753.67	3573.66	3941.13	112.00	0.38	150
(4000,4500)	4333.373	4032.85	4943.24	230.49	0.30	86	4248.86	4024.17	4493.75	141.65	0.32	125
(4500,5000)	NA	NA	NA	NA	NA	NA	4704.90	4535.46	4999.14	173.83	0.16	64
(5000,5500)	NA	NA	NA	NA	NA	NA	5292.95	5000.29	5499.94	139.74	0.24	95
(5500,6000)	NA	NA	NA	NA	NA	NA	5696.66	5500.85	5954.89	193.04	0.05	21
(6000,6500)	NA	NA	NA	NA	NA	NA	6205.31	6063.91	6383.93	128.58	0.12	49
Total	455.55	0.00	4943.24	573.17	100	28439	393.67	0.01	6383.93	618.26	100	39477

NA=Not Applicable

Table 23 (A): Descriptive Statistics for Long and Short Strategies Profit for BANKNIFTY Year-wise

Long							Short					
Year	Mean	Mini- mum	Maxi- mum	Standard Deviation	%	Total Count	Mean	Mini- mum	Maxi- mum	Standard Deviation	%	Total Count
2006	447.94	0.04	1578.78	399.65	34.31	10211	518.56	0.19	1852.15	390.22	41.34	16359
2007	390.44	0.00	1416.50	315.26	31.75	9449	722.70	0.03	2929.95	581.94	47.71	18883
2008	1237.51	0.13	4409.73	864.92	33.94	10101	611.57	0.08	2126.75	464.77	10.95	4333
Total	697.67	0.00	4409.73	700.37	100	29761	626.15	0.03	2929.95	507.37	100	39575

Table 23 (B): Descriptive Statistics for Long and Short Strategies Profit for BANKNIFTY Range-wise

Long							Short					
Range	Mean	Mini- mum	Maxi- mum	Standard Deviation	%	Total Count	Mean	Mini- mum	Maxi- mum	Standard Deviation	%	Total Count
(0,500)	205.827	0.006517	499.969	140.6933	51.86	15434	229.9232	0.027632	499.9528	142.5369	49.29	19508
(500,1000)	732.46	500.03	999.92	142.28	23.14	6886	719.01	500.01	999.85	142.93	29.23	11569
(1000,1500)	1209.40	1000.05	1499.72	650.47	13.15	3913	1214.17	1000	1499.64	138.41	15.35	6073
(1500,2000)	1715.78	1500.08	1999.42	141.65	5.11	1521	1713.01	1500.28	1999.59	132.78	4.20	1663
(2000,2500)	2219.83	2000.65	2499.56	145.91	3.45	1027	2199.46	2000.49	2499.04	132.70	1.54	607
(2500,3000)	2691.04	2500.48	2999.45	129.98	2.10	624	2695.10	2520.52	2929.95	129.55	0.39	156
(3000,3500)	3234.34	3000.21	3499.73	155.70	0.68	204	NA	NA	NA	NA	NA	NA
(3500,4000)	3705.99	3500.74	3986.57	173.83	0.38	114	NA	NA	NA	NA	NA	NA
(4000,4500)	4197.34	4003.06	4409.73	128.11	0.13	38	NA	NA	NA	NA	NA	NA
Total	697.67	0.01	4409.73	700.37	100	29761	626.15	0.028	2929.95	507.372	100	39575

NA=Not Applicable

Table 24 (A): Descriptive Statistics for Long and Short Strategies Profit for NIFTYJUNIOR Year-wise

Year	Long						Short					
	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count
2007	362.66	0.04	1352.54	312.24	23.64	3863	875.14	0.00	3065.43	660.77	73.69	11592
2008	1580.56	0.02	5973.17	1113.85	76.36	12481	748.39	0.74	2977.82	654.54	26.31	4137
Total	1292.79	0.02	5973.17	1112.73	100	16344	841.80	0.00	3065.43	661.48	100	15729

Table 24 (B): Descriptive Statistics for Long and Short Strategies Profit for NIFTYJUNIOR Range-wise

Range	Long						Short					
	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count
(0,500)	228.92	0.02	499.93	143.25	31.77	5192	245.12	0.00	499.99	141.83	38.49	6054
(500,1000)	736.71	500.14	999.85	147.51	18.74	3063	732.5	500.23	999.56	143.44	28.83	4534
(1000,1500)	1243.16	1000.65	1499.58	144.50	13.60	2223	1204.39	1000.14	1449.73	127.56	13.82	2174
(1500,2000)	1755.03	1500.02	1999.80	151.033	10.30	1684	1708.53	1450.08	1999.22	156.25	11.38	1790
(2000,2500)	2245.45	2000.18	2499.54	145.41	10.32	1687	2207.32	2000.14	2499.41	145.50	5.51	865
(2500,3000)	2737.34	2500.39	2999.88	137.80	7.59	1241	2707.47	2500.42	2999.67	150.49	1.84	290
(3000,3500)	3212.32	3000.38	3499.33	135.84	3.47	564	3024.15	3000.67	3065.43	26.15	0.13	21
(3500,4000)	3673.67	3500.20	3987.24	129.71	1.56	255	NA	NA	NA	NA	NA	NA
(4000,4500)	4219.01	4005.23	4498.98	137.62	1.19	195	NA	NA	NA	NA	NA	NA
(4500,5000)	4773.14	4503.37	4999.84	152.70	0.83	136	NA	NA	NA	NA	NA	NA
(5000,5500)	5212.73	5000.87	5450.54	115.51	0.42	69	NA	NA	NA	NA	NA	NA
(5500,6000)	5716.69	5553.06	5973.17	113.92	0.21	35	NA	NA	NA	NA	NA	NA
Total	1292.79	0.02	5973.17	1112.73	50.96	16344	841.80	0.00	3065.43	661.48	100	15729

NA=Not Applicable

Table 25 (A): Descriptive Statistics for Long and Short Strategies Profit for CNX100 Year-wise

Year	Long						Short					
	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count
2008/Total	700.21	0.06	2134.41	466.14	100	6146	265.30	0.26	848.23	190.53	100	1931

Table 25 (B): Descriptive Statistics for Long and Short Strategies Profit for CNX100 Range-wise

Range	Long						Short					
	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count	Mean	Mini-mum	Maxi-mum	Standard Deviation	%	Total Count
(0,500)	266.06	0.06	497.67	141.92	40.80	2508	208.28	0.26	499.22	138.03	85.55	1652
(500,1000)	718.63	500.92	999.58	147.00	32.47	1996	602.93	502.04	848.23	71.87	14.45	279
(1000,1500)	1232.43	1000.39	1498.94	141.15	20.43	1255	NA	NA	NA	NA	NA	NA
(1500,2000)	1685.50	1500.15	1998.84	120.55	6.16	379	NA	NA	NA	NA	NA	NA
(2000,2500)	2037.92	2000.96	2134.41	44.76	0.14	8	NA	NA	NA	NA	NA	NA
Total	700.21	0.06	2134.41	466.14	100	6146	265.30	0.26	848.23	190.53	23.90	1931

NA=Not Applicable

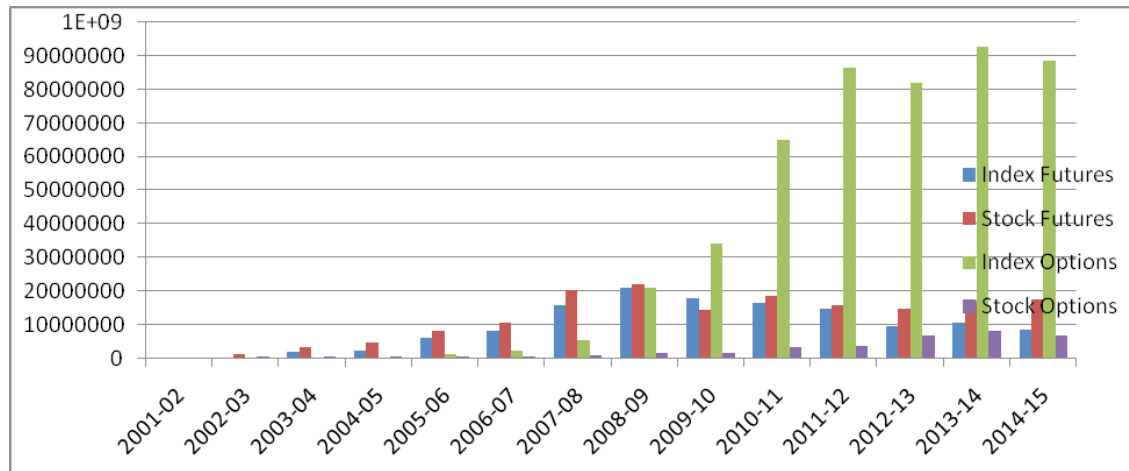


Fig. 1: Business Growth of Equity Derivatives in India