Does B-S-M Model Act as a Canopy to the Investors in Options Market?

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Abstract

Options contract are non-linear pay off which provides maximum profit with less risk. There is a bench mark model called Black-Scholes-Merton (B-S-M) model proposed by Fischer Black, Myron Scholes and Robert Merton in 1973, which made brake through development in pricing the European call and put options. An index is a portfolio of out-performing stocks and hence interest in index investments has led to increased trading in index option thereby to hedge the market risk. This study attempts to price the Index Options of National Stock Exchange of India using B-S-M options pricing model and to estimate options strategy by comparing actual and fair options price on four option index namely, S&P CNX Nifty options, Nifty MIDCAP 50 options, Bank Nifty options and CNX IT options. Near month At-the-money contracts were chosen for the period of six years from 1st January, 2009 to 31st December 2014 for all the four indices. The finding of the study reveals that in most of the contracts the calculated options price differs from the market value of the options contract. Though many studies suggest that B-S-M model is best for estimating European options price, it provides arbitrage opportunity for the market participants in Indian market.

Key Words: Index Options, Black-Scholes-Merton model, Risk Mitigation, At-the-money contract, European options.

JEL Code: G32, G11, O16, D53, C12

Introduction

In the dynamic world the investors have seen many inventions and innovations in the real and financial world. The capital market is a place where the smart people and smartest people make money through their investment. Anyhow the capital market has high degree of volatility because of its unbiased nature. The capital market involves different types of market participants like speculators, hedgers and arbitragers who make profit through various capital market instruments. Nowadays the passive or potential investors are also willing to make money with certain risk, after the invention of mutual fund. Even the institutional investors and mutual fund managers' use derivative to hedge their risk and to meet their uncertainty in near future. Derivative is a financial instrument which helps the futuristic

investor to mitigate their present and future risk. Derivative is a contract which derives its value from an underling asset like shares, bond, commodity, etc., to fix a price for a future date. There are four major instruments traded in derivative market such as Future, Options, Forward, and SWAPS. Among them future and options are exchange traded and other two forward and swaps are Over the Counter traded (OTC). In India, National Stock Exchange (NSE) introduced index futures followed by index options and others like stock futures, stock options. Among these future and options, index futures and stock futures are said to be secured instrument, where the investor can hedge their investment with a margin amount. Even though futures is secured, the instrument suffers from a drawback i.e. compulsorily execution of the contract. Due to this reason most of the investors prefer options contract. The options contract gives the right to the holder of the contract to execute the contract at his discretion.

Catalyst of options market is uncertainty which makes the options contract more viable to the investors. Through Options contract the temporary holding of the underlying securities is possible for the investors; with which the investors can hedge their risk in the capital market. The investor those who think their stock is in obscure they can invest in options. In the options contract the buyer of the contract should pay the premium amount for the privilege of availing the contract. The options are of two types they are call option and put option. Call option gives the buyer, the right to purchase but not the obligation to execute the contract. Put option give the buyer, the right but not the obligation to sell the quantity of underlying asset agreed. In financial market the derivatives are used as risk evasion instruments. Among derivative instruments, the options are the feasible investment for the investors those want to hedge their short-term risk.

In India most popular index derivatives are Nifty index future and Nifty index options. Not only the institutional investors and speculators invest in index derivatives, the individual investors or small investors also make their investment in index derivatives because of its inherent feature.

In this paper an attempt was made to price the Index Options using Black-Scholes-Merton options pricing model and to estimate options strategy by comparing actual and fair options price.

LITERATURE REVIEW

The academic and non-academicians have been continuously questioning which option pricing model helps in better pricing and hedging. The relevance of the option pricing model in various markets has been tested and relevant model has been suggested. The factors that affect the option pricing such as volatility, interest rate and underlying assets have also been researched. Some of the important studies in this area are discussed below:

The option prices differ from the actual and calculated by the Black-Scholes model under systematically with respect to the risk level of the options (Black and Scholes, 1973). When the neural network model and Black-Scholes model are compared both in pricing and hedging, the neural network model outperform the Black-Scholes though sometimes result shows insignificance (Amilon, 2003). The binomial and Black-Scholes option pricing model was converged using Microsoft excel which resulted in Cox, Ross and Rubinstein (1979), binomial options pricing model compares well in connecting to Black-Scholes model than other versions of the model (Feng and Kwan, 2012). When the Black-Scholes model accounts for stochastically varying volatility and interest rates, to be stochastic does not improve further pricing performance for long-term options (Bakshi and Chen, 2000). The relevance of Black-Scholes model of options of selected cement stocks revealed that the mean of expected option price calculated through Black-Scholes model and market price of option are similar thereby proving that the model is relevant for cement stocks option in India (Panduranga, 2013). The credit rate in India was assessed using Black-Scholes-Merton model which supports the argument that liquidity premium and transaction costs account for the unexplained component of market spreads (Kulkarni, Mishra, and Thakker, 2005). The comparison of Binomial and Black-Scholes model reveals that both models give similar result though Binomial Model has high steps and also when Black-Scholes model cannot be used to find price of American option, Binomial Model can be used (Ekram, 2005). Therefore the study intends to look at the efficiency of the so called B-S-M Model for the selected contracts in Indian market conditions.

METHODOLOGY

The study is of empirical nature based on secondary data of the four index options such as S&P CNX Nifty options, Nifty MIDCAP 50 options, Bank Nifty options and CNX IT options. Daily options price data of near-month, at-the-money contract was taken from NSE website for a period of six years from 1st January 2009 to 31st December 2014. The fair options price is calculated as per Black-Scholes-Merton model proposed by Fischer Black, Myron Scholes and Robert Merton in 1973. The calculated price is compared to the Market price using paired sample t-test to know whether the calculated and actual prices are similar. The formula for call option and put option are:

Call Option: $C = [S * N(d_1)] - [Ke^{-rt} * N(d_2)]$

Put Option: $P = [Ke^{-rt} * N(-d_2)]\ [S * N(-d1)]$

$$d1 = \frac{ln\left(\frac{S}{K}\right)+(r+0.5^2)*t}{\sigma\sqrt{t}}$$

$$d2 = d1 - \sigma\sqrt{t}$$

Where,

Ln = Natural Logarithm

S = Spot price of the underlying asset

K = Exercise or Strike price of the option

r = Annual Risk free rate of return

t = Time to expiry of the option

N = Cumulative standard normal Distribution

e = Exponential term (2.7183)

σ = Standard deviation of the continuously compounded annual rate of return of the underlying asset

P = Theoretical price of Put option

C = Theoretical price of Call ption

HYPOTHESIS OF THE STUDY

- H_0 = There is no significant difference between the calculated and actual options price.
- H_1 = There is significant difference between the calculated and actual options price.

ANALYSIS AND INTERPRETATION

In the study, options prices are calculated for every near month contract over a period of six years for 4 indexes. Only at-the-money contract has been taken for the study as it resulted in maximum trade. For the B-S-M model the historic volatility was computed with standard deviation of 20 days return. The calculated option price was compared with the market price using paired sample t-test.

Table – 1 shows the mean and standard deviation for call and put option contract for six years. For **CNX Nifty call option mean (114.07) is higher in 2011,** standard deviation (96.18) is higher in 2009, mean (73.3003) and standard deviation (56.25334) is lower in 2010. For the put option mean (126.6854) and standard deviation (101.90245) is high in 2009, mean (72.2211) and standard deviation (57.07929) is lower in 2012. For Nifty Midcap 50 the mean of call (70.755) and put (61.797) is higher in 2014. The standard deviation of call (68.697) and put (58.721) is higher in 2014. The lower mean of call (45.640) is in 2010 and lower mean for put (36.873), standard deviation of call (34.173) and put (31.011) is in 2013. In BANK Nifty, call option mean (310.620) is higher in 2013 and standard deviation (290.018) is higher in 2009. The call options mean (212.931) and standard deviation (178.645) is lower in 2010. For put option the mean (285.232) and standard deviation (293.375) is higher in 2014. Put option mean (201.146) is lower in 2010 and standard deviation (169.668) is lower in 2011. For CNX IT, the mean (194.630) and standard deviation (154.999) for call option is high in 2014. The call options mean (104.352) is lower in 2009 and standard deviation (73.614) is lower in 2010. The put option mean (162.295) is higher in 2014 and standard deviation (162.165) is higher in 2013.The put option mean (103.548) is lower in 2012 and standard deviation (96.245) is lower in 2010.

TABLE –1 – DESCRIPTIVE STATISTICS

		CNX Nifty			Nifty Midcap 50			BANK Nifty			CNX IT		
		Mean	N	S.D (σ)	Mean	N	S.D (σ)	Mean	N	S.D (σ)	Mean	N	S.D (σ)
Call 2009	Calculated Settle Price	109.401	247	96.182	63.230	243	53.655	267.169	247	290.018	104.352	247	78.286
	Market Settle Price	103.393	247	81.111	70.190	243	54.198	244.213	247	274.801	114.962	247	74.059
Call 2010	Calculated Settle Price	73.300	251	56.253	45.640	251	36.172	212.931	251	178.645	114.267	251	73.614
	Market Settle Price	75.448	251	59.110	51.243	251	36.937	199.543	251	185.879	122.608	251	74.407
Call 2011	Calculated Settle Price	114.067	246	94.749	60.098	246	56.794	287.305	246	231.301	150.461	246	124.713
	Market Settle Price	108.395	246	93.591	65.413	246	57.986	266.713	246	235.371	162.976	246	127.636
Call 2012	Calculated Settle Price	78.788	250	59.999	48.029	250	43.129	241.590	250	191.031	125.665	250	109.834
	Market Settle Price	82.023	250	62.567	51.913	250	44.502	229.502	250	192.723	137.628	250	111.797
Call 2013	Calculated Settle Price	100.198	249	73.804	48.035	249	34.173	310.620	249	243.579	160.297	249	141.140
	Market Settle Price	96.652	249	74.757	52.049	249	35.731	295.062	249	240.534	175.152	249	142.689
Call 2014	Calculated Settle Price	90.086	243	63.805	70.755	243	68.697	283.344	243	198.514	194.630	243	154.999
	Market Settle Price	94.554	243	67.355	75.950	243	69.437	292.990	243	207.555	206.215	243	161.622
Put 2009	Calculated Settle Price	126.685	247	101.902	56.731	243	55.584	246.776	247	190.023	121.045	247	102.350
	Market Settle Price	135.467	247	104.521	65.119	243	58.222	225.350	247	192.302	137.839	247	108.940
Put 2010	Calculated Settle Price	89.920	251	79.089	45.643	251	41.369	201.146	251	194.574	108.001	251	96.245
	Market Settle Price	97.248	251	77.278	48.984	251	40.569	203.123	251	188.728	118.464	251	97.756
Put 2011	Calculated Settle Price	88.562	246	65.964	40.895	246	32.126	224.188	246	169.668	133.714	246	105.889
	Market Settle Price	91.006	246	67.831	43.158	246	33.060	213.460	246	161.687	142.615	246	106.460
Put 2012	Calculated Settle Price	72.221	250	57.079	42.760	250	43.680	209.386	250	178.762	103.548	250	101.043
	Market Settle Price	80.526	250	63.903	73.750	250	124.679	216.647	250	190.999	114.318	250	98.972
Put 2013	Calculated Settle Price	81.395	249	78.080	36.873	249	31.011	254.258	249	238.583	156.987	249	162.165
	Market Settle Price	83.893	249	74.108	40.176	249	30.631	248.418	249	230.430	175.165	249	156.645
Put 2014	Calculated Settle Price	81.732	243	81.301	61.797	243	58.721	285.232	243	293.375	162.295	243	130.753
	Market Settle Price	92.304	243	98.487	66.965	243	59.982	291.792	243	299.288	178.162	243	134.280

Source: computed as per data taken from NSE.

TABLE –2 – PAIRED SAMPLES CORRELATIONS

		CNX Nifty			Nifty Midcap 50			BANK Nifty			CNX IT options		
		N	Correlation	Sig.	N	Correlation	Sig.	N	Correlation	Sig.	N	Correlation	Sig.
Call 2009	Calculated & Market Call Settle Price	247	0.868	0.000	243	0.899	0.000	247	0.880	0.000	247	0.777	0.000
Call 2010	Calculated & Market Call Settle Price	251	0.905	0.000	251	0.973	0.000	251	0.938	0.000	251	0.869	0.000
Call 2011	Calculated & Market Call Settle Price	246	0.957	0.000	246	0.988	0.000	246	0.956	0.000	246	0.946	0.000
Call 2012	Calculated & Market Call Settle Price	250	0.914	0.000	250	0.955	0.000	250	0.891	0.000	250	0.963	0.000
Call 2013	Calculated & Market Call Settle Price	249	0.931	0.000	249	0.944	0.000	249	0.920	0.000	249	0.873	0.000
Call 2014	Calculated & Market Call Settle Price	243	0.828	0.000	243	0.951	0.000	243	0.831	0.000	243	0.949	0.000
Put 2009	Calculated & Market Put Settle Price	247	0.911	0.000	243	0.971	0.000	247	0.830	0.000	247	0.991	0.000
Put 2010	Calculated & Market Put Settle Price	251	0.896	0.000	251	0.882	0.000	251	0.920	0.000	251	0.971	0.000
Put 2011	Calculated & Market Put Settle Price	246	0.867	0.000	246	0.870	0.000	246	0.850	0.000	246	0.900	0.000
Put 2012	Calculated & Market Put Settle Price	250	0.941	0.000	250	0.649	0.000	250	0.954	0.000	250	0.940	0.000
Put 2013	Calculated & Market Put Settle Price	249	0.952	0.000	249	0.869	0.000	249	0.926	0.000	249	0.959	0.000
Put 2014	Calculated & Market Put Settle Price	243	0.941	0.000	243	0.937	0.000	243	0.953	0.000	243	0.954	0.000

Source: computed as per data taken from NSE.

Table – 2 shows that Paired samples correlation between the calculated and actual option settle prices. The values are highly correlated for CNX NIFTY, MIDCAP 50, BANK NIFTY and CNX IT INDEX OPTIONS during the study period of 2009 to 2014 at 1% (0.01) significant level.

Table –3 – Paired Sample t-Test of CNX NIFTY

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Call 2009	Calculated & Market Call Settle Price	6.007	47.764	3.039	0.021	11.994	1.977	246	.049**
Call 2010	Calculated & Market Call Settle Price	-2.148	25.260	1.594	-5.288	0.992	-1.347	250	.179
Call 2011	Calculated & Market Call Settle Price	5.672	27.667	1.764	2.198	9.147	3.216	245	.001***
Call 2012	Calculated & Market Call Settle Price	-3.235	25.574	1.617	-6.420	-0.049	-2.000	249	.047**
Call 2013	Calculated & Market Call Settle Price	3.546	27.665	1.753	0.093	6.999	2.022	248	.044**
Call 2014	Calculated & Market Call Settle Price	-4.469	38.561	2.474	-9.342	0.404	-1.807	242	.072*
Put 2009	Calculated & Market Call Settle Price	-8.782	43.571	2.772	-14.242	-3.321	-3.168	246	.002***
Put 2010	Calculated & Market Call Settle Price	-7.328	35.653	2.250	-11.760	-2.896	-3.256	250	.001***
Put 2011	Calculated & Market Call Settle Price	-2.444	34.555	2.203	-6.783	1.896	-1.109	245	.268
Put 2012	Calculated & Market Call Settle Price	-8.305	21.907	1.385	-11.033	-5.576	-5.994	249	.000***
Put 2013	Calculated & Market Call Settle Price	-2.498	24.007	1.521	-5.494	0.499	-1.642	248	.102
Put 2014	Calculated & Market Call Settle Price	-10.573	35.172	2.256	-15.017	-6.128	-4.686	242	.000***

Note: ***1% Significance, **5% Significance, *10% Significance.
Source: computed as per data taken from NSE.

Table – 3 shows the paired sample t-statistics and its significance values. The null hypothesis of paired sample t test is there is no significant difference between calculated and market options price. For call 2010, put 2011 and put 2013, the significance value is greater than 10% level of significance, so the null hypothesis cannot be rejected which means that the calculated and market prices shows no difference . For rest of the years the significance value is lesser than 10% level of significance, so the alternate hypothesis is accepted.

Table –4 – Paired Sample t-Test of Nifty MIDCAP 50

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Call 2009	Calculated & Market Call Settle Price	-6.964	24.215	1.553	-10.023	-3.904	-4.483	242	.000***
Call 2010	Calculated & Market Call Settle Price	-5.603	8.585	0.542	-6.670	-4.536	-10.341	250	.000***
Call 2011	Calculated & Market Call Settle Price	-5.315	9.126	0.582	-6.461	-4.168	-9.133	245	.000***
Call 2012	Calculated & Market Call Settle Price	-3.884	13.287	0.840	-5.539	-2.228	-4.621	249	.000***
Call 2013	Calculated & Market Call Settle Price	-4.014	11.820	0.749	-5.489	-2.538	-5.358	248	.000***
Call 2014	Calculated & Market Call Settle Price	-5.195	21.741	1.395	-7.942	-2.447	-3.725	242	.000***
Put 2009	Calculated & Market Call Settle Price	-8.388	13.923	0.893	-10.148	-6.629	-9.392	242	.000***
Put 2010	Calculated & Market Call Settle Price	-3.341	19.909	1.257	-5.816	-0.866	-2.659	250	.008***
Put 2011	Calculated & Market Call Settle Price	-2.263	16.622	1.060	-4.350	-0.175	-2.135	245	.034**
Put 2012	Calculated & Market Call Settle Price	-30.990	101.899	6.445	-43.683	-18.297	-4.809	249	.000***
Put 2013	Calculated & Market Call Settle Price	-3.303	15.783	1.000	-5.273	-1.333	-3.302	248	.001***
Put 2014	Calculated & Market Call Settle Price	-5.168	21.099	1.354	-7.835	-2.502	-3.819	242	.000***

Note: ***1% Significance, **5% Significance, *10% Significance.
Source: computed as per data taken from NSE.

Table – 4 shows the paired sample t-statistics and its significance values. The null hypothesis of paired sample t-test is there is no significant difference between calculated and market options price. The alternate hypothesis is accepted as the significance value is less than 0.05 (5%) level of significance. Hence, there is difference between the calculated and market price of call and put options.

Table –5 – Paired Sample t-Test of Bank Nifty

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Call 2009	Calculated & Market Call Settle Price	22.956	139.059	8.848	5.528	40.384	2.594	246	.010**
Call 2010	Calculated & Market Call Settle Price	13.388	64.384	4.064	5.384	21.392	3.294	250	.001***
Call 2011	Calculated & Market Call Settle Price	20.592	69.495	4.431	11.864	29.319	4.647	245	.000***
Call 2012	Calculated & Market Call Settle Price	12.089	89.474	5.659	0.943	23.234	2.136	249	.034**
Call 2013	Calculated & Market Call Settle Price	15.558	96.959	6.145	3.456	27.660	2.532	248	.012**
Call 2014	Calculated & Market Call Settle Price	-9.646	118.353	7.592	-24.601	5.310	-1.270	242	.205
Put 2009	Calculated & Market Call Settle Price	21.426	111.389	7.088	7.466	35.386	3.023	246	.003***
Put 2010	Calculated & Market Call Settle Price	-1.978	76.801	4.848	-11.525	7.570	-0.408	250	.684
Put 2011	Calculated & Market Call Settle Price	10.728	91.049	5.805	-0.706	22.163	1.848	245	.066*
Put 2012	Calculated & Market Call Settle Price	-7.261	57.127	3.613	-14.377	-0.145	-2.010	249	.046**
Put 2013	Calculated & Market Call Settle Price	5.840	90.279	5.721	-5.428	17.109	1.021	248	.308
Put 2014	Calculated & Market Call Settle Price	-6.561	90.831	5.827	-18.039	4.917	-1.126	242	.261

Note: ***1% Significance, **5% Significance, *10% Significance.
Source: computed as per data taken from NSE.

Table – **5** shows the paired sample t-statistics and its significance values. The null hypothesis of paired sample t test is there is no significant difference between calculated and market options price. For call 2014, put 2010, 2013 and 2014 the significance value is greater than 10% level of significance, so the null hypothesis is accepted which means that the calculated and market prices are similar. For rest of the years the significance value is lesser than 10% level of significance, so the alternate hypothesis is accepted.

Table –6 – Paired Sample t-Test of CNX IT

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Call 2009	Calculated & Market Call Settle Price	-10.610	51.075	3.250	-17.011	-4.209	-3.265	246	.001***
Call 2010	Calculated & Market Call Settle Price	-8.341	37.829	2.388	-13.044	-3.638	-3.493	250	.001***
Call 2011	Calculated & Market Call Settle Price	-12.515	41.687	2.658	-17.750	-7.280	-4.709	245	.000***
Call 2012	Calculated & Market Call Settle Price	-11.963	30.008	1.898	-15.701	-8.225	-6.303	249	.000***
Call 2013	Calculated & Market Call Settle Price	-14.855	71.632	4.539	-23.796	-5.914	-3.272	248	.001***
Call 2014	Calculated & Market Call Settle Price	-11.585	51.119	3.279	-18.044	-5.125	-3.533	242	.000***
Put 2009	Calculated & Market Call Settle Price	-16.794	15.579	0.991	-18.746	-14.842	-16.942	246	.000***
Put 2010	Calculated & Market Call Settle Price	-10.463	23.560	1.487	-13.392	-7.534	-7.036	250	.000***
Put 2011	Calculated & Market Call Settle Price	-8.901	47.485	3.028	-14.864	-2.938	-2.940	245	.004***
Put 2012	Calculated & Market Call Settle Price	-10.770	34.745	2.197	-15.098	-6.442	-4.901	249	.000***
Put 2013	Calculated & Market Call Settle Price	-18.177	46.077	2.920	-23.928	-12.426	-6.225	248	.000***
Put 2014	Calculated & Market Call Settle Price	-15.867	40.229	2.581	-20.951	-10.784	-6.149	242	.000***

Note: ***1% Significance, **5% Significance, *10% Significance.
Source: computed as per data taken from NSE.

Table – **6** shows the paired sample t-statistics and its significance values. The null hypothesis of paired sample t-test is there is no significant difference between calculated and market options price. The alternate hypothesis is accepted as the significance value is less than 0.05(5%) level of significance. Hence, there is difference between the calculated and market price of call and put options.

Conclusion

The study attempt to find out whether the index option prices are fairly priced using Black-Scholes-Merton model over a period of 6 years. The previous studies have analysed various option pricing model under different market conditions. Most studies have accepted Black-Scholes-Merton model of options pricing as most suitable one and thus, it was used to examine on index options in the study. The Black-Scholes-Merton options pricing model was relevant in cement stock options in India (Panduranga, 2013), whereas in index options the calculated price and the actual price are significantly different in most of the years the CNX nifty and Bank nifty shows similarity between the calculated and actual in few years such as in Nifty call 2010, put 2011 and put 2013, Bank index call and put 2014, put 2010, 2013. Thus, the study results in an evidence for arbitrage opportunity that can be used by the speculators and arbitrageurs to gain profit and to modify their options strategies. The difference in price can differ with other contracts which are not taken for the study and the results may change accordingly. Hence, the study concludes that the Black-Scholes-Merton model of options pricing stands good in pricing index option in India whereby the trading difference can be used to strategies the portfolio using options.

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