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APPLICABILITY OF BLACK-SCHOLES AND BLACK'S OPTION PRICING MODELS IN PRICING NIFTY STOCK OPTIONS

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ABSTRACT

Derivatives market has played a vital role in the Indian financial system. Financial derivatives have become increasingly popular and are widely used. Options are commonly used financial derivatives. Valuation of Option is very important in the modern financial industry. Black-Scholes model is one of the most preferred and widely used model in the modern time. The study examines the pricing efficiency of Black-Scholes model and Black's model for pricing call options of five pharma stocks which were ranked as top five in the Nifty Pharma Index for the period from April 2019 - March 2020. The period of study is 12 months from April 2019 - March 2020. Results of the paired sample T-test revealed that for three pharma stocks there is a significant difference between the calculated model prices using Black-Scholes Model and actual market prices and also calculated model prices using Black's Model and actual market prices. Black-Scholes and Black's model are efficient in estimating stock option premium of two pharma stocks options. Both the option pricing models have overestimated call option premiums of two stocks and in the case of three stocks it has underestimated call options premium.

Keywords: Call option, Black Scholes, Black's model, option premium.

Introduction

There has been a rapid growth in the derivatives markets in India since its inception. There has been tremendous use of Derivative instruments for management of risk. The financial derivatives have become increasingly popular and are widely used. The Equity derivatives turnover on National Stock Exchange has increased from ₹ 2,365 cr in the year 2000-01 to ₹ 345391355.46 cr in the year 2019-20. Options are the commonly used financial derivatives. An option is a contract, which gives to the buyer the right, but not the obligation, to buy or sell a specified quantity of the underlying assets, at a stated price on or before the expiration date. The underlying may be physical commodities or financial instruments. The two types of options are call and put option. The call option gives the right to the buyer to buy whereas the put option gives the right to sell. Valuation of Option is very important in the modern financial

industry. Black-Scholes model is one of the most preferred and used model in the modern time. Correct pricing is crucial as it enables to make a decision to buy or sell. Black-Scholes model is one of the most preferred and used model in the modern time. There are many option pricing models which include Black-Scholes model, Black's model, Binomial model, Hull and white model, Heston model etc.

In this paper an attempt is made to study the applicability of Black-Scholes model and Black's model in Indian derivatives market with specific reference to pricing of stock call options from the Nifty Pharma index. This study is an applied research as it intends to find the relevance of Black-Scholes Model and Black's Option pricing models in Indian Derivatives Market.

Literature Review

Black and Scholes (1973) derived a

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theoretical valuation formula for options and empirically tested the formula. The findings show that the actual prices of options differ from calculated model price. Black (1976) has given formulas for the values of forward contracts and commodity options in terms of the futures price and other variables.

Tripathi & Gupta (2011) tested the predictive accuracy of the skewness and kurtosis adjusted BS model of Corrado and Su (1996) and the original Black-Scholes model for pricing the Nifty index option. The results show that the modified BS model has a better pricing effectiveness than the original Black-Scholes model.

Panduranga (2013) empirically tested Black-Scholes model for pricing banks stocks and the findings reveal that the model is appropriate for pricing majority of the selected bank stocks. Black, Derman and Toy (1990), presented a model of interest rates which can be used to value any interest rate security and have also shown the application of valuing options on Treasury Bonds.

Mitra (2012) and Mitra (2008) in his study used Black-Scholes as well as Black's model to calculate option prices. The calculated prices using the models were compared with the market prices to find out the predictability of the models. Findings reveal that the Black's model is better than the Black-Scholes model in terms of its predictability.

Nagendran and Venkateswar (2014) tried to find out whether the Black-Scholes model is relevant for pricing stocks options of India. The results show that the model is relevant and the pricing efficiency of the model improves when implied volatility is used in the model. Gupta (2014) found that the implied volatility gives better option prices as compared the use of historical volatility in the Black-Scholes formula.

Objectives

- 1) Determine the theoretical prices of stock options using Black -Scholes model and Black's Option Pricing Model.

- 2) Find out whether there is significant difference between model prices and the actual market prices of stocks.

Hypothesis

Based on the objectives of the study hypotheses are framed as follows:

H₀: There is no significant difference between the model prices and market prices of stocks.

H₁: There is a significant difference between the model prices and market prices of stocks.

Data and Methodology:

Study population constitutes five stock call options of stocks which are ranked top five as per their weightage in the Nifty Pharma Index for the period from April 2019 to March 2020. The selected stocks are Sun Pharmaceutical Industries Limited, Dr. Reddy's Laboratories Limited, Cipla Limited, Divi's Laboratories Limited and Lupin Limited. Deliberate Sampling method is used; the historical data has been collected from the NSE website. Weighted average interest rate of central government securities is used as proxy for risk free rate. Annualized volatility has been calculated on the basis of the daily closing prices of the previous financial year for each stock. Actual option prices of all the stocks for that year are used for comparing with the model prices. Pricing is done in four weeks advance for two strike prices, one at in- the -Money (ITM) and the other one Out- of- the Money (OTM). The call prices are calculated for select stocks using Black-Scholes Option Pricing Model and Black's model. Paired sample T-test is utilized to compare the actual option prices prevailing in the market with the option prices calculated as per Black-Scholes Model and Black's option pricing model.

Black – Scholes Option Pricing Model

The Black-Scholes model for pricing stock options was established by Fischer Black and Myron Scholes. It is the most important and commonly used option pricing model. The model has five variables which include spot price, variance, strike price, time to expiry and risk free rate. The model uses the following equations for pricing Call options:

Call Option Premium

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

$$d_1 = \frac{[\ln(S/X) + (r + \sigma^2/2)Xt]}{\sigma\sqrt{t}}$$

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

Where,

- C = Price of a call option
- S = Price of the underlying asset
- X = Strike price of the option
- r = Rate of interest
- t = Time to expiration
- σ = Volatility of the underlying

N represents a standard normal distribution with mean = 0 and standard deviation = 1

Black's Model

Black tried to address the problem of negative cost of carry. Forward price is used in option pricing formula instead of spot price. He replaced the spot term (S) by the discounted value of future price $F.e^{-rt}$ in the original Black-Scholes Option Pricing formula. The Black's model uses the following equation for pricing call options:

$$C = F.e^{-rt}N(d_1) - X.e^{-rt}(Nd_2)$$

Data Analysis

Table 1: Comparison of Market Premiums and Model Estimate Premium as per Black-Scholes and Black's Option pricing model

Stocks		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
SUNPHARM A	Market Premium – BS Model Premium	1.29750E1	2.22485	.45415	12.03553	13.91447	28.570	23	.000
	Market Premium – B Model Premium	1.36271E1	2.20164	.44941	12.69741	14.55676	30.322	23	.000
DRREDDY	Market Premium – BS Model Premium	-5.78542	15.47541	3.15891	12.32011	.74928	-1.831	23	.080
	Market Premium – B Model Premium	-3.68417	16.36345	3.34017	10.59384	3.22551	-1.103	23	.281

CIPLA	Market Premium – BS Model Premium	1.73083	3.37690	.68931	.30489	3.15677	2.511	23	.020
	Market Premium – B Model Premium	2.22375	3.56104	.72689	.72006	3.72744	3.059	23	.006
DIVISLAB	Market Premium – BS Model Premium	-2.84542	21.41230	4.37077	11.88704	6.19620	-.651	23	.521
	Market Premium – B Model Premium	-5.27958	25.20390	5.14473	15.92226	5.36309	-1.026	23	.315
LUPIN	Market Premium – BS Model Premium	1.33104E1	30.03710	6.13130	.62686	25.99397	2.171	23	.041
	Market Premium – B Model Premium	1.41833E1	30.29299	6.18353	1.39172	26.97494	2.294	23	.031

The paired sample t-test is done between the calculated premium using Black-Scholes Pricing Model and the actual market prices of stock call options and the calculated premium using Black's option Pricing Model and the actual market prices of stock call options. The Table shows that there is significant difference between the calculated model price and actual market price of SUNPHARMA, CIPLA and LUPIN stock call options using the two pricing models. While there is no significant difference between the model price calculated using the two pricing models and actual price of DRREDDY and DIVISLAB Stock call options. This indicates the effectiveness of the two models in pricing DRREDDY and DIVISLAB Stock call options.

It is observed that The Black-Scholes model and Black's Option pricing Model are

underestimating Stock call option premium of SUNPHARMA, CIPLA and LUPIN stocks, while these models have overestimated stock call options premium of DRREDDY and DIVISLAB.

Conclusion

This study will help to understand the Black-Scholes model and Black's option pricing model and their calculation. It will be useful to traders and investors as they rely on theoretical value to monitor the changing risk, for valuation of their option positions, and assist them in trading decisions. The results of the study showed that for three out of five stocks selected for the study there was significant difference between the calculated model prices and market prices. Black-Scholes and Black's model are efficient in estimating stock option premium of two pharma stocks options. Both the option pricing models

have overestimated call option premiums of two stocks and in the case of three stocks it has underestimated call options premium.

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