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A Study on Options Pricing Using GARCH and Black-Scholes-Merton Model

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Abstract

Options are instruments which have the special property of limiting the downside risk, while not limiting the upside potential, thus their use in hedging. The share of the options market in the Indian capital market has increased to 64% in just over a decade. The trading turnover of options in the FY11 was Rs. 193,95,710 crore, and the trading volume generated by options market was almost two times that of the volume generated in the cash market and futures market put together. So trading and pricing of stock option have occupied an important place in the Indian derivatives market.

Volatility is a critical factor influencing the option pricing; however, it is an extremely difficult factor to forecast. Hence the crucial problem lies with the accurate estimation of volatility. The estimated volatility can be used to determine future prices of the stock or the stock option. Empirical research has shown that using historical volatility in different option pricing models leads to pricing biases. The GARCH (1, 1) model can be a solution for this problem. The present study applies the GARCH (1, 1) model to estimate the volatility, and applies this estimated volatility to calculate option prices with the help of Black-Scholes-Merton model.

Keywords: GARCH model, Black-Scholes-Merton model, Option prices, Volatility

1. Introduction

An option is a derivative financial instrument that specifies a contract between two parties for a future transaction on an asset at a reference price called the strike price. The buyer of the option gains the right, but not the obligation, to engage in that transaction, while the seller incurs the corresponding obligation to fulfill the transaction. In return for assuming the obligation, called writing the option, the originator of the option collects a payment, the premium, from the buyer. So the loss for an option buyer is limited to the premium paid, whereas the loss for an option seller is unlimited. Many options are created in standardized form and traded on an options exchange among the general public, while other over-the-counter options are customized ad hoc to the desires of the buyer, usually by an investment bank. The price of an option derives from the difference between the reference price and the value of the underlying asset plus a premium based on the time remaining until the expiration of the option.

There are two types of options: call options and put options. A call option conveys the right to buy the underlying asset at a specific price, while a put option conveys the right to sell the underlying asset at a specific price. Option contracts have the following specifications: the type (call or put), the quantity and class of the underlying asset, the strike/exercise price (i.e. the price at which the underlying transaction will occur upon exercise of the option), the expiration date (the last date the option can be exercised), and the settlement terms (for instance, whether the writer must deliver the actual asset on exercise, or may simply tender the equivalent cash amount). Also, there are two option styles: European style options can be exercised only on the expiry date, while American style options can be exercised any time before the expiry date.

The Black-Scholes-Merton model (1973) is the most widely-used model of determining option prices. The model expresses the prices of European call and put options on a non-dividend-paying stock in terms of five parameters: the spot price of the underlying stock, the exercise price at which the transaction will be executed, the expiration period after which the option can be exercised, the risk-free rate of return, and the volatility of returns of the underlying stock.

Volatility is a critical factor influencing the option pricing; however, it is an extremely difficult factor to forecast. Hence the crucial problem lies with the accurate estimation of volatility. The estimated volatility can be used to determine future prices of the stock or the stock option, and thus an investor can use arbitrage strategies accordingly to benefit from the model.

2. Literature Review

There is a vast literature on options pricing using the GARCH-Black-Scholes-Merton model. Some of the relevant literature is reviewed in the following.

Adesi et al (2007) proposed a method for pricing options based on GARCH models with filtered historical innovations. They found that their model outperformed other GARCH pricing models and Black-Scholes models empirically for S&P 500 index options. Their model was validated by empirically obtaining decreasing state price densities per unit probability. Also, their model explained implied volatility smiles by the negative asymmetry of the filtered historical innovations. The study also provides empirical evidence and quantifies the deterioration of the delta hedging in the presence of large volatility shocks. Cristofferson et al (2004) extended their results in the presence of conditional skewness. Siu et al (2004) proposed a method for pricing derivatives under the GARCH assumption for underlying assets in the context of a dynamic version of Gerber-Shiu's option-pricing model. Instead of adopting the notion of local risk-neutral valuation relationship (LRNVR) they employ the concept of conditional Esscher Transforms to identify a martingale measure under the incomplete market setting. Under the conditional normality assumption for the stock innovation, the pricing result is consistent with that of Duan. In line with the Gerber-Shiu's option pricing model, they also justify the pricing result within the dynamic framework of utility maximization problems which makes the economic intuition of the pricing result more appealing. Numerical results for the comparison of the model with the Black-Scholes-Merton option pricing model are also presented. Dash et al (2012) applied the GARCH options pricing model for options traded on the National Stock Exchange, India. They used the GARCH(1, 1) model to obtain volatility projections, and calculated option prices using these volatility projections in the Black-Scholes-Merton model. They found that the implied volatilities (for both calls and puts) were overestimated, and that call and put option prices were predominantly overvalued, and, further, that put options were more overpriced than call options. They also found that the overestimation of volatility and overvaluation of options prices increased with higher market capitalization and moderate/higher trading volume of the underlying stocks. Duan (1995) introduced the GARCH option pricing model, linking econometric models with the options pricing literature. Heston and Nandi (2000) developed a closed-form option valuation formula for a spot asset whose variance follows a GARCH (p, q)-process that can be correlated with the returns of the spot asset. They found empirically for S&P500 index options that their model had lower valuation errors than the Black-Scholes-Merton model with implied volatilities. They argued that the GARCH model was able to simultaneously capture the correlation of volatility with spot returns and the path dependence in volatility. Hao and Yang (2011) presented a scenario-based risk measure for a portfolio of European-style derivative securities over a fixed time horizon under the regime-switching Black-Scholes economy. The study derived a closed-form expression for the risk measure for vanilla European options and barrier options, and this approach can be applied to some other exotic options. The results of the study provide some guidelines and insights for portfolios containing different kinds of derivatives. Jacobs and Christofferson (2004) compared a range of GARCH models with different lags, using option prices and returns. They found that, in contrast to the returns-based objective function, using an option price-based objective function favored a more parsimonious model. Jacobs et al (2004) suggested that index option prices differ systematically from those predicted by the Black-Scholes-Merton model. In particular, out-of-the-money put prices and in-the-money call prices were higher than predicted by the Black-Scholes-Merton model. They suggested an analytic option pricing formula consistent with the stock return dynamic, viz. an inverse Gaussian GARCH model, which performed better than the usual BSM model for out-of-the-money puts on the S&P 500 Index. Singh et al (2011) empirically investigated the forecasting performance of closed-form discrete time GARCH option pricing model with benchmark Black-Scholes and its version practitioner Black-Scholes model for pricing S&P

CNX Nifty 50 index option of India, relative to market price using error metrics, moneyness-maturity-wise. They found that the practitioner Black-Scholes model outperforms the other two models, and reduced the price bias between model and market.

Varma (2002) evaluated the volatility pricing of the index options with the help of the Black-Scholes-Merton option pricing formula and the GARCH (1, 1) model and has found severe mispricing in Indian Index options. He has also established the significant difference in volatility smiles for call and put options. Lehar et al (2002) examined the performance of two extensions of the Black-Scholes-Merton framework, the GARCH and the stochastic volatility option pricing model. They found empirically for FTSE 100 option prices that GARCH dominated over the stochastic volatility and the Black-Scholes-Merton model. However, they found significant errors in the prediction of the market risk from hypothetical derivative positions in all the models.

3. Methodology

The objective of the present study is to analyse systematic mispricing of stock and index options on the NSE using the GARCH model and the Black-Scholes-Merton options pricing model. To analyses the stock options ten companies from ten different sectors, closing stock prices were obtained from the National Stock Exchange[1] for the period of 1-May-2012 to 30-Apr-2013 were taken to calculate the volatility using the GARCH(1,1) model for 30-,60-, and 90-day periods. The volatility values thus obtained were used in the Black-Scholes-Merton model to calculate the call and put prices for the stocks.

3.1. GARCH (Generalized Autoregressive Conditional Hetroscedasticity) Model

The Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models were propounded by Engle (1982) and Bollerslev (1986). The distinctive feature of these models is that they recognize that volatilities and correlations are not constant: i.e. volatility clustering and excess kurtosis. The GARCH models are discrete-time models, attempting to track changes in the correlation and volatility over time. The GARCH model is used to estimate volatility for a variety of financial time series: stock returns, interest rates, and foreign exchange rates. GARCH models have been applied in various fields such as asset allocation, risk management, and portfolio management, and option pricing.

The GARCH (p, q) model is formulated as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \cdots + \alpha_q \epsilon_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_p \sigma_{t-p}^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \epsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2,$$

where p is the order of the GARCH (lagged volatility) terms, and q is the order of the ARCH (lagged squared-error) terms.

In the academic literature, the GARCH (1, 1) process seems to be perceived as a realistic data generating process for financial returns. An intuitively appealing interpretation of the GARCH (1, l) model is easy to understand. The GARCH forecast variance is a weighted

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average of three different variance forecasts. One is a constant variance that corresponds to the long-run average. The second is the forecast that was made in the previous period. The third is the new information that was not available when the previous forecast was made. This could be viewed as a variance forecast based on one period of information. The weights on these three forecasts determine how fast the variance changes with new information and how fast it reverts to its long-run mean. Volatility and risk both terms are used interchangeably today. If one decides to approach the difficult problem of forecast evaluation, the first consideration is: which volatility is being forecast? For option pricing, portfolio optimization and risk management one needs a forecast of the volatility that governs the underlying price process until some future risk horizon. Future volatility is an extremely difficult thing to forecast because the actual realization of the future process volatility will be influenced by events that happen in the future, e.g. large market movements at any time before the risk horizon. Thus the real problem is that of prediction of volatility. The predicted volatility can be used to determine future prices of the stock or the stock option, and thus an investor can use arbitrage strategies accordingly to benefit from the model.

The GARCH (1, 1) model is represented as $\sigma_t^2 = \gamma V_L + \alpha r_{t-1}^2 + \beta\sigma_{t-1}^2$, where γ represents the weight of long run variance; V_L represents the long-run variance, α the weight of periodic returns, and β the weight of variance. The parameters α, β and ω are estimated by using the Maximum Likelihood Method, maximizing the log-likelihood function $-\frac{1}{2}\sum_{i=1}^{n}\left(\ln(v) + {u_i^2}/{v}\right)$, subject to the constraint α + β < 1. Once the values of α, β and ω are obtained, γ = 1 – α – β, and V_L is calculated as ω/γ. The annualized volatility is calculated as 251*V_L. This volatility is then used to calculate the option prices.

3.2. The Black-Scholes-Merton Model

The Black Scholes-Merton model (1973) is one of the most important concepts in modern financial theory. The BSM model gives the formulae for European call and put options on a non-dividend-paying stock as follows:

$$C = S * N(d1) - X * e^{-rt} * N(d2)$$

$$P = X * e^{-rt} * N(-d2) - S * N(-d1)$$

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

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

Where S represents the spot price of stock, X represents the exercise price of the option, r is the annual risk-free rate of return, t is the time to expiry of the option, and σ is the annual volatility of the stock. In the analysis, for each option, the exercise price was taken at par with the spot price on 1-Jan-2013; the times to expiry considered were 30-, 60-, and 90-days; and the risk-free rate considered was 7.27% p.a. The volatility used was the long-run volatility estimated by the GARCH model.

The market values of the options were compared with the estimated values using the paired-samples Wilcoxon test. The %age difference between the market values and the estimated GARCH-BSM prices were calculated to assess the extent of mispricing. Also, the extent of mispricing for 30-, 60-, and 90-day call and put options were compared using the paired-samples Wilcoxon test.

4. Analysis

4.1 Call Option:

Table 1. Comparison of call option values calculated using Black-Scholes and the Market Option value for 30, 60 & 90 day expiry

Companies	Call Option					
	Black-Scholes Option Value			Market Value		
	30 Day	60 Day	90 Day	30 Day	60 Day	90 Day
Ambuja Cements Limited	4.23	11.59	16.17	7.6	19.45	19.45
Bharti Airtel	13.1	15.51	29.2	18.65	26	38.5
Cipla Limited	12.6	20.96	28.05	17.3	35.2	35.2
DLF Limited	11.19	13.59	14.35	18.6	29	15.55
Hero MotoCorp Limited	106.18	130.69	133.8	354.25	214.45	134.4
Hindustan Petroleum Corporation Limited	24.07	22.78	17.73	23.8	38	15
Hindustan Unilever Limited	15.68	30.67	26.05	19.35	89.2	29
Infosys Limited	98.18	119.48	167.6	102.15	5	138.1
State Bank of India	52.56	63.85	100.96	92.3	150	145.3
Sun TV Network Limited	21.62	28.98	27.41	32.5	23.95	40.5

Table 2. Average difference in three different stock call options for different time period of expiry

Companies	Percentage Difference		
	30 Day	60 Day	90 Day
Ambuja Cements Limited	0.443421	0.404113	0.168638
Bharti Airtel	0.297587	0.403462	0.241558
Cipla Limited	0.271676	0.404545	0.203125
DLF Limited	0.398387	0.531379	0.07717
Hero MotoCorp Limited	0.700268	0.390581	0.004464
Hindustan Petroleum Corporation Limited	-0.01134	0.400526	-0.182
Hindustan Unilever Limited	0.189664	0.656166	0.101724
Infosys Limited	0.038864	-22.896	-0.21361
State Bank of India	0.430553	0.574333	0.305162
Sun TV Network Limited	0.334769	-0.21002	0.32321

Average difference in call option prices varies based on time effect of 30, 60 & 90 days. There is only a minute difference in the option prices and the above table also shows that the stock call option with 30 days to expiry has a difference which is minimum between the model and market values.

4.2 Put Option:

Table 3. Comparison of put option values calculated using Black-Scholes and the Market Option value for 30, 60 & 90 day expiry

Companies	Put Option					
	Black-Scholes Option Value			Market Value		
	30 Day	60 Day	90 Day	30 Day	60 Day	90 Day
Ambuja Cements Limited	16.2	9.7	8.37	17.4	14.25	14.8
Bharti Airtel	8	10.99	17.66	16.6	25	25
Cipla Limited	8.69	8.48	21.27	15.8	19.5	30.35
DLF Limited	9.66	12.21	9.23	17	51.5	21.1
Hero MotoCorp Limited	92.63	72.79	83.57	119.6	62.05	120.95
Hindustan Petroleum Corporation Ltd.	15.75	18.76	11.29	18.85	71.05	18.5
Hindustan Unilever Limited	6.68	13.94	14.11	15.7	6.35	29.55
Infosys Limited	57.91	88.86	113.41	76.8	453.75	94.85
State Bank of India	17.44	44.99	51.38	68.15	128.7	128.7
Sun TV Network Limited	19.3	21.11	17.74	30.95	80.5	39.8

Table 4. Average difference in three different stock put options for different time period of

expiry

Companies	Percentage Difference		
	30 Day	60 Day	90 Day
Ambuja Cements Limited	0.069	0.3193	0.4345
Bharti Airtel	0.5181	0.5604	0.2936
Cipla Limited	0.45	0.5651	0.2992
DLF Limited	0.4318	0.7629	0.5626
Hero MotoCorp Limited	0.2255	-0.1731	0.3091
Hindustan Petroleum Corporation Limited	0.1645	0.736	0.3897
Hindustan Unilever Limited	0.5745	-1.1953	0.5225
Infosys Limited	0.246	0.8042	-0.1957
State Bank of India	0.7441	0.6504	0.6008
Sun TV Network Limited	0.3764	0.7378	0.5543

Average difference in put option prices varies based on time effect of 30, 60 & 90 days. There is only a minute difference in the option prices and the above table also shows that the stock call option with 30 days to expiry has a difference which is minimum between the model and market values.

4.3 Paired T-Test

Table 5. SPSS Output of Paired Sample T-Test to compare the model and market prices of thirty day call option price

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair	ThirtydayBSM	35.9410	10	37.304 50	11.796 72
1	ThirtydayMV	68.6500	10	105.602 34	33.394 39

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	ThirtydayBSM & ThirtydayMV	10	0.849	0.002

Paired Samples Test

		Paired Differences							
					95% Confidence interval of the Difference				
Pair	Thirtyday BSM Thirtyday	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
1	MV	32.709 00	76.511 47	24.195 05	87.442 01	22.024 01	-1.352	9	0.209

Paired sample T-test is done to check whether the numerical difference between the actual and the expected thirty day call option price of stock option which is significant in this case. The SPSS result show that the p value is greater than 0.05. So we can accept the null hypothesis that there is no significant difference between the actual and expected call option prices of stock option.

Table 6. SPSS Output of Paired Sample T-Test to compare the model and market prices of sixty day call option price

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair	SixtydayBSM	45.8100	10	44.403 36	14.041 57
1	SixtydayMV	63.0250	10	68.232 35	21.576 96

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	SixtydayBSM & SixtydayMV	10	0.564	0.089

Paired Samples Test

		Paired Differences							
					95% Confidence interval of the Difference				
		Mean	Std.Deviation	Std.Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair	SixtydayBSM								
1	SixtydayMV	17.21500	56.641 61	17.911 65	57.733 96	23.303 96	-961	9	0.362

Paired sample T-test is done to check whether the numerical difference between the actual and the expected sixty day call option price of stock option which is significant in this case. The SPSS result show that the p value is greater than 0.05. So we can accept the null hypothesis that there is no significant difference between the actual and expected call option prices of stock option.

Table 7. SPSS Output of Paired Sample T-Test to compare the model and market prices of ninety day call option price

T-Test

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	NinetydayBSM	56.1320	10	56.300 98	17.803 93
	NinetydayMV	61.1000	10	54.734 31	17.308 51

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	NinetydayBSM & NinetydayMV	10	0.948	0.000

Paired Samples Test									
		Paired Differences							
					95% Confidence interval of the Difference				
Pair	NinetydayBSM	Mean	Std.Deviation	Std.Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
1	NinetydayMV	-4.968 00	18.034 38	5.702 97	-17.869 02	7.933 02	-87 1	9	0.406

Paired sample T-test is done to check whether the numerical difference between the actual and the expected ninety day call option price of stock option which is significant in this case. The SPSS result show that the p value is greater than 0.05. So we can accept the null hypothesis that there is no significant difference between the actual and expected call option prices of stock option.

Table 8. SPSS Output of Paired Sample T-Test to compare the model and market prices of thirty day put option price

T-Test

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	ThirtydayBSM	25.2260	10	27.958 25	8.841 18
	ThirtydayMV	39.6850	10	36.170 13	11.438 00

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	ThirtydayBSM & ThirtydayMV	10	0.925	0.000

Paired Samples Test

		Paired Differences							
					95% Confidence interval of the Difference				
		Mean	Std.Deviation	Std.Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	ThirtydayBSM ThirtydayMV	-14.459 00	14.800 94	4.680 47	-25.046 96	-3.871 04	-3.089	9	0.013

Paired sample T-test is done to check whether the numerical difference between the actual and the expected thirty day put option price of stock option which is significant in this case. The SPSS result shows that the p value is less than 0.05. So we can reject the null hypothesis that there is a significant difference between the actual and expected call option prices of stock option.

Table 9. SPSS Output of Paired Sample T-Test to compare the model and market prices of sixty day put option price

T-Test

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	SixtydayBSM	30.1830	10	28.937 11	9.150 72
	SixtydayMV	91.2650	10	132.681 40	41.957 54

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	SixtydayBSM & SixtydayMV	10	0.793	0.006

Paired Samples Test

		Paired Differences							
					95% Confidence interval of the Difference				
		Mean	Std.Deviation	Std.Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	SixtydayBSM SixtydayMV	61.082 00	111.134 79	35.143 91	-140.583	18.419 04	-1.738	9	0.116

Paired sample T-test is done to check whether the numerical difference between the actual and the expected sixty day put option price of stock option which is significant in this case. The SPSS result show that the p value is greater than 0.05. So we can accept the null hypothesis that there is no significant difference between the actual and expected put option prices of stock option.

Table 10. SPSS Output of Paired Sample T-Test to compare the model and market prices of ninety day put option price

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	NinetydayBSM	34.8030	10	36.414 27	11.515 20
	NinetydayMV	52.3600	10	44.451 33	14.056 74

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	NinetydayBSM & NinetydayMV	10	0.823	0.003

Paired Samples Test

		Paired Differences							
					95% Confidence interval of the Difference				
		Mean	Std.Deviation	Std.Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	NinetydayBSM NinetydayMV	-17.557 00	25.239 35	7.981 38	-35.61214	498 14	-2.200	9	0.55

Paired sample T-test is done to check whether the numerical difference between the actual and the expected ninety day put option price of stock option which is significant in this case. The SPSS result show that the p value is greater than 0.05. So we can accept the null

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hypothesis that there is no significant difference between the actual and expected put option prices of stock option.

4.4. MULTIPLE REGRESSIONS

Table 11. SPSS output of Multiple Regression for Stock Call Options:

Regression

Variables Entered/ Removed [b]

Model	Variables Entered	Variables Removed	Method
1	Maturity, Stock, Price, Volatility, Strike Price [a]		Enter

a. All reserved variables entered

b. Dependent Variable: Option Price

Model Summary

Model	R	R Square	Adjusted R square	Std. Error of the estimate
1	0.971[a]	0.943	0.934	11.73665

a. Predictors: (Constant), maturity, Stock Price, Volatility, Strike Price

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	57392.765	4	14348.191	104.162	0.000[a]
	Residual	3443.722	25	137.749		
	Total	60836.487	29			

a. Predictors: (Constant), maturity, stock Price, Volatility, Strike Price

b. Dependent Variable: Option Price

Multiple regression is done to find out the independent variables on which call option prices of the stock option depends upon. The independent variables considered are strike price, spot price, volatility and maturity time. The results of the SPSS output show there is dependency of call option prices of the stock option on all the variables except the maturity time as R square value is high and the p values are less than 0.05 in all the cases except maturity time.

Table 12. SPSS output of Multiple Regression for Stock Put Options:

Regression

Variables Entered/ Removed [b]

Model	Variables Entered	Variables Removed	Method
1	Maturity, Stock, Price, Volatility, Strike Price [a]		Enter

a. All reserved variables entered

b. Dependent Variable: Option Price

Model Summary

Model	R	R Square	Adjusted R square	Std. Error of the estimate
1	0.966[a]	0.932	0.922	8.5351

a. Predictors: (Constant), maturity, Stock Price, Volatility, Strike Price

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	25142.779	4	14348.191	86.286	0.000[a]
	Residual	1821.177	25	72.847		
	Total	26963.957	29			

a. Predictors: (Constant), maturity, stock Price, Volatility, Strike Price

b. Dependent Variable: Option Price

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
1		B	Std. Error	Beta	t	Sig.
	(Constant)	-28.825	5.624		-5.125	0
	Stock Price	-0.742	0.08	-22.412	-9.277	0
	Strike price	0.755	0.079	23.187	9.611	0
	Volatility	307.237	54.425	0.436	5.645	0
	Maturity	-72.704	32.503	-0.163	-2.237	0.034

Multiple regression is done to find out the independent variables on which call option prices of the stock option depends upon. The independent variables considered are strike price, spot price, volatility and maturity time. The results of the SPSS output show there is dependency of put option prices of the stock option on all the variables as R square value is high and the p values are less than 0.05 in all the cases.

5. Discussion

The findings of the study suggest that options are significantly overpriced. However, an interesting possibility suggested by the findings is that this overpricing decreases with expiration period. Also, the findings suggest that put overpricing is significantly higher than call overpricing, as suggested by Dash et al (2012), particularly for longer expiration periods.

The study has several limitations. The sample size used for the analysis is small, and the selected stocks are all large-cap stocks; so that it is not clear whether the results of the study extend to medium- and small-cap stocks. Another difficulty is that of trading volume, which may also affect overpricing, as suggested by Dash et al (2012). Finally, another limitation that may bias the results of the study is the choice of research period; it is not clear whether the results extend to other periods, particularly under high volatility.

There is great scope for applying GARCH option pricing models to examine several other interesting properties of options, including implied volatility, volatility smiles, and the time-variability of options properties (e.g. Greeks).

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