THE GREEKS & BLACK AND SCHOLE MODEL" TO EVALUATE OPTIONS PRICING & SENSITIVITY IN INDIAN OPTIONS MARKET

Dr. M. Tulasinadh*, Dr.R. Mahesh
* Assistant Professor, Dept of MBA KBN College-PG Centre, Vijayawada
Assistant Professor, Dept of MBA Amrita Sai Institute of Science & Technology, Vijayawada

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ABSTRACT
Derivatives' trading is a core part of the Indian Stock Market in the Current Scenario. Trading volumes in stock options have grown up tremendously during recent years. This also leads to be high volatility in the options prices Options Pricing is crucial factor for hedging and Speculative activities. Pricing plays a vital role for option writers. In this paper we have tried to find out the price of an option in the future and its sensitivity through the Greek & Black and Scholes Option pricing model. Many option traders rely on the "Greeks" to evaluate option positions and to determine option sensitivity.

INTRODUCTION
In the financial literature, the Greeks are referred to as the quantities representing the sensitivity of the portfolio of the derivatives with respect to underlying parameters like the spot prices and their volatilities. As these quantities of sensitivities are denoted by the Greek letters$(\Delta, \Gamma, \nu, \Theta, \rho)$, that's why the name Greeks is given to them. They are also known by the names as risk sensitivities, hedge parameters or risk measures. Mathematically, the Delta and the Gamma are the first derivative and second derivative with respect to the underlying spot price. Other Greeks like Vega, Theta and Rho are calculated as the first order partial derivatives of the portfolio value with respect to the underlying parameters or factors which determine the value of an option. The five Greeks that this study will focus on are Delta (first derivative of the price of underlying), Gamma (2^{nd} derivative of price), Vega(volatility), Theta(time), Rho(risk-free interest rate). In order to reduce the risk associated with portfolio, hedgers use options, futures and stocks. The change in the portfolio value containing options is subject to change in the option sensitivities summarized in delta, gamma, Vega, theta and rho, In construction of any strategy, Delta, Vega and Theta, as well as other Greek positions play a vital role. To know the reward and the risk associated with the specific strategy or the portfolio, one can calculate Greeks value when the options are traded outright and otherwise also. Knowing what the Greeks are telling is as important as hedging your portfolio risk with any other tool of risk management. Greeks can be used for establishing a strategy design using linear and quadratic programming or with the help of different sophisticated software. But for simply hedging the risk associated with the portfolio, basic knowledge of Greeks and their implementation will be beneficial. One should try to match his/her outlook on a market with respect to the position Greeks in a strategy so that if their outlook is correct and then they can capitalize on favorable changes in the strategy at every level of Greeks.

What are 'the Greeks'?
This is a colloquial term given to the set of measures derived from the Black Scholes option pricing formula. Letters from the Greek alphabet are used to represent these derived measures:

- delta – a measure of an option's sensitivity to changes in the price of the underlying asset
- gamma – a measure of delta's sensitivity to changes in the price of the underlying asset
- vega – a measure of an option's sensitivity to changes in the volatility of the underlying asset
- theta – a measure of an option's sensitivity to time decay
- rho – a measure of an option's sensitivity to changes in the risk free interest rate

These measures are not static, but are interdependent and change constantly. When you look at one measure it is on the basis that all other variables are held constant.

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LITERATURE REVIEW

This section reviews the literature on determining the use of Greeks as in how they have been used as the hedging tools in the derivatives market. Comparison of Delta hedging of written options had been done by Hull and White (1987) and they concluded that the last of these works best. Willard (1987) calculated sensitivities for derivative securities which are path independent in multifactor models, while Ross(1998) calculated sensitivities for European options which are multi-asset. Using an option pricing context, Ferri, Oberhelman and Goldstein (1982) examined yield sensitivities for short term securities, while Ogden (1987) examined corporate bond's yield sensitivities. Delta hedging had been widely applied by investors who have positions of long or short options in their portfolio to hedge risks from the changes of the price of option. Due to its broad application in financial engineering, there is as vast literature on delta hedging. Hull (2003) provided an introducing of hedging. Jarrow and Turnbull (1999) provided a detailed explanation of how to replicate portfolios in order to achieve a delta-neutral position and implementation of dynamic delta hedging. Pelsser and Vorst (1994) discussed the determination of the mainly used Greeks in the context of the binomial model (see Cox and Rubinstein 1983). Garman (1992) christened three more partial derivatives with the names speed, charm and color. The duration of option portfolios was defined in Garam (1985), while Gamma duration and volatility immunization were defined in Garman (1999). Similarly, Haug (1993) discussed the aggregation of option's Vegas of different maturities. Estrella (1995) derived an algorithm for the determination of arbitrary price derivatives of the BMS option formula. He the examined Taylor series expansions in the stock price and found the radius of convergence.

OBJECTIVES OF THE STUDY

1. To Study the Greeks and their significance in options pricing
2. Analyze the price by using black and schools model and its sensitivities.
3. To analyze the volatility and guide investors to hedge risk by estimating future price

RESEARCH METHODOLOGY

The research study is to calculating the option prices using Black and Scholes option pricing model for call option and put options and its sensitivities. The secondary data is collected form NSE and used single strike price movement formulas to calculate option price and its sensitivities. Samples are taken from top most 5 Companies and 8% risk free rate of interest of T-bills and historical volatility of the companies.

BLACK AND SCHOLES OPTION PRICING MODEL: THE MODEL

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

$$P = X\, e^{-rt} * N(-d_2) - S_0\, e^{-qt} * N(-d_1)$$

C=Theoretical call premium
S=Current Stock price
t= time until option expiration
K=Option Strike price
R= risk free interest rate
N=Cumulative Standard Distribution
E=exponential term

$$d_1 = \frac{ln(\frac{S_0}{X}) + t\,(r - q + \frac{\sigma^2}{2})}{\sigma\sqrt{t}}$$

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

Delta

$$Call\ delta = e^{-qt} * N(d_1) \quad Put\ delta = e^{-qt} * \ (N(d_1) - 1)$$

Gamma

$$Gamma = \frac{e^{-qt}}{S_0\, \sigma \sqrt{t}} * \frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}$$

Theta

$$Call\ theta =$$

$$= \frac{1}{T}\left(-\left(\frac{S_0\, \sigma\, e^{-qt}}{2\sqrt{t}} * \frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}\right) - r\, X\, e^{-rt}\, N(d_2) + q\, S_0\, e^{-qt}\, N(d_1)\right)$$

$$Put\ theta =$$

$$= \frac{1}{T}\left(-\left(\frac{S_0\, \sigma\, e^{-qt}}{2\sqrt{t}} * \frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}\right) + r\, X\, e^{-rt}\, N(-d_2) - q\, S_0\, e^{-qt}\, N(-d_1)\right)$$

… Where T is the number of days per year (calendar or trading days, depending on what you are using).

Vega

$$Vega = \frac{1}{100} S_0\, e^{-qt} \sqrt{t} * \frac{1}{\sqrt{2\pi}} * e^{\frac{-d_1{}^2}{2}}$$

Rho

$$Call\, rho = \frac{1}{100} X\, t\, e^{-rt} * N(d_2)$$

$$Put\ rho = -\frac{1}{100} X\, t\, e^{-rt} * N(-d_2)$$

Table-1 Calucation of Premium and Its Sensitivities

Particulars	**Companies**				
	BHEL Call Option	**ONGC Put Option**	**HDFC BANK Call Option**	**Tata Motors Put Option**	**Reliance Call Option**
Price of the Underlying	**175.45**	**219.8**	**1040**	**265**	**270**
Risk-Free Interest Rate	**8**	**8**	**8**	**8**	**8**
R : risk free rate of Interest	**0.08**	**0.08**	**0.08**	**0.08**	**0.08**
Strike Price	**190**	**190**	**190**	**190**	**190**
Annual Volatility	**35**	**45**	**30**	**38**	**44**
Volatility (%)	**0.45**	**0.45**	**0.45**	**0.45**	**0.45**
Time to Expiration date left	**30**	**20**	**15**	**10**	**3**
T-t: Time to expiration	**0.082192**	**0.054795**	**0.00015**	**0.00015**	**0.00015**
Price of Call Option	**4.18**	**32.33**	**71.21**	**76.19**	**81.18**
Price of Put Option	**17.48**	**1.37**	**0.04**	**0.03**	**0.02**

Delta for call option	**0.308**	**0.9**	**0.996**	**0.997**	**0.998**
Delta for put option	**-0.692**	**-0.1**	**-0.004**	**-0.003**	**-0.002**
Theta for call option	**-0.144**	**-0.122**	**-0.048**	**-0.046**	**-0.045**
Theta for Put option	**-0.102**	**-0.081**	**-0.007**	**-0.005**	**-0.003**
Gamma for call option	**0.016**	**0.006**	**0**	**0**	**0**
Gamma for Put option	**0.016**	**0.006**	**0**	**0**	**0**
Vega for call option	0.177	0.107	0.009	0.006	0.004
Vega for Put Option	0.177	0.107	0.009	0.006	0.004
Rho for call option	0.041	0.127	0.144	0.144	0.144
Rho for Put option	-0.114	-0.018	-0.001	-0.001	0

From the above table, some of the inferences drawn are mentioned below

1. It was observed that BHEL Call option value 4.18 and put value 17.48.Delta 0.308 for call showing market is increasing and the put value -0.692 and showing underlying is increasing. Delta 0.308 for call showing market is increasing and for put value -0.692 and showing underlying is increasing. Theta value -0.144 and -0.102 because time to expiry is near. Gama for both call 0.016 and put is 0.016 based on time to expiry. Vega is positive 0.177 when volatility increases. Both call and put value 0.041 and -0.114 changes very small friction based on 1 unit change in interest rate.
2. It is observed that ONGC call option value 32.33 and put option 1.37. Delta 0.9 for call showing market is increasing and for put value-0.1 and showing underlying is increasing .Theta value -0.122 and -0.081 because time to expiry is near. Gamma for both call and put is 0.006 based on time to expiry. Vega is positive 0.107 when volatility increases. Both call and put value 0.127 and -0.018 changes very small friction based on 1 unit change in interest rate.
3. It is observed that HDFC BANK call option value 71.21 and put option 0.04. Delta 0.996 for call showing market is increasing and put value -0.004 and showing underlying is increasing. Theta value -0.048 and -0.007 because time to expiry is near. Gama for both call and put is 0 based on time to expiry. Vega is positive 0.009 when volatility increases. Both call and put value 0.144 and -0.001changes very small friction based on 1 unit change in interest rate.
4. It is observed that TATA MOTORS call option value 76.19 and put option 0.03. Delta 0.997 for call showing market is increasing and for put value -0.003 and showing underlying is increasing. Theta value -0.046 and -0.005 because time to expiry is near. Gama for both call and put is 0 based on time to expiry. Vega is positive 0.006 when volatility increases. Both call and put value 0.144 and -0.001 changes very small friction based on1 unit change in interest rate.
5. It is observed that RELIANCE call option value 81.18 and put option value 0.02. Delta 0.998 for call showing market is increasing and for put value -0.002 and showing underlying is increasing. Theta value -0.045 and -0.003 because time to expiry is near. Gama for both call and put is 0 because one day maturity. Vega is 0.004when volatility low. Both call and put value 0.144 and 0 changes very small friction based on 1 unit change in interest rate.

SUGGESTIONS

1) The investor should wait for a time to increase in underlying value to make profits in BHEL.
2) Strike price should increase in ONGC
3) The investor is advised to purchase a call option in HDFC and TATA MOTORS.
4) The investor can generate in-the-money in RELIANCE option
5) By calculating sensitivities one can evaluate the price of option exactly.

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CONCLUSION

This makes the investor to understand how to price an option strategically and make in-the-money in the option market. The Greek letters are used to understand to identify the market price fluctuation or simply it is used to calculate the risk sensitivities in option pricing.

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