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Derivatives Growth Confirming Financial Sustainability: Anecdotes from Derivatives in CBOE & NSE

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EDITORIAL BOARD EXCERPT Initially at the Time of Submission (ToS) submitted paper had a 21% plagiarism and after rectification it was reduced to 16%, which is an accepted percentage for publication. The editorial board is of an observation that paper had been rectified and amended by the authors (Namita, Shoeba and Sufiya) based on the reviewer's remarks at various stages. The comments related to this manuscript are noticeable related to **Derivatives Growth confirming Financial Sustainability** both subject-wise and research-wise. Considering the important role of derivatives in measuring the country's growth, the paper made a modest attempt to study and compare the Indian options with European options. Also findings of the paper are pretty interesting and noteworthy. All the comments had been shared at different dates by the authors' in due course of time and same had been integrated by the authors in calculation. By and large all the editorial and reviewer's comments had been incorporated in paper and the manuscript had been earmarked and decided under "**Empirical Research Paper**" category.

ABSTRACT

Purpose: A country's growth can better be measured in terms of financial indicators; derivatives is one of them. It is one of the evolving instruments to hedge risk and offer information about market and thereby economy. With this background, the objective of the paper is to study and compare the Indian options with European options.

Research Methodology: The data has been used for Nifty and CBOE exchange for 2018-19. To analyse the determinants, options mispricing in B-S model is explained. The linear Granger causality test has been used to identify potential variable to determine implied volatility smile.

Findings: The study finds difference in volatility in both the markets. It is advocated that European market is more mature than nascent Indian market.

Value: Derivatives being the instruments of hedging needs to be developed in India. In this regard the paper study the relationship between implied volatility and money-ness has been analysed and compared in both the markets. The determinants affecting volatility has been identified.

Key Words: Implied Volatility, Volatility smile, smile asymmetry, causality

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Introduction

Derivative is one of the most evolving products of capital market around the world and in India also. It is a type of security whose price is derived from one or more underlying assets. In other words, the value of derivative is dependent on the fluctuations in the underlying assets. The underlying assets may be in the form of bonds, stocks, commodities, currencies, interest rates and market indexes. People use Derivatives as instrument to hedge risk or for speculation. It can be of various types like, future contracts, forward contracts, options and swap.

In this paper we restrict our study to most common types of options i.e., put option and call option options in derivative market. To restrict our study, we are considering option trading only in European Stock Exchange (CBOE) and Indian Stock Exchanges (NSE). As we all knew that Indian option market follows European option style, where options are exercised only at the date of maturity not before, unlike American style. In this paper we are trying to compare the nature of volatility i.e., money-ness between two markets. The comparison is relevant as European option market is much mature in relation to Indian option market.

Review of Literature

Black and Scholes (1973), presents the ground breaking and first successful paper of option pricing formula, also considered as the basic guidelines for pricing another derivative instrument. It originally prices European put or call options on stock and assumes that the underlying stock price follows a geometric brownion motion with constant volatility. Its assumption of no dividend and other distribution of profits makes it practically non-applicable.

Hull and White (1987), takes European call on assets having stochastic volatility and explain option-pricing problem in it. The study concludes that the volatility and stock price both are correlated. Also, as the time to maturity increases, recurrent over-pricing and the degree of that over-pricing of options increases by Black-Scholes model.

Amin and Victor (1993), have extended the equilibrium outline designed by Rubinstein and Brennan to designed an alternative formula for option pricing with systematic and stochastic volatility. In the option valuation process they incorporated interest rate process. This formula may be considered favourable if one can predict mean, covariance processes and volatility for the consumption growth and stock return.

Derman and Kani (1994), argues that as compared to Binomial trees in option pricing, trinomial trees have more parameters. According to this paper implied tree model ensures the consistency of exotic options price with the market price of liquid standard options. It provides more freedom for state space, making it more flexible and advantageous.

Ruubnstein (1994), following the crash of 1987, the study advances a new method for deducing risk-neutral possabilities from concurrently detected prices of S&P 500 index options. The study finds that after the crash, crash-o-phobia causes a slightly bimodal implied distribution. Also, very small pattern changed with respect to post-crash period's shocks.

Bakshi, Chen and Cao (1997), compared different option pricing model with the Black-Scholes model and their pricing and hedging performance. The study examines the S&P 500 call options from June 1st, 1988 through May 31st, 1991. This study observes that Black-Scholes model smile pattern is of clear U-shaped pattern across money-ness levels, whereas, options happen near expiration have most distinguished smile.

Dumas, Fleming and Whaley (1998), focused on the data from June 1998 to December 1993 of S&P 500 options and concentrate on the Deterministic Volatility Function (DVF). The paper concentrates on the results of DVF option valuation model and concludes that it only smoothens Black-Scholes implied volatility.

Jeff Fleming (1998), had examined implied volatility of S&P 100 as a forecast of market volatility. The result shows that although, implied volatility contains relevant information about future volatility, yet it is biased on a positive slope. It further suggests that linear model is useful in estimating conditional volatility as they rectifies the volatility bias.

Heston and Nandi (2000), concluded that unlike Black-Scholes formula the parameters of GARCH model are held constant, yet this model even superior. Under this empirical study of the option prices of S & P 500 are conducted and concluded that the valuation errors are less in GARCH as compared to Black-Scholes model.

Hafner & Wallmeier (2000), use daily call and put prices of duration 1995 to 1999, to find determinants and pattern of DAX implied volatility across exercise prices. The outcomes are that the data fit very accurately and also reveal cross-sectional disparity of implied volatilities.

Beber (2001), examined the volatility smile of Italian stock index Mib30 for a period ranging from 1995 to 1998 and thereby studies the determinants of volatility smile. He concludes that time to expiration, historical volatility and number of options contracts have linear relationship and causes asymmetrical smile profile.

Verma (2001), analysed futures and options prices of Nifty for a shorter period starting from June 2001 to February 2002 for studying the mispricing of volatility. The study concludes that the probability of market improvements in either direction is underestimated in market and there exists severe under-pricing volatility. It also observes inconclusive evidence of put-call parity violation and overpricing of deep in-the-money calls.

Pierre Giot (2005), their findings on S&P 100 and NASDAQ 100 stock indexes and their corresponding implied volatility indexes are negatively correlated. For S&P 100, there exist an asymmetric correlation, while for NASDAQ the asymmetry is weak. It concludes that high levels of implied volatility are the results of positive forward-looking returns.

Misra et al. (2006), study the data for NSE Nifty options from Jan. 1, 2004 to Dec. 31, 2004 to examine volatility surfaces and factors responsible for implied volatility. The study concludes that, volatility for in-the-money out-of-the-money call option is comparatively higher than in-the money calls; the far month contracts have higher implied volatility in comparison with near month contracts.

Vijayakumar (2008), study the determinants of implied volatility function on Nifty Index options market. With the help of linear regression model, they conclude that there is a positive asymmetry profile for both and put options. Based on their findings they further conclude that Black-Scholes Model is still useful in present scenario.

Becker & Clements (2008), make a contrast between implied volatilities and model-based forecasts and thereby concludes the implied volatility reflects potential information that later couldn't. It also concludes that Deterministic Volatility Functions (DVF) performs well to evaluate option market volatility forecasts as compared to traditional Black-Scholes model.

Ahoniemi Lane(2009), advocates the method of time varying multiplicative error model (TVMEM) to calculate the implied volatility of call and put options on the USD/EUR exchange rates. It further concludes that mean squared error reduces if we use bivariate model instead of univariate model.

Constantinides (2009), argued that Black-Scholes model is a good indicator in case of pre- crash option prices. While Black-Scholes model misprices, the index related to time series data. It advocates the supremacy of DVF over Black-Scholes model. Also contradicts the findings of B-S model that decrease in violations indicate that option market has become more rational.

Berkowitz(2010), defend the practicability of Black-Scholes option pricing model and concludes it as best. It conducts simulation study regarding the various useful ingredients like sample size, order of polynomial etc. to show the impact on option price. It has gathered data from S&P 100 options to prove that Black-Scholes model results are quite authentic.

Corrado & Su (2014), argues that Black-Scholes Model mispriced deep-in-the-money and deep-out-of-the-money options. The paper examines the biases of non-normal skewness and kurtosis of stock-return distribution by using B-S model. Gram-Charlier series expansion of the normal density function has been used to calculate skewness and kurtosis adjustments of B-S formula. The paper concludes that measurement of skewness and kurtosis derives by option prices are non-normal.

Objectives

1. To study the nature of money-ness in Indian option market.
2. To study the nature of money-ness in European option market.
3. To compare the nature of money-ness in Indian option market with that of European.
4. To determine the factors affecting implied volatility.

Research Design

For Indian market, S&P CNX Nifty Index of options contract, from the NSE derivative segment has been taken. Similarly, data from CBOE has been gathered for European market. As Indian option market is based on European style having trading cycle of three months, ranging from near month, next month and far month. In both the market the expiry date of option contract is last Thursday of a month. Option premium value is computed using Black-Scholes (1973) model as defended by Hull & White (1987), Duman, Fleming & Whaley (1998), Beber(2001), Berkowitz(2010) and many others.

Nifty options' put and call data consisting of daily closing prices and trading volumes for option having near month maturity for the period starting from 1st April 2018 to 31st March 2019 has been gathered from the NSE website. 91-day Treasury Bill rates (estimates of risk-free rate of return) has been gathered from RBI website, which in turn is used for calculating IV. Likewise, European Index options daily put and call data consisting of closing prices, trading volumes, underlying value and volatility index has been gathered from CBOE website. On the data so gathered, various filtration process has been applied.

Options closing prices having zero transactions are first eliminated. Secondly, to consider options data only for near month, last five trading days to expiration are eliminated.

Initially IV (σ_{it}) calculated for each European Call (C_{it}) and Put (P_{it}) data of the concerned sample, by using Black-Scholes (1973) formula.

$$C_{it} = S_0 (Nd_1) - Ke^{-rt} N (d_2) \quad (1)$$
$$P_{it} = Ke^{-rt} N(d_2) - S_0 N(-d_1) \quad (2)$$

Where, $d_1 = \frac{\ln(S_0/K) + (r + \sigma_{it}^2/2)T}{\sigma_{it} \sqrt{T}}$

$d_2 = d_1 - \sigma_{it} \sqrt{T}$

N(x) = Cumulative Probability Distribution Functions

S_0 = Stock-Index Price at time zero

K = Strike Price

r = Continuously Compounded risk-free Rate of Return 91-days Treasury-bill Yield Rate)

T = Time to Expiration of an Option

First, average of option price relative to each day average implied volatility has been calculated and then money-ness measured as a ratio between the exercise price and the averages calculated previously. Money-ness can be computed in different ways as described in the coming paragraphs.

Firstly, it can be measured as a ratio of option strike price to the underlying index price (Jackworth and Rubinstein,1996). In other words, it can be calculated that as an absolute difference between strike price index and index value as a proportion to index value (which is further referred as M1). An improvised measure of money-ness also calculated by incorporating volatility and time to maturity, (hereafter referred as M2). Another approach to calculate money-ness is with the help of delta, (hereafter referred as M3) which is almost like Black-Scholes model (Beber, 2001).

Due to non-availability of certain parameters in both the markets we restrict our study to M1 only. Thus, in this paper further we calculate money-ness in Indian and European option market using M1 and thus discretion is based on its value only.

To calculate relationship between volatility money-ness linear and quadratic regression models have been used (Shimko, 1993; Dumas et al., 1998; Beber, 2001).

$$\text{Model 1: } Y = \beta_0 + \beta_1 X + \varepsilon \quad (3)$$
$$\text{Model 2: } Y = \beta_0 + \beta_1 X + \beta_2 X^2 + \varepsilon \quad (4)$$

Where, Y = Implied Volatility

X = Money-ness of the Option

For simplicity, we are hereafter considering only linear equation and ignoring quadratic equation. To avoid time varying sensitivity to implied volatility, we fit the models on every trading day separately and for simplicity we assume IV is constant during the day. The average of daily estimates for the required parameters are computed for this purpose.

After rearranging the variables, we get the following equations:

$$Y_{t,\tau} = \beta_0 + \beta_1 X_{t,\tau} + \varepsilon \quad (5)$$

Where, Y = Implied Volatility

X = Measure of Money-ness

t = Trading Days

τ = Options' time to maturity

Table 1

Indian Option Market

Call R square=0.302995

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.24251	0.005235	46.3206	0
M1	2.240997	0.034799	64.39918	0

Put R square=0.17721

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0.747007	0.003916	190.7604	0
M1	1.094483	0.025372	43.13674	0

European Option Market

Call R Square=0.009923

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	2.700967	5.283925	0.511167	0.609571
M1	0.016717	0.007999	2.08986	0.037384

Put R square=0.033769

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	36.45203	6.364386	5.727501	2.27E-08
M1	-0.01553	0.004351	-3.56971	0.00041

By fitting the least square linear model, we calculate various results, which are shown in Table 1. The reported parameters i.e., adjusted R^2 is calculated with estimated parameter averages for the whole period. With the help of parameters average value and average standard error, t-statistics have been computed. The mean intercept β_0 given by the equation 5 shows the IV's general level, which is neutral of money-ness. Similarly, β_1 represents mean slope which is sensitivity towards money-ness.

A significant value of β_1 for call and put both in Indian market is found to be positive, which reflects the asymmetry in market, arises due to the existence of immature market. The positive asymmetry is in violation of various characteristics of most mature markets, and may be attributed to biases in expectations of volatility. While if we look at European market, β_1 is negative for put whereas positive for call, indicating a different behaviour. The results for European market are significant too, implying that investors in European market are immature in case of call but they behave differently for put options. It may be interpreted from the results that although Indian option market is much newer than European option market still in case of call options both the markets show positive asymmetry, i.e., immature. But put option market shows a remarkable maturity having negative asymmetry in European option market compared to Indian option market.

Analysis

1. Time to Expiration-(expiration date-trading days)/252
2. Options Market Liquidity-sum of all strike prices
3. Momentum-21-day simple moving-average
4. Historical Volatility-previous 14-days annualised standard deviation
5. Volatility of Volatility-standard deviation of previous 14-trading days volatility

Table 2 shows the bi-directional causality results of individual determinants with β_1 (money-ness calculated with M1 is considered). Based on the findings, we may conclude that for call.

TEXP causes money-ness, while money-ness causes HVOL, which is consistent with mature markets but not completely. Moreover, if we concentrate on put options, we may find that none of the determinants causes money-ness, but money-ness causes MOM and HVOL. In Indian market, we may say that being immature; there are mainly momentum traders who ignore the hedging role of options.

Conclusion

The results show that both the markets show remarkable difference in terms of money-ness. Positive asymmetry for both put and call options, in Indian market, depicts a high level of immaturity. The positive asymmetry may be due to higher transaction cost, in violation to B-S Model (1973) and short-selling restrictions in Indian market. It shows exactly opposite behaviour of investors in terms of positive asymmetry i.e., there are mainly momentum traders who ignore the hedging role of options. While the result for call in European market, being oldest one in option trading, still shows signs of immaturity in terms of positive asymmetry. Put of the European market exactly commensurate with the market maturity and shows negative asymmetry. In causality results we find, for call only TEXP causes money-ness while money-ness causes HVOL. For put only money-ness is responsible for HVOL and MOM. Moreover, the source of these dependencies is not describing by the tests.

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The Editorial Board had used the turnitin plagiarism [http://www.turnitin.com] tool to check the originality and further affixed the similarity index which is 16% in this case (See Annexure-I). Thus the reviewers and editors are of view to find it suitable to publish in this Volume-11, Issue-3, Jul-Sep, 2019

Annexure 1

Submission Date	Submission Id	Word Count	Character Count
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Reviewers Comments

Reviewer's comment 1:
The paper is quite contemporary in nature. Derivatives being the instruments of hedging need to be developed in India. So there is a need of studies of these kinds.

Reviewer's comment 2:
In the manuscript, the data has been used for Nifty and CBOE exchange for 2018-19. This means very recent data has been used.

Reviewer's comment 3:
The paper has a quite strong review of literature portion. Each and every literature is very well explained.

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