

# IMPACT ON INDIAN STOCK MARKET VOLATILITY

**Dr. R. PALANISAMY**

**M.Com., M.Phil., C.I.L.P., NET(UGC), Ph.D.**

Assistant Professor,

Department of Commerce (BPS and CM)

Krishna Arts and Sciences College (Autonomous),

Kuniamuthur Coimbatore

## ABSTRACT

The research focused on the volatility implications of the introduction of derivatives on stock market volatility in India using the S&P CNX Nifty Index as a benchmark. To account for non-constant error variance in the return series, a GARCH model is fitted by incorporating futures and options dummy variables in the conditional variance equation. The researcher find clustering and persistence of volatility before and after derivatives, while listing seems to have no stabilization or destabilization effects on market volatility. The post-derivatives period shows that the sensitivity of the index returns to market returns and any day-of-the-week effects have disappeared. That is, the nature of the volatility patterns has altered during the post-derivatives period.

## 1. INTRODUCTION

The modelling of asset returns volatility continues to be one of the key areas of financial research as it provides substantial information on the risk patterns involved in investment and transaction processes. A number of works have been undertaken in this area. Given the fact that stock markets normally exhibit high levels of price volatility, which lead to unpredictable outcomes, it is important to examine the dynamics of volatility. With the introduction of derivatives in the equity markets in the late nineties in the major world markets, the volatility behaviour of the stock market has become further complicated as derivatives open new avenues for hedging and speculation. The derivatives market was launched mainly with the twin objectives to transfer risk and to increase liquidity, thereby ensuring better market efficiency. The examination of how far these objectives have materialised is important both theoretically and practically.

In India, trading in derivatives started in June 2000 with the launch of futures contracts in the BSE Sensex and the S&P CNX Nifty Index on the Bombay Stock Exchange (BSE) and National Stock Exchange (NSE), respectively. Options trading commenced in June 2001 in the Indian market. Since then, the futures and options (F&O) segment has been growing continuously in terms of new products, contracts, traded volume and value. At present, the NSE has established itself as the market leader in this segment in India, with more than 99.5 percent market share. The F&O segment of the NSE outperformed the cash market segment with an average daily turnover of Rs291.91 billion, as compared to Rs114.79 billion in the cash segment from 2006 to 2007 (Derivatives Updates on NSE website, www.nseindia.com, 2007). This shows the importance of derivatives in the capital market sector of the economy. Previous studies on the volatility effects of derivatives listing provide mixed results, suggesting case-based biases. In addition, in India, there is a lack of robust examination of the impact of derivatives on market volatility. In India, trading in derivatives contracts has existed for the last six years, which is an adequate time period to evaluate its major pros and cons. Against this backdrop, it is important to empirically examine the impact of derivatives on the stock market.

In this research, we attempt to study the volatility implications of the introduction of derivatives on the cash market. Through this study, we seek evidence regarding whether the listing of futures and options lead to any significant change in the volatility of the cash market in India. We select a general index called the S&P CNX Nifty Index to which the first derivatives contract was introduced by the NSE in India. The previous study noted the peculiar characteristics of IT stocks and arrived at the conclusion that stock-specific characteristics must be studied for any general conclusion. As a benchmark index, the Nifty Index is expected to show wider, more balanced and more applicable results and thus can be treated as a true replica of the Indian derivatives market. Most of the Indian studies did not consider options contract, but this study examines the introduction of options while also analysing volatility. The period under analysis spans from October 1995 through June 2006. Furthermore, to allow for a non-constant error variance in the return series, we applied a GARCH model that was more appropriate to describe the data collected. Therefore, the present work offers a valuable addition to the existing literature and should prove to be useful to investors as well as regulators.

## Review of literature

**Muzammil Hussain, et al., (2015)<sup>1</sup>** identified in their research that the relationship between stock returns volatility and macroeconomic variables in Pakistan. This study had used monthly observations covering the period from 2001-01 to 2011-06. First, Exponential Generalized Autoregressive Conditional Heteroskedasticity (2, 2) model was used to analyze the volatility in stock returns. Graph of news impact curve shows that higher risk was contributed toward negative shocks in stock market as compared to positive shocks of the same magnitude. In the next step the researcher had explored the macroeconomic determinants of stock market volatility through ARDL approach because variables were I (0) in addition to I (1). Results from ARDL approach revealed that macroeconomic variables were responsible factors in explaining stock market volatility. Inflation, real exchange rate and oil prices were found encouraging factors of stock market volatility while Industrial sector output and real supply of money affects the volatility negatively.

**Namrata Sandhu, et al., (2015)<sup>2</sup>** found in their research that growth theorists opine that there was a significant and positive correlation between stock market development and economic growth. Well-developed stock markets mobilize savings and boost investments. However, the Indian retail investors exhibit a remarkable reluctance in investing in the stock market. Given this contention, this study attempts to examine the reasons for the same. Analysis of the views of 234 Indian investors, who do not invest in the stock market, reveals seven factors that impede stock market investments - myths regarding suitability of stock market instruments, volatility, poor understanding, multiple incomprehensible risks, uncertain returns, fraudulent practices and psychological fears.

**Deepak Agrawal, et al., (2015)<sup>3</sup>** evaluated in their study that the impact of derivatives on various stock characteristics such as valuation, price efficiency, and liquidity. They resolve the endogeneity issue faced in the extant literature by using an order issued by the Indian market regulator that resulted in the delisting of 51 stocks from the derivative segment. Using this policy experiment, they examine the connecting hypothesis regarding the impact of derivatives on stock fundamentals. They find that excluded firms underperform the market by 4.07% during the event window. They identify a decline in price efficiency and reduction in liquidity as channels through which the above phenomenon manifests. Contrary to the expectations of the regulators, volatility remains largely unchanged. They rule out regulatory targeting by employing several placebo and robustness tests. They conclude that derivatives indeed add value by improving price efficiency and liquidity of a stock.

**Sathya, (2015)<sup>4</sup>** explored in the research that the compares the equity, commodity, and currency derivatives in India – evidence from future market. This study focus on the risk and return associated with derivatives used in equity, commodity, and currency market in India. The average and standard deviation to access the risk and return factor and also comparative tool for correlation analysis were used to find out relationship among risk and return. It was found that the risk premium of equity was essentially the same as commodity, equity returns were negatively correlated with commodity return and currency return and also found that the equity, commodity, and currency of derivatives were used for hedging purpose

**Sumbul Kabir, (2015)<sup>5</sup>** reported in the study that the India, Derivatives trading commenced since June 2000 with the introduction of Stock Index Futures by BSE and NSE. Futures and Options were hedging instruments. This study provides a theoretical background to and pragmatic confirmations of the impact of Index futures on the spot market volatility. This study was based on closing price returns as well. The sample data comprise of daily opening and closing price returns of S&P CNX Nifty and S&P Nifty Index futures from June1997 to June 20012. Previous studies had used different time series techniques like Event Study, IGarch, ECM, OLS, etc. to access the impact of derivatives on the spot market volatility. The present study uses family of GARCH techniques to confine

<sup>1</sup> Muzammil Hussain, Bedi-uz-Zaman and Nisar Ahmad, (2015). Relationship between stock Market volatility and Macro economic variables: Evidence from pakistan. *Pakistan Business Review* 2015, 723-743.

<sup>2</sup> Namrata Sandhu, Dilpreet Singh, & Niharika Mankotia (2015). Perceptual Factors Impeding Stock Market Investment - An Empirical Study. *International Conference on Technology and Business Management*, 120-124.

<sup>3</sup> Deepak Agrawal, K R Subramanyam, Prasanna Tantri & Ramabhadran, S Thirumalai, (2015). Do Derivatives Matter?: Evidence From A Policy Experiment. 1-49.

<sup>4</sup> Sathya, S. (2015). A Comparative Study on Equity, Commodity, Currency Derivatives in India - Evidence from Future Market with special reference to BSE Ltd, Mumbai. *International Journal of scientific research and management*, 3 (2), 2175-2182.

<sup>5</sup> Sumbul Kabir, Saraswathi, S. & Ramakrishna, Y. (2015). A Pragmatic Investigation on Index Futures Trading and Volatility in Indian Spot Market. *International Journal of Marketing, Financial Services & Management Research*, 4 (7), 171-186.

the time varying nature of volatility and the effect of Index Futures on Spot market in India. The pragmatic evidence suggests that Index futures reduced the volatility of the spot market and the structure of the volatility had been changed to some amount.

**2016 Divya Verma Gakhar, (2016)<sup>6</sup>** observed in the study that Derivatives Market had an important role to play in the economic development of a country. The objective of the study was to examine the impact of financial derivatives (futures and options) on the underlying market volatility. The study also analysed derivatives awareness level of Indian investor and perception of investor about future of derivatives market in India. Data had been collected for a period of 18 years from January 1, 1997 to February 5, 2015. The questionnaire was distributed to 1000 respondents but 522 filled questionnaires were received and had been analyzed in this study. The final AR (1)-GARCH (1,1) model showed that overall volatility had reduced in the spot market after the introduction of derivatives. The results of Structural Equation Modelling revealed perception of investors about future of derivatives market in India includes having an investor grievance redressal mechanism which is approachable under trading hours, steps to be taken by regulators to increase investments, conducting investor training and awareness programmes, global integration will happen, derivatives market will affect growth of the economy and consolidation of exchanges was required.

**2016 Rabia Najaf and Khakan Najaf, (2016)<sup>7</sup>** analysed in their research that the relationship between Indian rupee-US dollar exchange rate and Nifty returns. This research was based on dynamic behavior between stock markets movement and volatility of stock market for this purpose; they had applied several statistical tests. They had taken the data from period of October 2008, to March, 2010. It study had proved that exchange rate and Nifty returns were non-normally disturbed. Unit root tests had proved that Nifty returns and exchange rate were stationary and they were stationary at level form. There was negative relationship between exchange rate and Nifty returns exchange rate. For testing the causal relationship between these variables they had used Granger causality test. This test had shown that there was unidirectional relationship between exchange rate and Nifty returns. This study was trying to attempt that stock market was crucial for the economy. Different researchers had proved from their research that exchange rate was the main determinates of business profitability. This study had provided such type of information, which would be favorable for the gaudiness of management decision about the risk and investment. This information will be beneficial for government policies. The maintenance of foreign exchange would motivate the foreign investors.

**2016 Sachita Yadav, (2016)<sup>8</sup>** obtained in the study that financial market of a country signified the financial strength of an economy. A good financial health of a country helped in enhancing the cash flow and creates capital, which contributed to develop a country. After privatization and globalization, financial market had entered into a new segment of global integration and liberalization with lots of new and innovative financial instruments. The stock market was unpredictable as the prices were changed very frequently. During the year 2001, India had launched a risk minimizing tool and that was Derivatives. The idea behind announcing derivatives trading in India was to control over the fluctuations in the stock and commodity prices. It also facilitated in increasing the trading volume in the stock market and cash flows in India. This study was going to find out the impact of financial derivatives on the spot stock market volatility. In this regard enormous studies had been conducted by various researchers of the world. Numerous readings contributed different outcomes regarding the impact of the financial derivatives on the spot market volatility. This created a confusion regarding increasing or decreasing volatility in the stock market due to the introduction of derivatives trading in the stock market. So, there was a requirement to stretch an overview of the literature review. The conclusion of various studies is to be analyzed in this research, so that the role of derivatives trading can be understood in context to the volatility of the stock market.

**2016 Saurabh Singh and Tripathi, (2016)<sup>9</sup>** determined in their research about one of the most important issues that had engaged the financial managers and the academicians in Finance all over the world was the financial markets volatility and the need to forecast it accurately. The stock prices depend on the investment behavior which, in turn, was affected by the efficiency of volatility forecasting. The purpose of this study was to examine the volatility in the Indian stock market after the introduction of futures contracts on the SENSEX index. To explore the time series properties Unit Root Test and ARCH LM test had been employed. GARCH (1,1) model had been applied to study the impact on underlying volatility, for this sample period of 26 years had been taken. The results of this study indicated that the introduction of futures leads to a significant change in the spot market volatility of the SENSEX index and it was successful in reducing the volatility.

<sup>6</sup> Divya Verma Gakhar, (2016). Indian Derivatives Market: A Study of Impact on Volatility and Investor Perception. *International Journal of Social Science and Humanity*, 6(12), 913-918.

<sup>7</sup> Rabia Najaf, & Khakan Najaf, (2016). A study of exchange rates movement and stock market volatility. *International Journal of Research - Granthaalayah*, 4(1), 70-79.

<sup>8</sup> Sachita Yadav, (2016). Impact of derivatives trading on the volatility of stock market in India: A review. *Asian Journal of Management Research*, 6(3), 567-579.

<sup>9</sup> Saurabh Singh, & Tripathi, L.K. (2016). The Impact of Derivatives on Stock Market Volatility: A Study of the Sensex Index. *Journal of Poverty, Investment and Development*, 25, 37-44.

**2016 Subbalakshmi, (2016)<sup>10</sup>** inferred that in the year 1990's financial sector reforms had changed the Indian capital markets into a dynamic and extensive in the context of world financial market. With the arrival of globalization in India accurate efforts were made in strengthening the investor assurance. Financial markets were very resourceful in increasing the popularity of derivatives instruments which exemplified how resourcefully markets were capable to package and manage risk. At the present in world markets for trade and business have become further incorporated, derivatives have strengthened these significant linkages between global markets, increasing market liquidity and effectiveness. In India, the emergence and growth of derivatives market was relatively a recent phenomenon. By underling asset prices, derivative products lessen the effect of fluctuations in asset prices on the profitability and cash flow position of riskaverse investors. Derivatives had been commenced in June 2000, derivatives market had exhibited exponential growth both in terms of volume and number of contract traded. Thus the present study was an effort to analyze derivative trading in India, rules and regulation in relation to Indian stock market. It was an endeavor to demonstrate the growth and expansion of financial derivative of NSE in India in the time period 13 years.

**2017 Chakrabarti, et al., (2017)<sup>11</sup>** explored in their study that two portfolios with the same payoffs should be priced similarly if it doesn't happen, then there exists an arbitrage opportunity where the trader can make a profit, the trader can sell the higher priced portfolio and buy the cheaper portfolio. Arbitrage brings back prices of such portfolios to their fundamental price. They had surveyed literature discussing the limitation to arbitrage and research related to arbitrage opportunities in financial markets. In this study they found such arbitrage opportunities using the NIFTY 50 stocks. The research was divided into two sections – the Spotfutures and Put-Call options. The mispricing in spot and futures markets had been found in stocks such as IDEA, ONGC, BPCL, COALINDIA, BHARTIARTL, INDUSINDBK, GAIL, YESBANK, KOTAKBANK, AUROPHARMA, BANKBARODA, TATAPOWER, MARUTI, HCLTECH, HEROMOTOCO, ICICIBANK. All the stocks are found to be in the normal backward markets. Some of the profits after all the transaction expenses were deducted were as follows: BPCL – Rs.3.08 per share; COALINDIA – Rs.1.48 per share; BHARTIARTL – Rs.1.25 per share; MARUTI – Rs.1.35 per share. The mispricing in spot and options market were also found in various stocks such as BHEL, BHARTIARTL.

**2017 Palamalai Srinivasan and Vasudevan, (2017)<sup>12</sup>** examined in their research that the linkage between the change in implied volatility index and the underlying stock index return in the Indian stock market. The empirical results revealed that the contemporaneous return was the most important factor that determined the changes in the current India implied volatility. Besides, the empirical evidences confirmed the negative asymmetry volatility- return relation, supporting the behavioral explanations (the affect and representativeness heuristics) rather than financial leverage hypothesis

## STATEMENT OF THE PROBLEM

Some experts in financial markets also hold a view that derivatives markets solely create market efficiency and hence, find no ground for regulation within the financial sector and derivatives trading. There are still disagreements on what role derivatives trading play regarding the stock market volatility. Taking into consideration the above factors there is a need to study the impact of derivatives contracts on Indian market.

The focus area of this thesis is to investigate the role of Index futures and Stock futures trading on the volatility of the Indian spot markets. At this juncture, the researcher has been probed the following questions.

What extent the impact of index futures and stock futures trading on the Indian spot market volatility?

What extent the impact of derivatives trading on price discovery in Indian Stock Market?

How the impact of derivatives trading on Indian Stock Market volatility of indices and individual shares?

## OBJECTIVES OF THE STUDY

Based on the above research problems, the followings objectives have been framed for examining the impact of derivatives in Indian Stock Market.

1. To estimate the level of volatility prevailing in the Indian stock market.
2. To study the impact of derivatives trading on price discovery.
3. To analyze the impact of derivatives trading on stock market volatility of indices and that of individual shares.

## RESEARCH DESIGN

The present study utilizes **Descriptive Research Design**. Descriptive research design is a scientific method which involves observing and describing the behavior of a subject without influencing it in any way. Though the study is primarily descriptive in nature, it also utilizes Experimental research

<sup>10</sup> Subbalakshmi, S. (2016). An Empirical Study on Derivative Trading in India. *International Journal of Research and Development - A Management Review*, 5(3), 96-100.

<sup>11</sup> Chakrabarti, B.B., Rambabu, A., Swapnil Chaudhari, Tarun Sangishetty, & Ramesh Naidu, (2017). Arbitrage Opportunities in Indian Derivatives Market. *Indian Institute of Management Bodh Gaya Turi Buzurg, Bihar*, 1-17.

<sup>12</sup> Palamalai Srinivasan, & Vasudevan, R.D. (2017). Linkage between India Implied Volatility Index and Stock Index Returns. *Theoretical Economics Letters*, 7, 929-938.

design where we have controlled the impact of other macro economic factors on volatility.

### Data Collection

The historical stock price time series data & the data on indices have been collected from the official website of National Stock Exchange of India i.e. www.nseindia.com. Other sources of data collection include various books, newspapers, journals, & internet.

The data set comprises of time series data on 125 individual stocks and 2 indices from National Stock Exchange (NSE) of India. NSE is India's leading stock exchange and records highest trading volume in the derivatives segment. It is one of the 5<sup>th</sup> largest exchange in the world in terms of number of derivatives contracts traded. Daily closing stock prices have been used to find the impact of derivatives trading on stock market volatility.

The data has been analyzed over a span of 14 years 4 months starting from 9<sup>th</sup> November 2001 to 29<sup>th</sup> February, 2016. Fourteen years is quite a good span of time to study the impact of any policy implication.

In this study, it has tested the impact of introduction of Index Futures and Single Stock Futures on volatility. So, the data comprises of two categories:

- Data related to individual stocks.
- Data related to indices.

### Sample Selection

The study incorporates a sample of 10 such stocks on which derivatives are available. The stocks on which futures and options are made available are chosen by the exchange from amongst the top 50 stocks in terms of average daily market capitalisation and average daily traded value in the previous six months on a rolling basis. Considering the availability of longer time series data, 10 stocks have been selected randomly from all such stocks on which derivatives are traded at NSE.

### Software used

The data has been analysed using Eviews 7.0 and Microsoft Excel.

### Statistical tools

The following statistical tools have been used in the study:

### Statistical tools

The following statistical tools have been used in the study:

**ADF test** : Before estimating the models, the unit root properties for the time series data have been tested individually for all the stocks and indices using Graphical method & ADF test statistic. Graphical method gives a visual estimate of the stationarity of the series which has been confirmed by ADF test statistic. Augmented Dickey fuller test is given by the following equation:

$$ADF = \Delta y_t = \alpha y_{t-1} + x_t' \delta + e_t$$

Where  $\alpha$  &  $\delta$  are parameters to be estimated &  $e_t$  is white noise error term

The ADF tests the following hypothesis:

H0:  $\alpha = 0$  (series has a unit root)

H1:  $\alpha < 0$  (series does not have a unit root) and is evaluated using t ratio.

### ARCH & GARCH Models

A way to build an ARCH model consists of three steps. Step (1) builds an econometric model for example an ARMA model for the return series to remove any linear dependence in the data and use the residual series of the model to test for ARCH effects. Step (2) specifies the ARCH order and performs estimation. Step (3) involves checking the fitted ARCH model carefully and refining it if necessary.

Linear models such as:

$$Y_t = \alpha_0 + \alpha_1 X_t + e_t$$

Where:  $\beta_0$  - intercept,

$\beta_1$  - slope of the function

$\epsilon_t$  - an error term containing all the factors affecting  $Y_t$  other than the specified independent variable(s) & where  $\epsilon_t \sim N(0, \sigma^2)$  models the mean of the time series.

These models are based on certain assumptions about the error terms such as

1. There is no correlation between the error terms.
2. No correlation between the independent variable & the error term  
i.e.  $E(\epsilon|X) = E(\epsilon) = 0$ ,
3. The variance of the error term is constant.
4. The error term is normally distributed.

TABLE NO .1

ARCH & GARCH COEFFICIENTS FOR INDIVIDUAL STOCK FUTURES

S.No.	COMPANY	ARCH ( $\alpha$ )	GARCH ( $\beta$ )	( $\alpha+\beta$ )
1.	ACC Ltd.	0.213058 (0.0000)	0.706101 (0.0000)	0.919159
2.	ADANI	0.131672 (0.0000)	0.845310 (0.0000)	0.976982
3.	AMBU	0.098902 (0.0000)	0.883822 (0.0000)	0.982724
4.	ASIAN	0.133145 (0.0000)	0.839069 (0.0000)	0.972214
5.	AXIS	0.121483 (0.0000)	0.850198 (0.0000)	0.967305
6.	BAJAJ	0.066482 (0.0000)	0.905716 (0.0000)	0.972198
7.	BOB	0.135283 (0.0000)	0.773824 (0.0000)	0.909107
8.	BHEL	0.163476 (0.0000)	0.804766 (0.0000)	0.968242
9.	BPCL	0.131471 (0.0000)	0.849711 (0.0000)	0.981182
10.	BHAR	0.110064 (0.0000)	0.875538 (0.0000)	0.985602

**Note:** Figures in the parenthesis report p values

Level of significance 5%

The results presented in table Table no 1 show that the stocks have experienced changes in the structure of volatility after introduction of derivatives and have experienced a stronger persistence of volatility in comparison to derivative period.

#### Findings and suggestion

Out of the 10 stocks analyzed in the above table, stocks report a simultaneous decrease in ARCH term & an increase in GARCH term. Thus, 60% of the total stocks report that the impact of new news on volatility has declined and the impact of old news on volatility has increased. i.e just 40% of the total stocks go with the theoretical viewpoint that derivatives lead to more efficient markets by quicker dissemination of information and hence lead to price discovery. Out of the remaining stocks, 5 report increase in both ARCH & GARCH terms. Only one stock ASIANPAINT report a decrease in both ARCH & GARCH terms in the derivative period i.e., a slower dissemination of new information and shorter impact of news leading to a lower persistence of volatility in general

## Reference:-

1. Muzammil Hussain, Bedi-uz-Zaman and Nisar Ahmad, (2015). Relationship between stock Market volatility and Macro economic variables: Evidence from Pakistan. *Pakistan Business Review* Jan 2015, 723-743.
2. Namrata Sandhu, Dilpreet Singh, & Niharika Mankotia (2015). Perceptual Factors Impeding Stock Market Investment - An Empirical Study. *International Conference on Technology and Business Management*, 120-124.
3. Deepak Agrawal, K R Subramanyam, Prasanna Tantri & Ramabhadran, S Thirumalai, (2015). Do Derivatives Matter?: Evidence From A Policy Experiment. 1-49.
4. Sathya, S. (2015). A Comparative Study on Equity, Commodity, Currency Derivatives in India - Evidence from Future Market with special reference to BSE Ltd, Mumbai. *International Journal of scientific research and management*, 3 (2), 2175-2182.
5. Sumbul Kabir, Saraswathi, S. & Ramakrishna, Y. (2015). A Pragmatic Investigation on Index Futures Trading and Volatility in Indian Spot Market. *International Journal of Marketing, Financial Services & Management Research*, 4 (7), 171-186.
6. Divya Verma Gakhar, (2016). Indian Derivatives Market: A Study of Impact on Volatility and Investor Perception. *International Journal of Social Science and Humanity*, 6(12), 913-918.
7. Rabia Najaf, & Khakan Najaf, (2016). A study of exchange rates movement and stock market volatility. *International Journal of Research - Granthaalayah*, 4(1), 70-79.
8. Sachita Yadav, (2016). Impact of derivatives trading on the volatility of stock market in India: A review. *Asian Journal of Management Research*, 6(3), 567-579.
9. Saurabh Singh, & Tripathi, L.K. (2016). The Impact of Derivatives on Stock Market Volatility: A Study of the Sensex Index. *Journal of Poverty, Investment and Development*, 25, 37-44.
10. Subbalakshmi, S. (2016). An Empirical Study on Derivative Trading in India. *International Journal of Research and Development - A Management Review*, 5(3), 96-100.
11. Chakrabarti, B.B., Rambabu, A., Swapnil Chaudhari, Tarun Sangishetty, & Ramesh Naidu, (2017). Arbitrage Opportunities in Indian Derivatives Market. *Indian Institute of Management Bodh Gaya Turi Buzurg, Bihar*, 1-17.
12. Palamalai Srinivasan, & Vasudevan, R.D. (2017). Linkage between India Implied Volatility Index and Stock Index Returns. *Theoretical Economics Letters*, 7, 929-938.