International Journal of Modern Agriculture, Volume 9, No.3, 2020
ISSN: 2305-7246

SPOT VOLATILITY PREDICTION BY FUTURES AND OPTIONS: AN INDIAN SCENARIO

Arpita Sharma[*], Shailesh Rastogi

Symbiosis Institute of Business Management

Symbiosis International (Deemed) University, Pune, India

Email: **arpitasharma@sibpune.edu.in**

Abstract

There are a plethora of studies on the determinants of the spot volatility. The issue of determining spot volatility becomes more convoluted and esoteric when the security concerned also trade-in options and futures markets as its derivative instrument. Most of the research seems to inadequately address the issue of a determinant of spot volatility using only options market and leaves futures market unaccounted for. This paper is an attempt to fill the gap and includes both the markets to determine the spot volatility. Spot volatility measures are regressed on options volume and futures volume using multiple regression analysis. Both the acceptable and popular measures of volatility, GARCH (1,1) estimates, and implied volatility, are used to represent spot volatility. The regression results for options volume as well as futures volume are statistically significant in both the regressions of GARCH (1,1) estimates and implied volatility. This result adds value to the existing lode of knowledge that not only options volume but also the futures volume determines the spot volatility. This is the unique contribution of the present study. Informed investors and equity researchers can reasonably use the findings of this paper to value the shares and predict the future share price, which are the major implications of the study. However, diagnostic testing and model specification is not consistent which are the limitations of the present study. A further study with the improved model specification can be the future scope of the study on the topic.

Key Word: Options; Futures; Volatility; Markets; Volatility Spillover

1. Introduction

The securities which have their futures and options contracts as well, practically are traded in the three markets together (Rastogi and Athaley, 2019). This is obvious that the volatility in the three markets also gets affected and therefore there are evidences that the volatility of one market impacts the volatility of the other markets (Rastogi and Agarwal, 2020). It becomes perplexing to see that there are many theories and findings of different papers discussing volatility at their center stage (Andersen and Bollerslev, 1998, Arouri et al., 2012, Bansal et al., 2014, Baykut and Kula, 2019). There are another set of studies which provide different findings to corroborate the idea that options market, the trading volume in the options market impact the spot volatility (Augustin et al., 2016, Black and Scholes, 1973, Bollen, 1998, Chen and Wang, 2017, Sarwar, 2003, Sarwar, 2004, Sarwar, 2005). In addition to this there are some studies which deal with spot volatility and futures market as well (Bae et al., 2004, Bessembinder and Seguin, 1992, Bologna, 2000, Darrat and Rahman, 1995, Edwards, 1988, Grossman, 1988).

Despite all the clamour on the role of options market and futures markets to impact the spot volatility, there is practically a void when it comes to a possible discussion on spot volatility due both the markets (options and futures market) together. The discussion of Sarwar (2005) and Shenbagaraman (2003) aptly talks how options volume impacts the spot volatility but without an obvious discussion on futures volume and its role on the spot volatility determinations. This paper is an attempt to figure out how both the markets (futures and options market) impact the spot volatility. Objective of this paper is to investigate the impact of options and futures markets on the spot volatility.

The remaining parts of the paper is divided into six more sections. A review of the literature section discusses the relevant literature on the topic. The theoretical model section presents the theoretical model applied in the paper for empirical investigation. The fourth section on data and methodology provides the details about the source of data, time period of the data and methodology used in the paper. The results are discussed in the fifth section. Discussion on the findings of the paper, its contribution and implication are covered in the sixth section of the paper. The paper is concluded in the seventh section.

2. Review of Literature

The extant literature on volatility is spread across a very wide spectrum. The relevant literature on the determinants of volatility is mainly concentrated into three main categories or themes.

A good number of literature uses options as a determinant for spot volatility. As a matter of fact, in the estimation of the price of options, volatility is an important variable (Rastogi et al., 2018). Therefore, in all likelihood, options finds its mention in the discussion of spot volatility (Ni et al., 2008, Pan and Poteshman, 2006, Pathak, 2015, Sarwar, 2003, Sarwar, 2005, Srinivasan, 2010). Options volume are usually found in having the endogenous association between them (Sarwar, 2005). The endogeneity is addressed by 2SLS or GMM methods in most of the studies. Some studies have also taken into account the moneyness issues along with put and call options as part of their discussion and have related them with the spot volatility. The options volume and spot volatility studies are also talking in term of directional traders and hedgers (Baillie and Myers, 1991, Pan and Poteshman, 2006).

There are many studies which takes into account the role of futures for determining spot volatility (Agnolucci, 2009, Bae et al., 2004, Bessembinder and Seguin, 1992, Bologna, 2000, Chang et al., 2000, Chernov, 2001, Thenmozhi, 2002, Sarkar and Rastogi, 2011, Rastogi, 2011a, Rastogi, 2016). It is really surprising to see that studies relating the futures market and its volume to spot volatility are there but whenever options volume is in the discussion, researchers prefer to ignore the futures as a determinant for spot volatility (Chen and Wang, 2017, Sarwar, 2005). It is a fact that in the option pricing formula (both continuous option pricing and binomial option pricing) spot volatility is one of the important inputs. Therefore, it seems the obvious reason for the preference of options volume to determine the spot volatility. However, the surprising element is that there are enough studies to relate the futures with the spot volatility, but in isolation not with the options volume (Hodgson and Nicholls, 1991, Malhotra and Sharma, 2016).

There are a few studies which move across futures and options both and deal with spot volatility (Bae et al., 2009, Bandivadekar and Ghosh, 2003, Bhaumik et al., 2008, Singh and Kansal, 2011, Srinivasan, 2010). The presence of both, futures volume and options volume to impact the spot volatility is justified as well. But this is an area which is quite less researched (Rastogi and Athaley, 2019, Rastogi and Agarwal, 2020). It is quite common to see in literature the isolated cases of options or futures market impacting the spot volatility, but the number of studies which cover both is quite less. Rather, the literature is lopsided with the options market and its impact on the spot volatility.

There are varied studies on volatility which talks about many interactions of different markets across the same securities as well as different securities (Rastogi, 2010, Rastogi and Srivastava, 2011, Rastogi, 2013, Rastogi, 2014). Volatility spill over is also another phenomenon which is quite evident in the literature of spot volatility (Baele, 2005, Christiansen, 2007, Dedi and Yavas, 2016, Erten et al., 2012, Hong, 2001, KIRKULAK ULUDAG and EZZAT, 2017, Liu, 2016). Most of the studies uses bivariate tool to figure out volatility spill over and there is strong evidence for the same. But most of the studies do not talk about integration of the volatility among the three markets except a few studies (Rastogi and Athaley, 2019, Rastogi and Agarwal, 2020). It is different thing to have options volume and futures volume driving the spot volatility, it is reasonable to have a few studies to integrate the three markets.

3. Theoretical Model

The proposed model applied in the paper is as follows:

$$GARCH_t = \alpha + \beta_1 LOGFV + \beta_2 LOGPV \qquad \text{Eq-1}$$

$$IV_t = \ + \beta_1 LOGFV + \beta_2 LOGPV \qquad \text{Eq-2}$$

Equation 1 explains the association of GARCH (historical spot volatility measured by GARCH 1,1) mode and its association with futures volume and options volume. Bollerslev (1986) argued that GARCH (1,1) model is a good model to estimate volatility and the same is done in the paper to estimate the volatility. Equation 2 talks about the association of implied volatility (IV) with options and futures volume. It is discussed in the literature that IV can also be another good measure of the volatility of the stock prices (Imlak and Puja, 2014, Ryu, 2012). This paper has used both the popular measure of volatility to explore the determinants of volatility. Based on the above-mentioned discussion, following directional hypothesis is formulated:

Hypothesis: spot volatility is associated with both options volume and futures volume.

4. Data and Methodology

Daily stock prices of the NIFTY 50 index are pulled out from the CMIE Prowess database from January 2016 to September 2017. Option volume and futures volume of Nifty 50 options and futures are used in the paper. Both the volume series have also been pulled out for the same time period. Log transformation is used for volume

International Journal of Modern Agriculture, Volume 9, No.3, 2020
ISSN: 2305-7246

data of both the time series to bring the better consistency in the application of optimum least square based estimator to estimate the coefficients of Equation 1 and 2 (Wooldridge, 2016). Log transformed values of the variables have higher probability of unbiased and consistent estimates of the coefficients. Therefore, the same is applied in the estimation of the model (Table 2).

Table 1 reports the descriptive of the variables used in the paper. The GARCH estimate of the annual volatility of the stock indices (NIFTY 50) has mean, minimum and maximum values of 12.30%, 8.09, and 20.17% respectively. The standard deviation of GARCH estimate of volatility is 3.13%. The same descriptive statistics of IV are 24.61%, 12.61%, 58.09% and 7.31% respectively. The similar values of LOGFV and LOGOV are also reported in Table 1.

Table 1. Descriptive Statistics

Variables	Min	Max	Mean	SD
GARCH	8.09%	20.17%	12.30%	3.31%
IV	12.61 %	58.09%	24.61%	7.31%
LOGFV	10.12	15.13	13.59	.83
LOGOV	9.64	18.88	15.71	1.32

Note: LOGFV and LOGOV are natural logs of future volume and option volume respectively. GARCH is historical volatility estimated by GARCH (1,1) model and IV is implied volatility. GARCH and IV are **annual** volatilities estimated in percentages.

Table 2. Result of Regression Analysis

PART A. GARCH	**Coefficients**		**SE**	**t-stat**	**p-value**
	Unstd.	Std.			
Constant	.0541	-	.0302	1.79	.0740
LOGFV	.0104	.2614	.0019	5.60	.0000
LOGOV	-.0046	-.1823	.0012	-3.91	.0000
F-test (Model)	21.99 (.0000)				
R-Square (Adjusted)	9.54%				
SE of Regression	.0316				
DF	417				
Note: No of observations (n)	420				
Test for Heteroscedasticity[1]	62.27 (.0000)				
RESET Test[2]	9.43 (.0000)				
Test of Autocorrelation[3]	337.21 (.000)				
PART B. Implied Volatility (IV)	**Coefficients**		**SE**	**t-stat**	**p-value**
	Unstd.	Std.			
Constant	-.4006	-	.0626	-6.40	.0000
LOGFV	.0318	.3632	.0038	8.30	.0000
LOGOV	.0137	.2460	.0024	5.62	.0000
F-test (Model)	53.43 (.0000)				
R-Square (Adjusted)	20.41				
SE of Regression	.0654				
DF	417				
Note: No of observations (n)	420				
Test for Heteroscedasticity[2]	23.50 (.0000)				
RESET Test[2]	7.38 (.0000)				
Test of Autocorrelation[3]	241.313 (.0000)				

Note: [1] Test of heteroscedasticity has the null of no heteroscedasticity. [2]RESET test has null of correctly specified model. [3]Test of autocorrelation has the null of no autocorrelation. P-value are in parentheses.

Multiple regression analysis is applied to estimate both the equations using OLS (Optimum Least Square) estimators. STATA 15 is used to estimate the coefficients and other values. We have also tested both the models for OLS assumptions (Heteroscedasticity, Perfect Collinearity and Autocorrelation) and for model specification. The results for the same are reported in Table 2.

5. Results

The estimation of both the theoretical models is reported in Table 2. Equation 1 is reported in the former part and equation 2 in the latter part of Table 2. Both the proxy of volatility is regressed on futures volume and options volume as per the equation 1 and 2. The results of the regressions are significant in both the cases for both the variables. Options volume as well as futures volume are significantly associated with both the definitions of spot volatility. R-square of GARCH definition of volatility is less as compared to the IV definition of the volatility (they are 9.54% and 20.5% respectively). The RESET test of model specification is also significant which explains the low values of R-squares in both the estimated regression analysis. In addition to this, Heteroscedasticity as well autocorrelation assumptions of OLS are also not holding in both the cases. Despite this, the model is significant and standard error of the model is also at the moderate levels.

6. Discussion

This is a reality that the securities which exist in spot, future and options markets to have higher probability of integration among the three markets. The same results are propounded in this paper. It has been found that the spot volatility is having significant association with both futures and options volume. Therefore, it can be said that the hypothesis of spot volatility having significant association with options volume and futures volume cannot be rejected and due to insufficient evidence.

The literature is replete with instances of options volume significantly impacting the spot volatility (Chang et al., 2010b, Sarwar, 2005, Augustin et al., 2016, Black and Scholes, 1973, Bollen, 1998, Chang et al., 2010a, Lin et al., 2017, Rastogi and Athaley, 2019, Shenbagaraman, 2003, Singh and Kansal, 2011, Srinivasan, 2010). Instances of futures volume impacting are lesser as compared to the instances of options impacting the spot volatility (Boonvorachote and Lakmas, 2016, Darrat and Rahman, 1995, Edwards, 1988, Grossman, 1988, Lin et al., 2017, Rastogi, 2011b, Rastogi and Athaley, 2019, Sarkar and Rastogi, 2011, Shenbagaraman, 2003). However, both futures and options are impacting the spot volatility are modicum in number (Lin et al., 2017, Rastogi and Athaley, 2019, Shenbagaraman, 2003, Srinivasan, 2010).

The main contribution of the paper is that the options volume and futures volume are concurrently and significantly impacting the spot volatility. Moreover, it is observed by the authors that the application of IV and GARCH (1,1) model to use as proxy for variability are also quite less. This knowledge that both options and futures volume are significantly impacting the spot volatility is of immense value for the practical, managerial and policy implications. The findings of the paper will help investors especially informed investors to predict the stock price movement by having an eye on the futures and options transactions.

7. Conclusion

Both options volume and futures volume are significantly impacting the spot volatility. Therefore, it can be concluded that both futures volume and options volume can be used as the determinants of the spot volatility. This result is rare as quite less number of times time there are empirical evidence where both futures and options volume significantly impact the spot volatility. The regression estimates of spot volatility on futures and options volume are having the violations of both the assumptions of homoscedasticity and no autocorrelation. In addition to this, the model specification is also not great. Both are the limitation of the paper. The remedial options like GLS (Generalized Least Square) estimator for heteroscedasticity and robust estimates of standard errors of coefficient estimators are some of the options to overcome the limitation of the paper. These remedial options to overcome limitations are the future scope of the study on this topic.

References

1. Agnolucci, P. (2009), "Volatility in crude oil futures: a comparison of the predictive ability of GARCH and implied volatility models", *Energy Economics*,Vol. 31 No. 2, pp. 316-321.
2. Andersen, T. G. & Bollerslev, T. (1998), "Answering the skeptics: Yes, standard volatility models do provide accurate forecasts", *International economic review*,Vol. No., pp. 885-905.
3. Arouri, M. E. H., Jouini, J. & Nguyen, D. K. (2012), "On the impacts of oil price fluctuations on European equity markets: Volatility spillover and hedging effectiveness", *Energy Economics*,Vol. 34 No. 2, pp. 611-617.
4. Augustin, P., Brenner, M., Grass, G. & Subrahmanyam, M. G. (2016), "How do Informed Investors Trade in the Options Market?☆",Vol. No., pp.
5. Bae, S. C., Kwon, T. H. & Park, J. W. (2004), "Futures trading, spot market volatility, and market efficiency: the case of the Korean index futures markets", *Journal of Futures Markets: Futures,*

Options, and Other Derivative Products,Vol. 24 No. 12, pp. 1195-1228.
6. Bae, S. C., Kwon, T. H. & Park, J. W. (2009), "Derivatives trading, volatility spillover, and regulation: Evidence from the Korean securities markets", *Journal of Futures Markets: Futures, Options, and Other Derivative Products*,Vol. 29 No. 6, pp. 563-597.
7. Baele, L. (2005), "Volatility spillover effects in European equity markets", *Journal of Financial and Quantitative Analysis*,Vol. 40 No. 2, pp. 373-401.
8. Baillie, R. T. & Myers, R. J. (1991), "Bivariate GARCH estimation of the optimal commodity futures hedge", *Journal of Applied Econometrics*,Vol. 6 No. 2, pp. 109-124.
9. Bandivadekar, S. & Ghosh, S. (2003), "Derivatives and volatility on Indian stock markets", *Reserve Bank of India Occasional Papers*,Vol. 24 No. 3, pp. 187-201.
10. Bansal, R., Kiku, D., Shaliastovich, I. & Yaron, A. (2014), "Volatility, the macroeconomy, and asset prices", *The Journal of Finance*,Vol. 69 No. 6, pp. 2471-2511.
11. Baykut, E. & Kula, V. (2019), "The Volatility and Shock Transmission Patterns between the BIST Sustainability and BIST 100 Indices", *Frontiers in Applied Mathematics and Statistics*,Vol. 5 No., pp. 50.
12. Bessembinder, H. & Seguin, P. J. (1992), "Futures-trading activity and stock price volatility", *the Journal of Finance*,Vol. 47 No. 5, pp. 2015-2034.
13. Bhaumik, S. K., Karanasos, M. & Kartsaklas, A. (2008), "Derivatives Trading and the Volume-Volatility Link in the Indian Stock Market",Vol. No., pp.
14. Black, F. & Scholes, M. (1973), "The pricing of options and corporate liabilities", *Journal of political economy*,Vol. 81 No. 3, pp. 637-654.
15. Bollen, N. P. (1998), "A note on the impact of options on stock return volatility", *Journal of banking & Finance*,Vol. 22 No. 9, pp. 1181-1191.
16. Bollerslev, T. (1986), "Generalized autoregressive conditional heteroskedasticity", *Journal of econometrics*,Vol. 31 No. 3, pp. 307-327.
17. Bologna, P. (2000), "INDEX FUTURES ACTIVITY AND STOCK MARKET VOLATILITY: AN EMPIRICAL ANALYSIS OF THE ITALIAN STOCK EXCHANGE", *Giornale degli Economisti e Annali di Economia*,Vol. 59 (Anno 113) No. 1, pp. 49-86.
18. Boonvorachote, T. & Lakmas, K. (2016), "Price volatility, trading volume, and market depth in Asian commodity futures exchanges", *Kasetsart Journal of Social Sciences*,Vol. 37 No. 1, pp. 53-58.
19. Chang, C.-C., Hsieh, P.-F. & Wang, Y.-H. (2010a), "Information content of options trading volume for future volatility: Evidence from the Taiwan options market", *Journal of Banking & Finance*,Vol. 34 No. 1, pp. 174-183.
20. Chang, C. C., Hsieh, P. F. & Wang, Y. H. (2010b), "Information content of options trading volume for future volatility: Evidence from the Taiwan options market", *Journal of Banking and Finance*,Vol. 34 No. 1, pp. 174-183.
21. Chang, E., Chou, R. Y. & Nelling, E. F. (2000), "Market volatility and the demand for hedging in stock index futures", *Journal of Futures Markets: Futures, Options, and Other Derivative Products*,Vol. 20 No. 2, pp. 105-125.
22. Chen, C. C. & Wang, S. H. (2017), "Net Buying Pressure and Option Informed Trading", *Journal of Futures Markets*,Vol. 37 No. 3, pp. 238-259.
23. Chernov, M. (2001), "Implied volatilities as forecasts of future volatility, time-varying risk premia, and returns variability",Vol. No., pp.
24. Christiansen, C. (2007), "Volatility-spillover effects in European bond markets", *European Financial Management*,Vol. 13 No. 5, pp. 923-948.
25. Darrat, A. F. & Rahman, S. (1995), "Has futures trading activity caused stock price volatility?", *The Journal of Futures Markets (1986-1998)*,Vol. 15 No. 5, pp. 537.
26. Dedi, L. & Yavas, B. F. (2016), "Return and volatility spillovers in equity markets: An investigation using various GARCH methodologies", *Cogent Economics & Finance*,Vol. 4 No. 1, pp. 1266788.
27. Edwards, F. R. (1988), "Futures trading and cash market volatility: Stock index and interest rate futures", *Journal of futures markets*,Vol. 8 No. 4, pp. 421-439.
28. Erten, I., Tuncel, M. B. & Okay, N. (2012), "Volatility spillovers in emerging markets during the global financial crisis: diagonal BEKK approach",Vol. May 2012 No., pp.
29. Grossman, S. J. (1988), "An Analysis of the Implications for Stock and Futures Price Volatility of Program Trading and Dynamic Hedging Strategies", *The Journal of Business*,Vol. 61 No. 3, pp. 275-298.
30. Hodgson, A. & Nicholls, D. (1991), "The impact of index futures markets on Australian sharemarket volatility", *Journal of Business Finance & Accounting*,Vol. 18 No. 2, pp. 267-280.
31. Hong, Y. (2001), "A test for volatility spillover with application to exchange rates", *Journal of*

Econometrics,Vol. 103 No. 1-2, pp. 183-224.

32. Imlak, S. & Puja, P. (2014), "Stylized patterns of implied volatility in India: a case study of NSE Nifty options", *Journal of Indian Business Research*,Vol. 6 No. 3, pp. 231-254.
33. Kirkulak Uludag, B. & Ezzat, H. (2017), "Volatility Spillover Effect in MENA Stock Markets: Evidence from Pre-and Post-Egyptian Revolution", *Journal of Yasar University*,Vol. 12 No. 45, pp.
34. Lin, W. T., Tsai, S.-C., Zheng, Z. & Qiao, S. (2017), "Does options trading convey information on futures prices?", *The North American Journal of Economics and Finance*,Vol. 39 No., pp. 182-196.
35. Liu, C. (2016), "Spillover effects in major equity markets: a GARCH BEKK approach", *Open Access Library Journal*,Vol. 3 No. 2, pp. 1-21.
36. Malhotra, M. & Sharma, D. K. (2016), "Volatility Dynamics in Oil and Oilseeds Spot and Futures Market in India", *Vikalpa*,Vol. 41 No. 2, pp. 132-148.
37. Ni, S. X., Pan, J. & Poteshman, A. M. (2008), "Volatility information trading in the option market", *The Journal of Finance*,Vol. 63 No. 3, pp. 1059-1091.
38. Pan, J. & Poteshman, A. M. (2006), "The information in option volume for future stock prices", *The Review of Financial Studies*,Vol. 19 No. 3, pp. 871-908.
39. Pathak, R. (2015), "Volatility informed trading in the options market: evidence from India", *Business: Theory and Practice/Verslas: Teorija ir Praktika*,Vol. 17 No. 1, pp. 13-22.
40. Rastogi, S. (2010), "Volatility Spillover Effect Acrossbric Nations: An Empirical Study", *Paradigm*,Vol. 14 No. 1, pp. 1-6.
41. Rastogi, S. (2011a), "Impact of Currency Futures on Spot Market Volatility: An Empirical Study", *Vidwat: The Indian Journal of Management*,Vol. 4 No. 2, pp. 3-8.
42. Rastogi, S. (2011b), "Impact of Currency Futures on Spot Market Volatility: An Empirical Study", *Vidwat: The Indian Journal of Management*,Vol. 4 No. 2, pp. 23-28.
43. Rastogi, S. (2013), "Long-term association of stock markets of different nations: An empirical study", *Vision*,Vol. 17 No. 4, pp. 303-313.
44. Rastogi, S. (2014), "The financial crisis of 2008 and stock market volatility–analysis and impact on emerging economies pre and post crisis", *Afro-Asian Journal of Finance and Accounting*,Vol. 4 No. 4, pp. 443-459.
45. Rastogi, S. (2016), "Gold Future Market Efficiency Post 2007 Financial Crisis: An Empirical Study", *Vishwakarma Business Review*,Vol. 6 No. 2, pp. 30-39.
46. Rastogi, S. & Agarwal, A. (2020), "Volatility Spillover Effect in Spot, Futures and Option Markets", *Test Enginnering and Management*,Vol. 83 No. May-June, pp. 10114-10127.
47. Rastogi, S. & Athaley, C. (2019), "Volatility Integration in Spot, Futures and Options Markets: A Regulatory Perspective", *Journal of Risk and Financial Management*,Vol. 12 No. 98, pp. 1-15.
48. Rastogi, S., Don, J. & Nithya, V. (2018), "Volatility Estimation using GARCH Family of Models: Comparison with Option Pricing", *PACIFIC BUSINESS REVIEW INTERNATIONAL*,Vol. 10 No. 8, pp. 54-60.
49. Rastogi, S. & Srivastava, V. K. (2011), "Comparative study of conditional volatility of Indian and US stock markets using GARCH (1, 1) model", *Asia Pacific Business Review*,Vol. 7 No. 1, pp. 92-101.
50. Ryu, D. (2012), "Implied volatility index of KOSPI200: Information contents and properties", *Emerging Markets Finance and Trade*,Vol. 48 No. sup2, pp. 24-39.
51. Sarkar, A. & Rastogi, S. (2011), "Impact of gold and silver futures on the spot rate volatility: An Indian perspective", *Nice Journal of Business*,Vol. 6 No. 1, pp. 23-28.
52. Sarwar, G. (2003), "The interrelation of price volatility and trading volume of currency options", *Journal of Futures Markets*,Vol. 23 No. 7, pp. 681-700.
53. Sarwar, G. (2004), "The informational role of option trading volume in the S&P 500 futures options markets", *Applied Financial Economics*,Vol. 14 No. 16, pp. 1197-1210.
54. Sarwar, G. (2005), "The informational role of option trading volume in equity index options markets", *Review of Quantitative Finance and Accounting*,Vol. 24 No. 2, pp. 159-176.
55. Shenbagaraman, P. (2003), "Do futures and options trading increase stock market volatility?", *NSE Research Initiative paper*,Vol. 71 No., pp.
56. Singh, G. & Kansal, S. (2011), "Impact of Derivative Trading on Stock Market Volatility during Pre and Post F&O Period: A Case Study of NSE", *Management Convergence*,Vol. 1 No. 1, pp. 1-10.
57. Srinivasan, P. (2010), "Do futures and options trading increase spot market volatility in India? The case of S&P CNX Nifty", *International Journal of Business Performance and Supply Chain Modelling*,Vol. 2 No. 2, pp. 134-145.
58. Thenmozhi, M. (2002), "Futures trading, information and spot price volatility of NSE-50 index futures contract", *NSE Research Paper, NSE India*,Vol. No., pp.
59. Wooldridge, J. M. 2016. *Introductory econometrics: A modern approach*, Nelson Education.