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Volatility Impact of Derivatives Trading in India: An Empirical Evidence from NSE

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Abstract:
The purpose of the study is to empirically examine the volatility impact of derivatives trading in Indian equity market, especially using the closing prices of Nifty index of the NSE Ltd. The study alsoempirically evaluates the volatility impact in case of some selected individual stocks(HDFC, TATA Steel, L&T, ONGC, ACC and INFOSYS)representing various sectors. The study period covers from January 1997 to December 2014.The nature of volatility over time is investigated by using GARCH(1, 1) model.The findings of the study suggests that in case of Niftythe volatility is declining after the introduction of futures trading, however, the same is not statistically significant. Also, there is an interesting evidence of considerable increase in unconditional volatility in post-futures period in case of Nifty. In case of the individual stocks,the findings are quite mixed in nature.The introduction of derivatives trading has led to an increase in volatility on the underlying cash market of HDFC, TATA Steel, L&T and ONGC. Whereas,for ACC and INFOSYS the result shows reducingvolatility in the underlying cash market in post-derivatives period.

Keywords: *Derivatives, Futures, Volatility, Time Series*
JEL Classification: G10; C580

1. Introduction

The need to create some kind of financial instruments that will allow investors to hedge and thus to be secured from price fluctuations has given birth to concepts of derivatives. Derivatives permit investors to customize their exposure to the market either through hedging or speculation. The relationship between stock index futures and spot market has got an important place in the public policy arena (Chang *et al.*, 1999).

To reduce the risk and to improve the depth of financial markets, financial derivatives have received a lot of attention worldwide over the years and in the developing countries like that of India in the recent period. Derivatives today account for the largest amount of business on most major stock exchanges in the world. In India, the introduction of derivative instruments in a phased manner starting from June 2000 in NSE and BSE is one such important step to achieve greater stabilization in markets and to introduce sophisticated risk management tools. Derivatives marked with the ability to partially or fully transfer the risk by locking in asset prices are gaining popularity among the investors in India. Due to the backdrop of the financial crisis, fraud cases and the near failure of some market participants, the derivatives market has attracted more attention among the investors.

The total turnover of equity derivatives in NSE on the F&O segment was 5, 56, 06,453crores during 2014-2015 which has increase substantially from 2365 crore during 2001-2001. The average daily turnover was 2,28,833 croresduring the same period also witnessed a considerable increase from 11 crores in 2000-2001.

The impact of introduction of derivative products on the underlying stock market volatility received major attention all over the world. Some researchers claim that volatility[1] in the cash market increases after the introduction of derivatives trading due to increased speculative activities. Thus futures trading were blamed by some for the stock market crash of 1987 in the USA.But in 1995 Antoniou and Holmes suggested that trading in futures is generally expected to reduce the volatility in spot market since speculators are expected to migrate to futures market. The concern over how derivative trading affects the spot market has been an interesting subject for investors, academicians, regulators and exchanges in all over the world. Thus the debate on the impact of derivatives trading on stock market volatility cannot be resolved wholly on a theoretical level and so should be analyzed by empirical investigation (Baumol, 1957).

Under this background, this paper tries to examine whether the Indian stock markets (in this case NSE and some selected stocks of NSE) show some significant change in the volatility after the introduction of futures trading. Including the introductory section, I, this Chapter has been divided in to five sections. Section II briefly outlines the important studies conducted relating to this particular area. Background about the methodologies used, definitions of variables used and data sources for conducting the empirical tests with the spatial coverage are given in the Section III. Section IV contains the analysis and findings of the empirical estimations. Concluding observations with major findings of the study is covered in the Section V.

2. FutureTradingandSpot MarketVolatility:Some Theoretical Studies and EmpiricalEvidences

Previous studies on impact of derivatives trading on stock market volatility document mixed evidences (increase / decrease in volatility). Some of the notable contributions of different researchers are cited below. According to Stein (1987) futures market improves risk sharing and therefore reduces price volatility and if the speculators observe a noisy but informative signal, the hedgers react to the noise in the speculative trades producing an increase in volatility. Danthine (1978) argue that the futures markets improve market depth and reduce volatility because the cost to informed traders of responding to mispricing is reduced. Bessembinder and Seguin (1992), Kumar et al. (1995), Antoniou et al. (1998), Homes and Priestley (1998), and Gulen and Mayhew (2000) found results supporting this proposition. Ross (1989) assume that in case of no arbitrage condition, if futures increase the flow of information then there will be increase in the volatility of the spot prices. Overall, the theoretical work on futures listing effects offer no consensus on the size and the direction of the change in volatility. Thus empirical literature must be reviewed on evidence relating to the volatility effects of listing index futures.

Matanovic and Wagner (2012) conducted a study on volatility impact of DAX futures trading using GARCH model. The sample data sample covers daily closing prices of the DAX and CDAX stock indices for the period January 1, 1970 to May 1, 2009.The findings confirm a volatility-reducing impact of DAX futures trading, whereas the observed deterioration of the fundamental price building process related to futures trading proved to be statistically insignificant.

Gahlot*et al.* (2010) conducted a study on impact of derivatives trading on stock market volatility using closing prices in case of S&P CNX Nifty as well as five derivative stocks (BHEL, BPCL, Glaxo, M&M & ONGC) and five non-derivative stocks (Hindustan Motors Ltd., Reliance Capital Ltd, Rolta, Titan &Voltas) covering a period from April 2007 – March 2005 using GARCH analysis. The results of their findings suggest that the volatility in the S&P CNX Nifty has declined after the introduction of S&P CNX Nifty future. On the other hand, out of 10 individual stocks except BPCL, Glaxo &Rolta all other 7 stocks show increase in volatility after the introduction of futures.

Saravanan and Deo (2010) in their study on impact of futures and options trading on underlying spot market volatility in India used the closing prices of S&P CNX Nifty Index and Nifty Junior Index found that the volatility of spot market has declined after the futures and options trading. The study used GARCH analysis covering a period from January 1996 – March 2007.

Debashis (2009) did a study on effects of futures trading on spot price volatility for NSE Nifty using the dynamic linear regression model, and the GARCH models covering a period from April 1997 to April 2007. His findings suggest no structural change after the introduction of futures trading on Nifty. However, whilst the pre-futures sample was integrated, the post-futures sample was stationary and spot returns volatility is found to be less important in explaining spot returns after the advent of futures trading in NSE Nifty.

Mallikarjunappa and Afsal (2008) used GARCH model to study the implication of the introduction of derivative trading on spot market volatility for S&P CNX Nifty and CNX Bank Nifty. In case of CNX Nifty they concluded that price sensitivity to old news is higher during pre-future period than post future period and with introduction of futures, market volatility is determined by recent innovation. However, for CNX Bank Nifty there is no impact of future trading on spot market volatility. But, the impact of new news increased and persistence effect of old news decreased in post-future period.

Sakthivel and Kamaiah (2009) tried to investigate the relationship between stock market volatility and trading activity (trading volume and open interest) in the Nifty futures market using daily closing price, trading volume, and open interest for Nifty index futures for the period July 2000 to February 2008.The study introduces futures trading variables such as expected and unexpected futures volume and open interest in GARCH and GJR GARCH models to examine their effects on spot market volatility. The study finds that spot market volatility bears a positive relationship with unexpected trading volume and open interest and a negative relationship with expected futures trading volume and open interest in Nifty futures market.

[1] Volatility in the stock market is defined as a measure for the size and the frequency of fluctuations of the underlying asset's price for a time period (Maris *et al.,* 2004).

Shenbagaraman (2003) examined the impact of introduction of NSE Nifty index futures on Nifty index using GARCH techniques over the period from October 1995 to December 2002. She concluded that futures trading has not lead to a change in the volatility of the underlying stock index but the structure of volatility seems to have changed in post-futures period.
Pericli and Koutmos (1997) applied EGARCH model to examine the impact of index futures and options contract on the volatility of spot market in case of S&P 500 index using sample period extending from 1953 to 1994. Their findings suggest that with the introduction of currency and interest rate future contracts and the introduction of individual stock options, the unconditional variance of daily index stock returns rose significantly. However, the conditional variance of daily returns became less sensitive to innovations and more predictable.

3. Data Description, Data Sources and Research Methodology

3.1. Sources of Data and Definition of Variable
This study has used secondary data collected from website of the NSE Ltd., India. The data for this paper covers a period from 1st January 1997 to 31st December 2014. Along with S&P CNX Nifty index, six individual stocks (HDFC, TATA Steel, L&T, ONGC, ACC and INFOSYS) representing different sectors of the economy are selected. The daily closing price data are taken for the econometric estimations.
The entire period of the study is being divided into two parts for the respective index and stocks.

3.1.1. For CNX Nifty Index:

- Prefuture period *i.e.,* 01-01-1997 to 11-06-2000
- Post future period*i.e.,*12-06-2000 to 31-12-2014

3.1.2. For Individual Stocks:

- Pre future period *i.e.,*01-01-1997 to 08-11-2001
- Post future period *i.e.,*09-11-2001 to 31-12-2014

The futures trading for index and individual stocks initiated on 12th June 2000 and 9th November 2001, respectively.

All return series in the entire study has been calculated as the difference of the log of daily closing index or the stock price as per the case.

3.2. Methodology
This study has used the Augmented Dickey Fuller test to verify the stationarity properties of each data set. Then the General Autoregressive Conditional Heteroscedastic-GARCH (1,1) model is being used to measure the volatility during the per- and post introduction of derivatives trading in NSE.

3.2.1. Augmented Dickey-Fuller (ADF) Test
Before conducting any econometric test, the statationarity[2] properties of the variables need to be checked through unit root test. Most commonly used method of checking the stationarity properties of the variables is Augmented Dickey-Fuller (ADF) Test.
The testing for unit root in the time series was pioneered by Dickey and Fuller (Fuller, 1976; Dickey and Fuller, 1979). The objective behind the test was to examine whether there is a unit root in the time series data through the following random walk model without drift assuming the null hypothesis that $\phi = 1$.

- $y_t = \phi_t y_{t-1} + u_t$ ----------(Equ.1)

Whereas, $y_t$is the variable under consideration and $u_t$is the error term.
However, the following regression is used for the sake of ease of computation and interpretation

- $y_t = \psi y_{t-1} + u_t$ ----------(Equ.2)

Where, $\psi = \phi - 1$.
The above-mentioned test is valid only in case of the assumption that the $u_t$is not auto-correlated. However, there could be auto-correlation in the dependent variable of the above-mentioned equation (Eq. 2) which has not been taken in to consideration. Further, the auto-correlation in the dependent variable will increase the size of the test (the proportion of times a correct null hypothesis is incorrectly rejected) which could be higher than the nominal size used (*e.g.,* 5%) to reject the null hypothesis. To resolve this problem, Dickey-Fuller developed another test known as Augmented Dickey-Fuller (ADF) test using *p* lags of the dependent variable.

- $\Delta yt = \psi yt - 1 + \sum_{i=1}^{p} \alpha i \Delta yt - i + ut$ ----------(Equ.3)

The lags of Δy_t now will absorb any dynamic structure present in the dependent variable, to ensure that u_t is not auto correlated.

[2]A data series is stationary, if for each given lag the mean, variance and auto covariance are constant.

3.2.2. GARCH model

The most popular non-linear time series financial models used for modelling and forecasting volatility are the ARCH or GARCH models. In econometrics, Autoregressive Conditional Heteroscedasticity (ARCH) models are used to characterize and model observed time series. They are used whenever at any point in a series, the error terms will have a characteristic size or variance. In particular ARCH models assume the variance of the current error term or innovation to be a function of the actual sizes of the previous time periods' error terms: often the variance is related to the squares of the previous innovations. ARCH(q) model has the limitations that it lacks proper method to decide on the number of lags(q) of the squared residual. Also the value of q required to capture all of the dependence in the conditional variance, might be very large which would result in a large conditional variance model. Everything else equal, there will also be violations of non- negativity constraints if more parameters are included in the conditional variance equation. GARCH (p,q) model overcomes some of the limitations of ARCH (q) model where p represents number of lags of the conditional variance. Apart from this the volatility clustering and asymmetric effect in the return series are best captured by GARCH model.
Bollerslev and Taylor (1986) developed the GARCH model which allows the conditional variance to be dependent upon previous own lags. In a GARCH (1,1) model the conditional variance equation can be represented as follows:

- $\sigma_t^2 = \beta_0 + \beta_1\varepsilon^2_{t-1} + \beta_2\sigma^2_{t-1}$ ----------(Equ.4)

Where, $\sigma_t^2$is the conditional variance, $(\beta_1\varepsilon^2_{t-1})$ is information about volatility during the previous period, and$(\beta_2\sigma^2_{t-1})$ is the fitted variance from the model during the previous period.

The unconditional variance $\varepsilon_t$is calculated as follows:

- $\text{var}(\varepsilon_t) = \frac{\beta 0}{1-(\beta 1+\beta 2)}$ ----------(Equ.5)

when $\beta_1 + \beta_2 < 1$

The effect of any shock in volatility dies out at a rate of $1-(\beta_1+\beta_2)$. If $(\beta_1+\beta_2) \geq 1$ the effect of shock will never die out. Conditional volatility can be represented as sum of ARCH and GARCH coefficients *i.e.,* $(\beta_1+\beta_2)$. Any significant decrease in the conditional or unconditional variance in post-futures period means the spot market has stabilized after the introduction of derivatives trading and vice versa.
Dummy variable is used in the study to find out the impact of futures trading on volatility of spot market, which is '0'before the introduction of future and '1' after the introduction of future.
The conditional variance equation using dummy variable is mentioned below.

- $\sigma_t^2 = \beta_0 + \beta_1\varepsilon^2_{t-1} + \beta_2\sigma^2_{t-1} + \gamma D_{futures}$ ----------(Equ.6)

when γ is significant and positive, then futures trading is expected to increase the spot market volatility and, if γ is significant and negative, then futures trading has stabilizing effect on the underlying market.

4. Analysis of Empirical Results

4.1. Unit Root Test

Before conducting any econometric analysis, first we try to analyse the stationary properties of the data / variables. The Unit Root Test results in form of ADF reveals that all the variables relating to both pre-future and post-future period under consideration are I(I), meaning that variables are non-stationary at level and stationary at their first differences (Table 1A and 1B).

Index and stocks	**ADF test ------- Level (t-statistics)**				
	Variable Pre-future period	Variable Post-future period	Critical Values		
			1%	5%	10%
CNX Nifty	-0.5308	-0.5498	-3.4354	-2.8637	-2.5680
HDFC	-1.3423	-1.3454	-3.4354	-2.8637	-2.5680
TATA Steel	-1.7308	-1.8309	-3.4354	-2.8637	-2.5680
L&T	-1.9854	-1.5790	-3.4354	-2.8637	-2.5680
ONGC	-1.9038	-2.3849	-3.4354	-2.8637	-2.5680
ACC	-1.9874	-1.8632	-3.4354	-2.8637	-2.5680
INFOSYS	-2.4398	-2.6532	-3.4354	-2.8637	-2.5680
Note: $H_{0:\ The}$ series under consideration has a unit root (Calculated value < Critical value) $H_{1:\ The}$ series under consideration is stationary (Calculated value > Critical value)					

Table 1A: Unit Root Test Results

Index and stocks	ADF test ------- First Difference (t-statistics)				
	Variable Pre-future period	Variable Post-future period	Critical Values		
			1%	5%	10%
CNX Nifty	-28.763	-42.9587	-3.4354	-2.8637	-2.5680
HDFC	-39.5114	-42.4927	-3.4354	-2.8637	-2.5680
TATA Steel	-33.8599	-54.421	-3.4354	-2.8637	-2.5680
L&T	-45.8863	-53.6615	-3.4354	-2.8637	-2.5680
ONGC	-36.5203	-55.0649	-3.4354	-2.8637	-2.5680
ACC	-25.2404	-41.6725	-3.4354	-2.8637	-2.5680
INFOSYS	-34.8963	-62.8543	-3.4354	-2.8637	-2.5680
Note: $H_{0:\ The}$ series under consideration has a unit root(Calculated value < Critical value) H_1 :The series under consideration is stationary (Calculated value > Critical value)					

Table 1B: Unit Root Test Results

4.2. Descriptive Statistics

Table 2 and Table 3 show the descriptive statistic of returns of S&P CNX Nifty and individual stocks for pre derivatives & post derivatives period. Basic statistics used in the study include the mean, median, maximum, minimum standard deviation, skewness, kurtosis and Jarque-Bera normality test.The mean value of index and all stocks except IFOSYS in post-future period is increased. Comparing the standard deviations of Nifty index and ACC stock in both pre derivatives and post derivatives period, it is observed that the variability in daily return series is more in pre derivatives period than that in post derivatives period. In all other five stocks such as HDFC, TATA Steel, L&T, ONGC and INFOSYS there is increase in volatility in post derivatives period. Several market wide factors such as economic policy, growth forecast, exchange rates, inflation rates *etc.,* or market wide volatility may affect the change in volatility in pre futures and post futures period. To avoid this problem a dummy variable is considered in the GARCH (1, 1) model. In pre derivatives period only for CNX Nifty and TATA steel deviations of the dataset from the mean are going to be positive but for all other five stocks (HDFC, L&T, ONGC, ACC and INFOSYS) it is negative. However, HDFC, ACC and INFOSYS show the chances of very large deviations from the mean. Whereas in case of post derivatives period except HDFC, all other stocks and the index are negatively skewed. Also ONGC and ACC show large deviations from the mean. The CNX Nifty and all the stocks show the tendency of leptokurtosis means the return series returns have distributions that exhibit fat tails and excess peakedness at the mean. The probability of the JB statistic is highly significant and hence we reject the null hypothesis that the data are from a normal distribution.

Index/Stocks	MEAN	MEDIAN	MAX	MIN	STD.DEV	SKEWNESS	KURTOSIS	JARQUE-BERA
CNX NIFTY	0.0005	0.0006	0.0993	-0.0884	0.0189	0.007	6.0414	330
								(0.000)
HDFC	-0.0009	-0.0007	0.1523	-2.2495	0.0695	-24.521	794.5089	36266076
								(0.000)
TATA STEEL	-0.0006	-0.0018	0.1139	-0.1724	0.0304	0.0091	4.5663	124
								0.0001
L&T	0.0001	-0.0008	0.1068	-0.1542	0.0292	-0.121	5.0281	304
								0.0000
ONGC	0.0002	0.0000	0.0954	-0.1170	0.0310	-0.0523	4.0261	57
								0.0000
ACC	-0.0012	-0.0013	0.0653	-1.1972	0.0853	-25.567	398.40	5467832
								0.0000
INFOSYS	0.0023	0.0054	0.0963	-0.1387	0.0356	-13.4963	98.45	98548
								0.0002

Table 2: Descriptive Statistics for Pre-Future Period

Index/Stocks	MEAN	MEDIAN	MAX	MIN	STD.DEV	SKEWNESS	KURTOSIS	JARQUE-BERA
CNX NIFTY	0.0006	0.0011	0.1633	0.1305	0.0154	-0.2870	11.6822	11426
								0.0000
HDFC	0.0001	0.0002	2.8181	-2.8127	1.1227	0.0004	2.9888	0.021
								0.9896
TATA STEEL	0.0005	0.001	0.1570	-0.4521	0.0494	-1.3288	22.582	53371
								0.0000
L&T	0.0006	0.0005	0.2368	-0.718	0.0305	-8.056	192.113	4887165
								0.0000
ONGC	0.0003	0.0002	0.1824	-1.4434	0.0347	-22.2163	917.0184	1.14E+08
								0.0000
ACC	0.0004	0.0018	0.0674	-0.1386	0.0295	-2.5456	29.8137	74539
								0.0001
INFOSYS	0.0019	0.0016	0.2648	-0.2952	0.0463	-19.7863	748.9863	1235689
								0.0000

Table 3: Descriptive Statistics for Post-Future Period

4.3. GARCH Analysis

The impact of futures trading on spot market volatility is analyzed by GARCH (1,1) model where ARCH coefficients show the effect of recent news on the market and GARCH coefficients show the effect of old news on the market. The results of conditional variance equation of ARCH (1) process in table 4and table5 reveal that ARCH coefficients of the index and the underlying stocks are significant for both pre derivatives and post derivatives period. The conditional variance equation of GARCH (1,1) from table4 and table5 show that for NIFTY index ARCH β_1 is 0.0718 in pre-futures period and 0.1232 in post-futures period which means there is an increase in the impact of the 'present news' on spot market volatility in the post-futures regime. Similarly, the GARCH coefficient $\beta_2$of NIFTY index is declined from 0.9280 in pre derivatives period to 0.8678 in post-derivatives period. This indicates that the effect of 'old news' on determining volatility has been decreased in the post future period. For individual stocks, (HDFC, L&T and INFOSYS) there is an increase in ARCH coefficients and for (TATA Steel, ONGC & ACC) there is decrease in ARCH co-efficients in post futures period. However, except L&T and INFOSYS all other individual stocks show increase in GARCH coefficients in the post futures period.

The study further finds that the sum of the coefficients on the lagged squared error and lagged conditional variance (table 7) is very close to unity in case of CNX Nifty, TATA Steel, HDFC and ONGC in post futures period implying that shocks to the conditional variance will be highly persistent. Except ACC, INFOSYS and the Nifty index, other four stocks (HDFC, TATA Steel, L&T and ONGC) show increase in both conditional and unconditional volatility after the introduction of futures trading in India (table 7). However, though there is decrease in conditional volatility of Nifty, it shows contradictory pattern of increase in unconditional volatility in post future period. Again using dummy variable (Table 8) in the conditional variance equation it can be interpreted that a significant positive (negative) coefficient is an indication of increase (decrease) in the volatility as a result of introduction of derivatives. For CNX Nifty, the coefficient of dummy variable is - 0.0006 which indicates that introduction of future trading decreases the volatility, but it has negligible impact. The coefficient of dummy variable is positive for all individual stocks except ACC and INFOSYS meaning HDFC, TATA Steel, L&T and ONGC show increase in volatility in post futures period. However, in case ofACC and INFOSYS the introduction of futures trading has a stabilizing effect on the underlying spot market.

Index and stocks	Conditional Variance Equation ARCH(1) $\sigma_t^2 = \beta_0 + \beta_1\varepsilon_{t-1}^2$		Conditional Variance Equation GARCH(1,1) $\sigma_t^2 = \beta_0 + \beta_1\varepsilon_{t-1}^2 + \beta_2\sigma_{t-1}^2$		
	β_0	AR(1)β_1	β_0	β_1	β_2
CNX Nifty	0.0003	0.0846	0.0000	0.0718	0.9280
	(22.9139)	(3.0110)	(3.8962)	(5.0833)	(24.1226)
HDFC	0.0033	0.0492	0.0031	-0.0015	0.5976
	(345.9827)	(1.8666)	(1.8761)	(-21.5673)	(1.3013)
TATA Steel	0.0006	0.1561	0.0002	0.1495	0.6806
	(19.6196)	(4.5505)	(4.5278)	(5.8909)	(12.0524)
L&T	0.0006	0.1297	0.0002	0.1479	0.6649
	(27.6983)	(5.2229)	(5.8084)	(7.6443)	(14.2048)
ONGC	0.0005	0.3124	0.0001	0.1946	0.6839
	(20.1204)	(6.5729)	(5.6860)	(6.6181)	(17.4512)
ACC	0.0007	0.8357	0.0001	0.1394	0.4485
	(18.2139)	(5.4729)	(4.3920)	(7.3189)	(20.6648)
INFOSYS	0.0015	0.8338	0.0012	0.2362	0.6723
	(10.4536)	(3.8976)	(3.2190)	(4.6784)	(15.9874)

Table 4: Estimates of ARCH (1) and GARCH (1, 1) in Pre- Derivatives period

Index and stocks	Conditional Variance Equation ARCH(1) $\sigma_t^2 = \beta_0 + \beta_1\varepsilon^2_{t-1}$		Conditional Variance Equation GARCH(1,1) $\sigma_t^2 = \beta_0 + \beta_1\varepsilon^2_{t-1} + \beta_2\sigma^2_{t-1}$		
	β_0	AR(1)β_1	β_0	β_1	β_2
CNX Nifty	0.0001	0.3385	0.0003	0.1232	0.8678
	(36.5836)	(22.7622)	(8.3997)	(15.5145)	(100.2378)
HDFC	0.0093	0.4617	0.0001	0.0453	0.9532
	(40.4441)	(3.0260)	(4.5441)	(13.9597)	(93.5445)
TATA Steel	0.0005	0.1944	0.0002	0.0453	0.9533
	(139.3889)	(10.3961)	(4.5441)	(13.9597)	(193.5445)
L&T	0.0006	0.3833	0.0003	0.4879	0.3769
	(98.7523)	(11.6167)	(16.8452)	(17.3992)	(10.5023)
ONGC	0.0009	0.0547	0.0001	-0.0003	0.9902
	(120.8884)	(5.0230)	(18.0393)	(-3.9100)	(102.502)
ACC	0.0008	0.0867	0.0001	-0.5437	0.9854
	(234.4432)	(89.0965)	(34.0210)	(12.9870)	(98.5345)
INFOSYS	0.0007	0.0345	0.0011	0.2381	0.4523
	(32.1231)	(1.4563)	(78.9854)	(34.6758)	(122.7654)

Table 5: Estimates of ARCH (1) and GARCH (1, 1) in Post - Derivatives period

Index and Stocks	β_0	ARCH β_1	GARCH β_2	CONDITIONAL VARIANCE	UNCONDITIONAL VARIANCE
CNX Nifty	0.0000	0.0718	0.9280	0.9998	0.0000
HDFC	0.0031	-0.0015	0.5976	0.5961	0.0077
TATA Steel	0.0002	0.1495	0.6806	0.8301	0.0012
L&T	0.0002	0.1479	0.6649	0.8128	0.0011
ONGC	0.0001	0.1946	0.6839	0.8785	0.0008
ACC	0.0001	0.1394	0.4485	0.5879	0.0002
INFOSYS	0.0012	0.2362	0.6732	0.9094	0.0132

Table 6: Conditional and Unconditional Variance of Spot Market –Pre- Future Period

Index and Stocks	β_0	ARCH β_1	GARCH β_2	CONDITIONAL VARIANCE	UNCONDITIONAL VARIANCE
CNX Nifty	0.0003	0.1232	0.8678	0.991	0.0333
HDFC	0.0001	0.0453	0.9532	0.9985	0.0666
TATA Steel	0.0002	0.0453	0.9533	0.9986	0.1428
L&T	0.0003	0.4879	0.3769	0.8648	0.0022
ONGC	0.0001	-0.0003	0.9902	0.9899	0.0099
ACC	0.0001	-0.5437	0.9854	0.4417	0.0002
INFOSYS	0.0011	0.2381	0.4523	0.6904	0.0036

Table 7: Conditional and Unconditional Variance of Spot Market –Post- Future Period

Conditional Variance Equation $\sigma_t^2 = \beta_0 + \beta_1\varepsilon^2_{t-1} + \beta_2\sigma^2_{t-1} + \gamma D_{futures}$				
Index and stocks	Constant(β_0)	ARCH(β_1)	GARCH(β_2)	Dummy γ
CNX Nifty	0.0000	0.1150	0.8735	-0.0006
	(9.1388)	(19.2854)	(156.0871)	(1.1757)
HDFC	0.0040	0.7017	0.1995	0.0046
	(20.3499)	(4.8458)	(5.1367)	(3.4362)
TATA Steel	0.0000	0.0448	0.9511	0.0007
	(6.1630)	(16.9778)	(257.8176)	(0.7749)
L&T	0.0003	0.2840	0.5060	0.0023
	(14.0781)	(22.5539)	(16.1541)	(2.8049)
ONGC	-0.0000	-0.0005	1.0007	0.0031
	-(0.8663)	-(54.9245)	(103.09)	(5.1280)
ACC	0.0001	0.2421	0.4385	-0.0002
	(0.6423)	(1.3021)	(21.6709)	-(0.8745)
INFOSYS	0.0004	0.0038	0.7924	-0.0001
	(4.8034)	(3.6549)	(86.6211)	-(4.627)

Table 8: Impact of Futures Trading On Volatility of Underlying Spot Market Using Dummy Variable

5. Conclusion

The impact of derivatives trading on the volatility of the underlying cash market is a matter of high significance as stock market volatility can have wide repercussions on the economy as a whole in general and financial market in particular. Keeping in view that very few studies have been carried out to analyse the impact of derivatives trading on stock market volatility in India, this study makes an attempt to further widen the research in the said area in Indian context. This article uses GARCH (1,1) model to examine the effect of introduction of futures trading on the volatility of underlying Nifty index and some of the select individual stocks (HDFC, TATA Steel, L&T, ONGC, ACC and INFOSYS) representing different sectors of the economy. The results show that the underlying cash market of Nifty index has been stabilized after the introduction of futures trading which is attributable to absence of volatility persistence in post-futures period. However, the conditional volatility decreased and unconditional volatility of Nifty index increased after the introduction of derivatives trading. The finding that there is decrease in volatility in post futures period in case of Nifty is supported by earlier studies in India such as (Thomas and Thenmozai, 2003; Vipul,2006; Mallikarjunappa and Afsal 2008; Saravanan and Deo,2010*etc.*). Moreover, individual stocks show mixed results in this study. WhereHDFC, TATA Steel, L&T, ONGC show increase in volatility after the introduction of futures trading, there is a volatility diminishing impact of futures trading in case of ACC and INFOSYS.

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