Derivative Trading and Spot Market Volatility: Evidence from Indian Market

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Abstract: The present study tries to estimate the effect of introduction of individual stock derivatives on the underlying stock volatility in Indian stock market. To estimate the effect of introduction of derivatives on stock market, GARCH family models which are known for their ability to model volatility. The return series of the ten companies were tested using methods like, unit root test and descriptive statistics to confirm that GARCH models could be used. Using these models, the asymmetric nature of stock returns and the volatility of stock returns on the introduction of derivatives are checked. The results reveal that the introduction of derivatives has decreased the volatility of the underlying stock returns. It was also found that most of the stock returns show asymmetric behaviour.

Key words: Derivatives, GARCH, Stock volatility

1. INTRODUCTION

The modelling of asset returns volatility remains as an active topic of analytic and empirical interest. It provides substantial information on the risk patterns involved in investment and transaction processes. Several empirical researches have been carried out to understand the effect of introduction of derivatives on the volatility of the spot markets and also to explore its role in stabilising or destabilising the cash markets. It is widely known in finance research that stock return volatility is highly persistent, especially in the developing markets. High levels of price volatility exhibited by the stock markets emphasizes on the need to examine the dynamics of volatility, to reduce the unpredictable outcomes. The volatility behaviour of the stock market has become further complicated with the introduction of derivatives in the equity markets in the major world markets. The derivative instruments were launched with the objectives to transfer risk and to increase liquidity, thereby ensuring better market efficiency. Along with this, derivatives open new avenues for hedging and speculation, which further complicates the volatility behaviour of the stock markets.

Cox (1976) Figlewski (1981) Stein, (1987) argued that the introduction of futures trading increased the spot market volatility which resulted in destabilizing the market. These researchers perceived derivative market as a market for speculators. They suggested that derivative market encouraged the participation of speculative traders with very little or no cash or shares which resulted in high degree of leverage in the market, thereby increasing the risk. This has also resulted in lowering the quality of information in the market. Chatrath, Ramchander and Song, (1995) commented that uninformed traders could play a destabilising role in cash markets.

Powers, (1970) Schwarz and Laatsch, (1991) found that the introduction of futures actually reduces the spot market volatility which will stabilise the market. All these debates clearly point out that volatility is undesirable. Questions pertaining to the impact of derivative trading on cash market volatility have been empirically addressed in two ways: by comparing cash market volatilities during the pre-and post-futures/ options trading eras and second, by evaluating the impact of options and futures trading (generally proxied by trading volume) on the behaviour of cash markets. The literature is, however, inconclusive on whether introduction of derivative products lead to an increase or decrease in the spot

market volatility. To capture the volatility in financial time-series, several models of conditional volatility have been proposed. An outstanding class of model was first introduced by Engle (1982) which was known as the ARCH (autoregressive conditional heteroscedasticity) model. This model was later generalized by Bollerslev (1986) to GARCH (generalized ARCH) model by including the lags of conditional variance itself. In these models, one very common finding in the financial asset is that shocks to volatility are often highly persistent.

The history of derivative trading in India can be traced way back to the 19th century. In the initial days it was mainly in the form of commodity forwards. In 1875, Bombay cotton trade association started trading commodity futures. During the early 1900s, India had one of the largest futures industry. However in 1952, the government banned such contracts and the derivative trading shifted to informal forwards. The ban on commodity derivatives was lifted in the early 2000s. The derivatives trading on the National Stock Exchange (NSE) commenced on June 12, 2000 with futures trading on S&P CNX Nifty Index. It was followed by trading in index options and options on individual securities which started on June 4, 2001 and July 2, 2001 respectively. Single stock futures were launched on November 9, 2001. 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. Indian market is one of the largest derivative markets in the world. The growth of Indian derivative market is shown in the following figure. (Fig.1)

Figure 1: Growth of Derivatives in India (Source: Compiled from NSE and BSE Websites)

Earlier studies have used two different methods to understand the impact of derivative trading on cash market volatility. The first method is by comparing cash market volatilities during the pre-and post-futures/ options trading eras and second, by evaluating the impact of options and futures trading (generally proxied by trading volume) on the behaviour of cash markets. However, the previous studies done on the volatility effects of derivatives trading in India had given inconclusive results which suggest the need for a robust examination of the impact of derivatives on market volatility. Against this backdrop, it is important to empirically examine the impact of derivatives on the stock market. The present study tries to estimate the effect of introduction of individual stock derivatives on the underlying stock volatility in Indian stock market by considering the stock derivatives introduced in the year 2010. This paper is organised as follows: following the introduction, the section 2 presents literature review, followed by section 3 on research methodology. The section 4 provides results and discussion on key findings and section 5 discusses the concluding remarks.

2. LITERATURE REVIEW

Prior studies have been conducted in India and abroad to study the effect of derivatives on the underlying asset's price volatility. Initial researches concentrated on the commodity futures and their effect on the underlying commodities. With the introduction of index futures, researchers were interested in estimating the effect of these derivatives on the underlying indices. After the introduction of individual stock derivatives, studies were done to identify their effect on the underlying assets. The results of the studies weren't similar as they were done in different markets at different time periods. Researchers used different approaches to understand the issues and the latest approach is the use of GARCH family techniques to study the volatility of stock returns. Cox (1976) studied price series of six commodities and concluded that the future trading has increased the amount of information known to the traders. He also concluded that the future trading has increased the efficiency of the underlying market which is a commodity market in this case. Antoniou and Holmes (1993) in their study based on the markets in United Kingdom found out that the introduction of index derivatives increased the spot price volatility on a daily basis. The reasons identified by them were the increased information in the market and the expansion of information route in the markets due to futures trading. Dennis et.al., (1999) conducted a study in the Australian market and concluded that most of the individual stock futures do not have any effect on the respective underlying stocks. But very few stocks showed change in volatility either increasing or decreasing. The study done on Taiwan Index futures by Min-Hsien and Cheng-Yu (2002) found that the introduction of TAIEX futures has increased the spot price volatility. They also found out that the asymmetric nature of the spot market has increased, as large numbers of uninformed non-institutional members overreacted to the bad news than to the good news. Bologna and Cvallo (2002) found out that the introduction of Fib30 has reduced the unconditional volatility in the post-futures period and also the effect was found out to be immediate. The results also suggested that the introduction of futures has increased the efficiency of the market by reducing the volatility.

There are a number of studies done in Indian markets to understand the effect of derivative trading on spot market volatility. Thenmozhi (2002) had carried out a study on NSE-50 Index Futures Contracts. She used regression analysis and found out that introduction of index futures has decreased the volatility of spot index returns. The main reasons identified were the greater information flow in the post futures period and the shift of speculators from spot market to the futures market due to low transaction and marginal costs.

Bandivadekar and Gosh (1993) conducted a study using ARCH and GARCH techniques on the futures of S&P CNX Nifty and BSE Sensex. They found out that in case of Nifty the volatility of underlying stock has decreased significantly, but in case of Sensex, the change was not significant as the amount trade of Sensex futures were considerably low. When Nath (1993) studied the impact of individual stock futures on the underlying stocks, it was the first of its kind study in the Indian market. He used the GARCH family models to understand the effect. He found out that the introduction of individual derivatives has decreased the volatility of most of the stocks under study. When compared with the earlier Indian studies he used a longer time period and has also taken into account the cyclical trends in the market. Results of the Indian studies given above were almost similar. They all said that the introduction of derivatives reduced the volatility of the underlying in the post derivative period. But Shenbagaraman (1993) came out with a contradicting result that the introduction of derivatives did not have any significant effect on the spot market. She also used GRCH family methods to identify the impact of derivatives introduction. Nair (2011) conducted a study on the impact of derivative trading on the volatility of the underlying assets in Indian stock markets. He studied the asymmetric nature of stock returns using GJR GARCH method. He found out that stocks got an asymmetric nature and that the introduction of derivatives has decreased the volatility of the underlying stocks. He also concluded that the introduction of derivatives has increased the effect of new information on the spot market.

The regulatory frame work for derivative trading is based on L.C Gupta Committee report and J.R. Varma Committee. The frame work in India is mostly consistent with regulations of international organization of securities commission. Securities Exchange Board of India (SEBI) is the primary regulatory body. Some of the regulations are also done by Reserve Bank of India and the financial ministry.

3. RESEARCH METHODS

The study was done with an objective to understand the change in spot market volatility with the introduction of stock derivatives. Minor objective of the study is to identify the asymmetric nature in returns.. The present study tries to estimate the effect of derivatives on all the stocks, for which derivatives were introduced in the year 2010 in the National Stock exchange (NSE). Here the researchers have considered only those derivatives which are still on trade and a minimum of 500 days trading data prior to the introduction of derivatives is available. Ten companies were found to be satisfying all the three above said criteria. Closing prices of these companies' stock for a total of 1000 days, 500 days before and after the commencement of derivatives was collected. To incorporate the effect of market

wide factors, the closing price of S&P CNX Nifty for the respective 1000 days is also collected. All these data are collected from NSE website. From the close prices collected, the returns are calculated using the following formula,

$$R_t = \ln \left(\frac{P_t}{P_{t-1}} \right)$$

Where $\ln$ stands for natural logarithm, P_t stands for closing price on trading day t and P_{t-1} stands for closing price on the previous trading day. During the calculations the data is used mainly in three forms, they are pre derivatives period, post derivative period and full period. Logarithmic return is preferred over percentage return as in case of percentage return negative values couldn't be below 100 while on positive side there was no limit.

The logarithmic returns were calculated using Microsoft Excel whereas the rest of the calculations were done using E-Views 7.2.

Robert F Engle in 1982 introduced a new model called Auto-Regressive Conditional Heteroscedasticity or ARCH. It was the first model that provided a systematic structure or framework to model volatility. The main features of this model are, it is a model with an autoregressive or regression on itself and the conditional variance had time variation built into it. Another feature of ARCH models is that it could explain the volatility clustering of financial asset returns. Volatility clustering means large changes in asset returns will be followed by large returns and small changes in asset returns will be followed by small changes, in both the directions. The ARCH model consists of the mean equation and the conditional variance equation. In the original formulation of ARCH model the variance is calculated as a moving average of past error terms which is given as,

$$h_t = \omega + \sum_{i=1}^p a_i \varepsilon_{t-i}^2$$

Where ω is a constant, a_i is a constant determined from the empirical data, both ω and a_i are non-negative and ε is the error term which is given as follows,
 $\varepsilon_t = \sqrt{h_t} Z_t$

Where Z terms are independent standard normal variables.

In 1986, Tim Bollerslev introduced a generalised form of ARCH called GARCH or General AutoRegressive Conditional Heteroscedasticity. This model is also a weighted average of past squared residuals, but this has declining weights which will never become zero, also all past errors will contribute to forecast volatility. The most simple form is GARCH (1,1), for which the conditional variance is,

$$h_t = \omega + a_i \varepsilon_{t-1}^2 + \beta_i h_{t-1}$$

Here the constants ω , a and β are greater than zero. The second last term of the equation represents the squared error terms and the last term represents the lagged conditional variance.

One of the drawbacks of the standard GARCH model is that it assumes response of volatility to information is symmetric. But in reality the return series show asymmetry, that is, the effect of 'bad' news is greater than that of the effect of 'good' news. Thus, the use of standard GARCH models in these cases may lead to misrepresentation of relationships and the inferences or interpretations will be misleading. This led to the development of new models which could measure the asymmetry in time series. One of the major asymmetric models is GJR-GARCH model. It was developed by Glosten, Jagannathan and Runkle in 1993. The conditional equation of this model is,

$$h_t = \omega + a_i \varepsilon_{t-1}^2 + \beta_i h_{t-1} + \gamma_i S_{t-1}^- \varepsilon_{t-1}^2$$

Where $S_{t-1}^- = 1$ if $\varepsilon_{t-1} < 0$ and $S_{t-1}^- = 0$ other wise. The term S_{t-1}^- is generally known as leverage parameter. So it's the apt model to be used in our study or analysis

To understand the changes in volatility, a dummy variable is included in the conditional variance equation. The dummy variable will take the value 0 prior to the introduction of derivatives and value 1 after the introduction of derivatives. After inclusion of this the conditional equation of standard GARCH model is,

$$h_t = \omega + a_i \varepsilon_{t-1}^2 + \beta_i h_{t-1} + \gamma D$$

The conditional variance of GJR GARCH will also change. The new formula is given as,

$$h_t = \omega + a_i \varepsilon_{t-1}^2 + \beta_i h_{t-1} + \gamma_i S_{t-1}^- \varepsilon_{t-1}^2 + \gamma D$$

While considering the effect of derivatives on stock market volatility, it is also important to consider the general changes in the market or the macroeconomic factors. For this, the return of nifty is included in the mean equations of the standard GARCH and GJR GARCH. The mean equation is given as,

$$R_t = c + \beta * R_{nifty} + \varepsilon_t$$

Where R_{nifty} is the return of nifty and ε_t is the white noise.

The data to be used with the GARCH model should be free of trends or should be stationary. In order to check for trends in the series, unit root test is performed. If some trend is found it could be removed through first differencing or through time trend regression. In the study we use Dickey-Fuller test and Phillips-Perron test for unit root testing. Hypothesis used for this are,

Null Hypothesis (H_0): Series has a unit root.

Alternate Hypothesis (H_1): Series is stationary.

The series is also tested using LM ARCH test. This test is done to identify the ARCH effect in the series. Hypothesis used for this test are,

Null Hypothesis (H_0): There is no ARCH effect.

Alternate Hypothesis (H_1): There is ARCH effect.

4. ANALYSIS AND EMPIRICAL RESULTS

a. Unit Root Test

Unit root test is done for the return series at level variables using both Dickey-Fuller (ADF) test and Phillips-Perron (PP) test. Lag length is selected based on Schwarz Info Criterion (SIC), and lag length is found to be 21. The table (Table 1) presents data on with intercept, with intercept and trend and without intercept and trend.

Table 1: Results of Unit Root Test (Source: Authors' computation using E- views)

Stock	Augmented Dickey- Fuller test			Phillips-Perron Test		
	With Intercept (-3.43)	With intercept and trend (-3.96)	Without intercept and trend (-2.58)	With Intercept (-3.43)	With intercept and trend (-3.96)	Without intercept and trend (-2.58)
Adani Enterprises Limited	-28.15215	-28.13921	-28.15575	-28.28822	-28.27564	-28.29400
Apollo Tyres Ltd	-29.74327	-29.74558	-29.74859	-29.73337	-29.72794	-29.74250
Exide Industries Ltd	-32.51020	-32.49902	-32.51507	-32.50465	-32.49360	-32.50931
Godrej Industries Ltd	-30.00500	-30.04834	-30.01626	-30.01106	-30.04497	-30.02275
Hexaware Technologies Ltd	-32.55469	-32.56125	-32.56517	-32.63327	-32.63951	-32.64197

Indraprastha Gas Ltd	-32.32824	-32.38008	-32.31221	-32.51426	-32.68961	-32.45567
Jain Irrigation Systems	-31.28017	-31.28457	-31.27036	-31.28081	-31.28477	-31.27161
Mcleod Russel India Ltd	-30.71959	-30.71751	-30.71293	-30.71959	-30.71751	-30.71293
NMDC Ltd	-27.30267	-27.29817	-27.31583	-27.35974	-27.35128	-27.37297
Shriram Transport Fin Co	-30.18953	-30.18578	-30.18336	-30.23013	-30.22129	-30.22500

The return series is tested for presence of unit root at level variable. The values given in brackets in the heading column are the critical values at 1% level of significance. As the absolute values of the results are greater than the critical values, we can confirm that the null hypothesis is rejected. Hence the alternate hypothesis that the series is stationary is accepted. Thus using the unit root test it is proved that the series is stationary or data is free from trends. Hence data could be used for modelling with GARCH.

Table 2: Summary Statistics for Pre Derivative Period (Source: Authors' computation)

Name of the Stock	Skewness	Kurtosis	Jarque-Bera	ARCH Test
Adani Enterprises Limited	-5.971783	87.987140	153447.200	0.17
Apollo Tyres Ltd	0.608704	6.575570	297.225	24.75
Exide Industries Ltd	0.257883	4.083841	30.015	65.25
Godrej Industries Ltd	0.395347	5.090797	104.096	38
Hexaware Technologies Ltd	2.696324	32.392080	18603.650	1
Indraprastha Gas Ltd	0.335557	7.625452	455.108	99.09
Jain Irrigation Systems	-0.023566	5.458958	126.015	64.91
Mcleod Russel India Ltd	0.412117	4.966420	94.712	12.01
NMDC Ltd	1.348030	8.602672	805.389	34.88
Shriram Transport Fin Co	0.051075	10.198480	1079.763	14.82

The results indicate that, for all the scripts in their pre derivatives period skewness is non zero and the kurtosis is in excess of three. Further, the Jarque-Bera (JB) test indicates that the assumption of normality is violated in the pre derivatives period. Further in most of the cases, ARCH test values are greater than the critical values at 1% level, so the hypothesis that there is no ARCH effect is rejected.

Table 3: Summary Statistics for Post Derivative Period (Source: Authors' computation)

Name of the Stock	Skewness	Kurtosis	Jarque-Bera	ARCH Test
Adani Enterprises Limited	-1.575358	16.984990	4281.3920	16.91
Apollo Tyres Ltd	0.193933	4.291068	37.860330	29.87
Exide Industries Ltd	-0.462067	5.580386	156.508700	4.59

Godrej Industries Ltd	0.037816	3.806154	13.658440	2.7
Hexaware Technologies Ltd	-10.592560	189.934200	737358.100	0.03
Indraprastha Gas Ltd	-4.870594	104.770900	217754.400	0.44
Jain Irrigation Systems	-17.132890	350.608300	2541785.000	0.034
Mcleod Russel India Ltd	0.010831	3.393678	3.238574	21.38
NMDC Ltd	-0.091716	3.917554	18.240660	28.63
Shriram Transport Fin Co	0.064470	4.309131	36.051030	27.67

The results indicate that, for all the scripts in their post derivatives period skewness is non-zero and the kurtosis is in excess of three. Further, the JB test indicates that the assumption of normality is violated in the post derivatives period. Further in most of the cases ARCH test values are greater than the critical values at 1% level, so the hypothesis that there is no ARCH effect is rejected.

Table 4: Summary Statistics for Full Period (Source: Authors' computation)

Name of the Stock	Skewness	Kurtosis	Jarque-Bera	ARCH Test
Adani Enterprises Limited	-5.600045	96.645690	370623.200000	0.08
Apollo Tyres Ltd	0.470506	6.128051	444.591900	48.46
Exide Industries Ltd	0.066636	4.826720	139.777800	85.61
Godrej Industries Ltd	0.344799	6.533070	539.922000	113.4
Hexaware Technologies Ltd	-3.617964	105.802000	442525.300000	0.05
Indraprastha Gas Ltd	-3.206844	81.087830	255785.200000	1.64
Jain Irrigation Systems	-18.892830	503.515500	10497648.000000	0.023
Mcleod Russel India Ltd	0.450328	6.236121	470.152300	60.23
NMDC Ltd	1.238368	10.195350	2412.802000	86.34
Shriram Transport Fin Co	0.060476	7.401833	807.948500	26.65

The results indicate that, for all the scripts in their full period skewness is non-zero and the kurtosis is in excess of three. Further, the JB test indicates that the assumption of normality is violated in the whole period. Further in most of the cases ARCH test values are greater than the critical values at 1% level the hypothesis that there is no ARCH effect is rejected.

b. Test for Asymmetry

GJR GARCH (1,1) used to check the asymmetric nature of the stock returns. For this data for the entire period is used. Following table shows returns and their significance values.

Table 5: Test for Asymmetry (Source: Authors' computation)

Name of the Stock	Constant	ARCH	GARCH	Leverage
Adani Enterprises Limited	0.003387 (64.0366)	0.159312 (2.664867)	-0.024564 (-27.25381)	0.131302 (1.429748)
Apollo Tyres Ltd	0.000145 (4.30695)	0.020495 (1.545564)	0.79923 (21.7316)	1.23e-01 (3.704372)
Exide Industries Ltd	5.92e-05 (3.244907)	0.074676 (3.09493)	0.818832 (21.56001)	0.052853 (1.622755)
Godrej Industries Ltd	9.28e-05 (3.39669)	0.045376 (3.538654)	0.865384 (35.35983)	0.074393 (3.19822)
Hexaware Technologies Ltd	0.001915 (1.298742)	0.117858 (1.241203)	0.554162 (1.648717)	-0.125071 (-1.291627)
Indraprastha Gas Ltd	0.000318 (14.63033)	0.232304 (5.095968)	0.071445 (1.861946)	0.618927 (9.004281)
Jain Irrigation Systems	0.003393 (0.743701)	0.015343 (1.875634)	0.580019 (1.025234)	-0.018706 (-7.363848)
Mcleod Russel India Ltd	0.00015 (2.642025)	0.028724 (1.809134)	0.867958 (21.30301)	0.050987 (2.117404)
NMDC Ltd	1.74e-05 (5.727117)	0.138112 (9.025231)	0.84626 (80.88347)	0.031157 (1.116173)
Shriram Transport Fin Co	0.000307 (6.337862)	0.164473 (3.234119)	0.272245 (2.650441)	0.140864 (2.437834)

The results of GJR GRCH test is shown in the above table. The leverage terms in the above table is used to analyse whether the returns are asymmetric. A positive coefficient of the leverage terms shows that the data is asymmetric. From the above table it's clear that all firms except Hexaware Technologies Ltd and Jain Irrigation Systems, stock returns are asymmetric. In this study GJR GARCH is used to understand the effect of the asymmetric scripts and standard GARCH model is used to estimate the effect of symmetric scripts.

To estimate whether the volatility has increased or decreased after the introduction of derivatives a dummy variable is introduced in the conditional variance equation. The dummy variable takes the value '0' in the pre derivatives period and '1' in post derivative period. For the asymmetric scripts GJR GARCH model is used and for symmetric scripts standard GARCH model is used. Initially the calculation is done without controlling the market pervasive factors then the return of nifty is introduced to include market pervasive factors.

Table 6: Effect of Derivatives on the Volatility of the Underlying Stock without considering the market pervasive factors (Source: Authors' computation)

Name of the Stock	Constant	ARCH	GARCH	Dummy
Adani Enterprises Limited	0.003387 (64.0366)	0.159312 (2.664867)	-0.024564 (-27.25381)	-0.002634 (-41.69495)
Apollo Tyres Ltd	0.000145 (4.30695)	0.020495 (1.545564)	0.79923 (21.7316)	-4.77e-05 (-3.276923)
Exide Industries Ltd	0.0000592 (3.244907)	0.074676 (3.09493)	0.818832 (21.56001)	-0.0000142 (-1.750911)
Godrej Industries Ltd	0.0000928 (3.39669)	0.045376 (3.538654)	0.865384 (35.35983)	-0.0000504 (-2.710073)
Hexaware Technologies Ltd	0.001993 (0.757792)	-0.006696 (-126.4043)	0.403251 (0.511243)	0.000531 (0.755359)
Indraprastha Gas Ltd	0.000318 (14.63033)	0.232304 (5.095968)	0.071445 (1.861946)	-0.0000804 (-4.156169)

Jain Irrigation Systems	0.0000513 (4.163448)	-0.002881 (-6.606537)	0.9568 (83.59746)	0.000275 (3.723491)
Mcleod Russel India Ltd	0.00015 (2.642025)	0.028724 (1.809134)	0.867958 (21.30301)	-0.000109 (-2.686567)
NMDC Ltd	0.0000174 (5.727117)	0.138112 (9.025231)	0.84626 (80.88347)	-0.00000379 (-0.990432)
Shriram Transport Fin Co	0.000307 (6.337862)	0.164473 (3.234119)	0.272245 (2.650441)	-0.0000174 (-0.744078)

The value of dummy variable is considered to analyse the impact of introduction of derivatives, positive coefficients indicate that the volatility has increased and negative coefficients indicate decrease in volatility. From the results presented it's clear that the volatilities of all except Hexaware Technologies Ltd and Jain Irrigation Systems decreased.

Table 7: Effect of Derivatives on the Volatility of the Underlying Stock after considering the market pervasive factors (Source: Authors' computation)

Name of the Stock	Nifty	Constant	ARCH	GARCH	Dummy
Adani Enterprises Limited	0.852689	0.01858 (40.70954)	0.188469 (3.137155)	-0.02389 (-1.273707)	-0.001309 (-37.47101)
Apollo Tyres Ltd	0.770584	0.00013 (3.49795)	0.022171 (1.391628)	0.789189 (16.79576)	-4.38e-05 (-2.998053)
Exide Industries Ltd	-0.008637	0.0000591 (3.185759)	0.074874 (3.105505)	0.819157 (21.28758)	-0.0000142 (-1.735585)
Godrej Industries Ltd	1.18201	-0.00000689 (-6.196118)	-0.007137 (-35.90861)	0.998996 (3506.619)	0.00000567 (6.167316)
Hexaware Technologies Ltd	0.188723	0.001784 (1.312453)	0.121871 (1.098549)	0.534876 (1.535907)	0.000287 (1.303064)
Indraprastha Gas Ltd	0.030528	0.000315 (14.32414)	0.22981 (4.842362)	0.077376 (1.883301)	-0.000079 (-4.132399)
Jain Irrigation Systems	0.597929	0.003237 (0.90319)	-0.003236 (-77.20411)	0.577392 (1.228505)	0.000231 (0.537899)
Mcleod Russel India Ltd	0.862044	0.001023 (4.327838)	0.097578 (2.696451)	0.127751 (0.734901)	-0.000709 (-4.200816)
NMDC Ltd	0.016206	0.0000177 (5.569008)	0.137112 (8.850966)	0.846432 (80.17397)	-0.00000403 (-1.020991)
Shriram Transport Fin Co	-0.017043	0.000307 (6.218456)	0.162444 (3.223196)	0.274081 (2.637577)	-0.0000168 (-0.714058)

To understand the effect of market pervasive factors the coefficients of dummy variables in above two tables are compared. After looking at the above two tables it's clear that the difference in dummy variable is negligible except in the case of Godrej Industries Ltd. In case of Godrej Industries Ltd the volatility has increased after controlling the market wide conditions. In a whole we can conclude that the effect of introduction derivatives reduced the volatility of the underlying stocks.

Now GJR GARCH model is used to model the pre derivative and post derivative period returns. This is done to compare the different coefficients like asymmetric nature, effect of recent news and old news.

Table 8 Pre Derivative Period Analysis (Source: Authors' computation)

Name of the Stock	Constant	ARCH	GARCH	Leverage
Adani Enterprises Limited	0.001411 (0.899198)	0.022175 (0.198525)	-0.029551 (-0.264649)	0.58691 (1.2781)
Apollo Tyres Ltd	0.000159 (3.580041)	0.014115 (0.809816)	0.17839 (3.389484)	7.73e-01 (17.19488)
Exide Industries Ltd	0.0000286 (1.976952)	0.090667 (2.980027)	0.03759 (0.729312)	0.860623 (25.94257)
Godrej Industries Ltd	0.0000694 (3.188329)	0.093623 (4.154984)	0.107582 (2.573885)	0.836416 (31.92443)
Hexaware Technologies Ltd	0.0000162 (3.165875)	-0.003093 (-2.824903)	0.041208 (4.408895)	0.98334 (326.0652)
Indraprastha Gas Ltd	0.000198 (4.35502)	0.373138 (4.683318)	-0.350429 (-4.063001)	0.399745 (3.259553)
Jain Irrigation Systems	0.0000828 (2.390627)	0.055388 (1.88217)	0.142533 (2.892687)	0.805025 (15.97991)
Mcleod Russel India Ltd	0.000788 (1.620075)	-0.014008 (-0.39901)	0.151843 (1.432098)	0.508858 (1.690289)
NMDC Ltd	0.00000809 (2.716723)	0.221119 (8.618058)	0.017658 (0.319949)	0.821749 (65.08233)
Shriram Transport Fin Co	0.000311 (5.165155)	0.135163 (1.79293)	0.270388 (3.071024)	0.249815 (1.86294)

Table 9: Post Derivative Period Analysis (Source: Author's computation)

Name of the Stock	Constant	ARCH	GARCH	Leverage
Adani Enterprises Limited	0.000203 (10.5344)	0.516984 (4.321113)	0.887041 (5.015182)	0.224701 (6.547536)
Apollo Tyres Ltd	0.000100 (1.895949)	0.028944 (1.207651)	0.093942 (1.834794)	0.798984 (9.878277)
Exide Industries Ltd	0.000321 (4.466421)	-0.032289 (-0.525213)	0.260554 (2.34212)	0.211873 (1.183734)
Godrej Industries Ltd	0.000094 (2.692423)	-0.092969 (-4.178533)	0.091554 (3.464427)	0.892248 (16.43776)
Hexaware Technologies Ltd	0.000035 (2.735031)	0.682632 (26.3624)	-0.687912 (-26.14388)	0.819834 (43.91858)
Indraprastha Gas Ltd	0.000237 (12.07297)	0.059320 (1.12058)	1.394057 (10.48985)	0.078355 (1.769246)
Jain Irrigation Systems	0.003890 (0.774645)	0.033649 (0.071563)	-0.037371 (-0.079473)	0.597827 (1.150916)
Mcleod Russel India Ltd	0.000083 (1.510712)	0.058197 (1.500276)	0.081526 (1.157899)	0.751448 (5.582003)
NMDC Ltd	0.000100 (2.954128)	0.022948 (0.634466)	0.263876 (3.260138)	0.627218 (6.667269)
Shriram Transport Fin Co	0.000296 (3.062141)	0.212957 (2.770574)	0.027965 (0.289783)	0.257081 (1.407193)

In the above tables (Table 8 & 9) the ARCH term stands for the effect of recent news on the returns and GARCH term stands for the effect of old news. From the table it's clear that after the introduction derivatives the ARCH of five scripts have increased showing the increased effect of recent news. At the

same time ARCH of five got reduced showing reduced effect of recent news. The GARCH term of seven scripts in the post derivative period has increased showing an increased effect of old news.

By looking at the leverage effect coefficient we could understand the asymmetric nature of the stocks. A positive value corresponds to an asymmetric nature where asymmetry means that the effect of bad news on a stock will be always greater than the effect of good news on the stock. By looking at the above two tables we can see that before introduction of derivatives two stocks namely Adani Enterprises Limited and Indraprastha Gas Ltd were symmetric and rest of the stocks were asymmetric. After the introduction of derivatives the above said two stocks have asymmetric nature, but two scripts, Hexaware technologies Ltd and Jain Irrigation Systems show symmetric nature and all the others are asymmetric. Thus it can be concluded that most of the stocks have an asymmetric nature irrespective of the introduction of derivatives.

The study has the following limitations. (1) Closing price considered are not adjusted for the effects of dividends and splits. (2) Only the effects of derivatives launched in a year are considered. (3) Volume of derivative trading is less for these stocks.

5. CONCLUSION

The aim of the current study was to estimate the effect of introduction of individual stock derivatives on underlying stocks. To do this GARCH family models were used. For the study, ten stocks on which derivatives were introduced in the year 2010 were considered. Closing prices of these stocks for 500 days before and after the introduction of derivatives were used.

Initially logarithmic returns of the closing prices of the ten companies considered were calculated. In order to find out whether the series are stationary, Dickey-Fuller test and Phillips-Perron test were used. Results of these tests proved that the series are stationary or are free of trends. Further analysis was done using skewness, kurtosis, Jarque-Bera statistics, ARCH test coefficients etc. for the pre derivative period, post derivative period and full period. Skewness for all the companies were found to be greater than zero, kurtosis were in excess of three, JB test statistics showed that assumption of normality is violated and in most of the cases ARCH test coefficients suggested that there is ARCH effect. All these results confirm that GARCH family models could be employed.

Then GJR GARCH model was used to find out the asymmetric nature of the stock returns. From the results it is clear that most of the companies showed asymmetric nature, i.e. effect of bad news is greater than the effect of good news. Then to find out whether the volatility has changed, a dummy variable is added in the variance equation of GJR GARCH model in case of asymmetric stocks and dummy variable is added in the variance equation of standard GARCH model in case of symmetric stocks. For most of the companies coefficients of dummy variable was found to be less than zero concluding that the volatility has decreased. To find the effect of market pervasive factors on volatility, return of nifty was used in the mean equation. Comparison of the two results showed that effect of market pervasive factors was insignificant. Finally GJR GARCH model was employed on the pre derivative period and post derivative period of all the stocks considered. Output of this showed that effect of old and recent news were different for pre and post derivative period. Most of the companies showed asymmetric nature in both the periods.

Result of the current study is in agreement with the studies done earlier in the Indian market that the introduction of derivatives has reduced the volatility of the underlying and the stocks show asymmetric nature. (Abhilash, 2011). Result of the study could be used by the players in the stock market to formulate their trading strategies, by regulators of market to put forward surveillance measures, which will make the market more efficient.

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Dr Roshna had been a research fellow with fellowship from University Grants Commission (UGC) in Mahatma Gandhi University for four years. She did PhD in the topic *Corporate Disclosure by Indian Companies*. She joined Rajagiri after working three years at Saintgits Institute of Management. She has presented research papers in various national and international conferences including those of IIMK, IIMC and Indian Academy of Management. Further she has published several articles in refereed national journals. She has two books publication in her credit and has contributed book chapters in many edited books. Dr. Roshna's research specialty is examining the voluntary disclosure in annual reports of companies. She also does work in corporate valuation, microfinance and capital market. Areas of expertise include capital markets, Financial restructuring, corporate finance and investments.

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