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Impact of Derivative Trading On Stock Market Volatility in India: A Study of S&P CNX Nifty

Ruchika GAHLOT[*], Saroj K. DATTA[**], Sheeba KAPIL [***]

Abstract

The Purpose of the study is to examine the impact of derivative trading on stock market volatility. The sample data consist of closing prices of S&P CNX Nifty as well as closing prices of five derivative stocks and five non derivative stocks from April 1, 2002 to March 31, 2005. The study uses GARCH model to capture nature of volatility over time and volatility clustering phenomenon of data. The evidences suggest that there is no significant change in the volatility of S &P CNX Nifty, but the structure of volatility has changed to some extent. However, results show mixed effect in case of 10 individual stocks. These results can assist investors in making investment decision. It also helps to identify need for regulation.

Keywords: *Derivatives, Volatility, S&P CNX Nifty, GARCH*

JEL Classification Codes*: G10.*

* Faculty of Management Studies, Mody Institute of Technology and Science, Deemed University, Rajasthan, India. E-mail: ruchikagahlot29@rediffmail.com

** Faculty of Management Studies, Mody Institute of Technology and Science, Deemed University, Rajasthan, India. E-mail: dean.fms@mitsuniversity.ac.in

*** Associate Professor, Indian Institute of Foreign Trade, New Delhi, India. Email: sheebakapil@iift.ac.in

1. Introduction

The issue of the impact of derivative trading on stock market volatility has received considerable attention during past few years. Although many factors contribute to stock market volatility, there is concern about the impact of derivative trading on stock market volatility. A large number of theoretical and empirical studies have examined the effect of stock index futures and options on the volatility of the underlying spot market. Some researchers have argument that introduction of derivatives affect the volatility of stock market while others disagree with the statement.

The derivatives were launched mainly with the twin objective of risk transfer and to increase liquidity thereby ensuring better market efficiency. In India, derivatives trading started in June 2000 with introduction of Index future followed by index options in June 2001, and options and futures on individual securities in July 2001 and November 2001, respectively. Since inception, National Stock Exchange of India (NSE) established itself as the sole market leader in this segment in the country and during 2008-09, it accounted for 99 % of the market share (NSE, 2009). The total turnover on the F&O Segment was Rs. 11,010,482 crore (US $ 2,161,037 million) during 2008-09.The average daily turnover during 2008-09 was Rs.45, 311 crore (US $ 8,893 million).

The introduction of derivative products may increase volatility in component stocks. This is because the spot and future markets are linked through risk transfer (hedging) and price discovery, two major contributions of the futures markets to economic activity(Rahman,2001). Theoretically, the impact of stock index futures and options on the stock market volatility is still not clear. The linkage between these derivatives markets and the stock market is generally established through arbitraging activities.

The study of impact of derivative trading is important as increased spot market volatility resulting from futures trading may suggest a need for more regulations. The findings of the study will be useful for investors to make investment decision.

2. Literature Review

Various studies are conducted on impact of derivative trading on the volatility of stock market all over the world. Previous studies document mixed evidences on the impact of derivative trading on the stock market volatility. Several studies have attempted to examine the behavior of stock market after introduction of derivatives.

Debashis (2008) studied the effect of future trading on volatility & operating efficiency of the underlying Indian stock market by using paired sample statistic and found that introduction of Nifty Index Future trading in India is associated with

both reduction in spot price volatility & reduced trading efficiency in underlying stock market.

Debashis (2008) did another study to explore the effect of future trading activity on the jump volatility of stock market by taking case of NSE Nifty stock index. He used multivariate Granger causality modeling technique and found that future trading is not force behind episodes of jump volatility.

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 concluded that price sensitivity to old news is higher during pre future period than post future period and with introduction of future, market volatility is determined by recent innovation. Mallikarjunappa and Afsal (2008) also explored effect of future trading on spot market volatility by using GARCH model on CNX Bank Nifty and found that there is no impact of future trading on spot market volatility. However, impact of new news increased and persistence effect of old news decreased in post future period.

Sabri (2008) examined the impact of change in trade volume on volatility of stock prices as expressed by unified Arab Monetary fund stock price index. He reported increase in both trading volume & stock price volatility. He also found the correlation between volume and price movement is higher in the stock markets of the oil Arab states compared to the nonoil Arab states.

Drimbetas et al. (2007) studied the effect of introduction of future & options into the FTSE/ASE 20 Index on the volatility of underlying index by using EGARCH model. He reported reduction in the conditional volatility of index and consequently increases its efficiency.

Alexakis (2007) used GJR-GARCH model to investigate the effect of introduction of stock index future on the volatility of spot equity market by taking case of FTSE 20 Index and concluded that the introduction of future contract has not had a detrimental effect on underling spot market.

Samanta and Samanta (2007) analyzed the impact of introducing index futures and stock future on the volatility of underlying spot market in India. He considered S&P CNX Nifty, Nifty Junior and S&P 500 and used GARCH model for the study. He found that there is no significant change in the volatility of spot market, but the structural changes in the volatility to some extent. He also found mixed result in spot market volatility in case of 10 individual stocks.

Rahman (2001) examined the impact of trading in DJIA Index future & future option on the conditional volatility of component stock. The study used GARCH model to make comparison of conditional volatility of intra-day return before and after introduction of derivatives. The result confirms that introduction of index future & future option on DJIA has no impact on conditional volatility of component stock.

Pilar and Rafael (2002) analyzed the effect of introduction of derivatives on the volatility and trading volume of underlying Ibex-35 index. The study used GJR model and found that trading volume increased significantly but conditional volatility decreased after introduction of derivatives.

Vipul (2007) investigated the change in volatility in Indian Stock market after introduction of derivatives by using extreme value measure of volatility. The result shows that there is reduction in volatility of underlying share after introduction of derivatives attributable to a reduced persistence in previous day's volatility. However, Nifty shows contradictory pattern of increase in its unconditional GARCH volatility & persistence.

Kim (2004) examined the relationship between trading activities of the Korea Stock Price Index 200 derivative contracts and their underlying stock market volatility by using EGARCH and ARIMA. He found positive relationship between stock market volatility and derivative volume while the relationship is negative between volatility open interests.

Robbani and Bhuyan (2005) used the GARCH model to examine the effect of introduction of future & option on the DJIA on the volatility & trading volume of its underlying stocks. The result shows that level of volatility and trading volume increased after introduction of future & option on the index.

This study is different from the previous studies on three counts. First, it examines the volatility of derivatives & non derivative stocks as well as index. Second, it considers longer period for the study. Thirdly, it makes comparative study of pre-derivative and post-derivative period volatility of the underlying.

3. Research Methodology

3.1. Data Collection

In India, Derivative trading is permitted on NSE & BSE. During 2008-09, the S&P CNX Nifty Index accounted for more than 96.61% of the turnover in Index future and options. The S&P CNX Nifty accounted for 93.78% of the total contracts (NSE Factbook, 2009). So S&P CNX Nifty index is selected to represent the whole market. Along with Index, 10 individual stocks are selected of which 5(BHEL, BPCL, Glaxo, M&M & ONGC) are derivative stock and another 5(Hindustan Motors Ltd., Reliance Capital Ltd, Rolta, Titan &Voltas) are non derivative stocks. The data is collected for 8 years & whole period is divided into two parts:

1. Pre future period i.e.01-04-1997 to 31-05-2000
2. Post future period i.e. 01-04-2001 to 31-03-2005
3. Whole period i.e. 01-04-1997 to 31-03-2005

The data of stock prices is collected from the website of NSE. This study uses the closing prices of S&P CNX Nifty & individual stock to measure the volatility.

3.2. Methodology of the Study

The results were obtained on the basis of Rt which is rate of return r in period t, computed in logarithmic first difference.

Without taking into account the presence of unit root test in variable, the analysis may produce spurious results. The Augmented Dickey-Fuller test is used to check the stationarity of variable. The descriptive statistic is also used for individual stocks and Index.

To study the impact of future on stock market volatility, we used univariate GARCH (1, 1) model instead of ARCH because it doesn't takes into account the persistence effect.

Generalized ARCH or the GARCH (r, m) model is proposed by Bollerslev (1986). Theoretically this model is equivalent to infinitive order ARCH model (that is why it gets its name the generalized ARCH model). In GARCH (r, m) model the conditional volatility ht is the function of past conditional volatility (ht-r) and past squared innovations in mean equation (ε2t-m)

The GARCH (1, 1) model is more popular in practice. This model for the stock returns can be presented as follows:

$$Rt = c + \rho Rt\text{-}1 + \varepsilon t$$
$$\varepsilon t = zt.\sqrt{ht}, \text{ where } zt \sim N(0, 1)$$
$$ht = \omega + \alpha \varepsilon 2t\text{-}1 + \beta\, ht\text{-}1$$

The unconditional (average) variance from this model is:

$$\sigma 2 = \frac{\omega}{1-\alpha-\beta}$$

$(\alpha + \beta)$ measures the persistence of volatility. In practice, this usually observed very close to 1, which signifies that the volatility of asset returns is highly persistent. The effect of any shock in volatility dies out at a rate of $(1-\alpha-\beta)$. If $(\alpha+\beta) \geq 1$ the effect of shock will never die out. The volatility will be defined only if $(\alpha+\beta) < 1$. Therefore, this condition is imposed while estimating the GARCH model.

Since the variance can not be negative, another parameter restriction which is required to be imposed while estimating a GARCH model is the non-negativity of ω, α and β coefficients.

Dummy variable is also used to study the impact of future on volatility of stock which is zero before the introduction of future and 1 after the introduction of future. The conditional mean equation:

$$Rt = c + \rho Rt\text{-}1 + \varepsilon t$$

$$\varepsilon t = zt.\sqrt{ht}, \text{ where } zt \sim N(0, 1)$$

The conditional variance equation is:

$$ht = \omega + \alpha \varepsilon 2t\text{-}1 + \beta\, ht\text{-}1 + \gamma Dummy$$

A significant positive (negative) coefficient of dummy variable would indicate that introduction of derivatives increases (decreases) the volatility of underlying stock & Index.

4. Results and Discussion

The result of unit root test is shown in Table 1. All the series are stationary at logarithmic first difference & they are significant at 1% level as p value is less than 0.05.

Table 1: Unit Root Test

COMPANY	INTERCEPT	INTERCEPT & TREND	NONE
BHEL	-21.90095	-21.89562	-21.90620
	(0.00000)	(0.00000)	(0.00000)
Before	-14.26450	-14.26059	-14.27294
	(0.00000)	(0.00000)	(0.00000)
After	-14.85306	-14.84485	-14.86318
	(0.00000)	(0.00000)	(0.00000)
BPCL	-21.71487	-21.70964	-21.72022
	(0.00000)	(0.00000)	(0.00000)
Before	-15.79633	-15.78190	-15.80739
	0.0000	(0.00000)	(0.00000)
After	-13.87055	-13.86947	-13.88011
	(0.00000)	(0.00000)	(0.00000)
Glaxo	-19.43394	-19.42994	-19.43792
	(0.00000)	(0.00000)	(0.00000)
Before	-15.83571	-15.82692	-15.84425
	(0.00000)	(0.00000)	(0.00000)
After	-15.22902	-15.21913	-15.23863
	(0.00000)	(0.00000)	(0.00000)
Hind Motors	-19.79376	-19.78931	-19.79876
	(0.00000)	(0.00000)	(0.00000)
Before	-13.70692	-13.69954	-13.71538
	(0.00000)	(0.00000)	(0.00000)
After	-14.99109	-14.98077	-15.00140
	(0.00000)	(0.00000)	(0.00000)
M&M	-20.26822	-20.26322	-20.27274
	(0.00000)	(0.00000)	(0.00000)
Before	-14.21762	-14.21120	-14.22631
	(0.00000)	(0.00000)	(0.00000)
After	-16.69810	-16.68700	-16.71032
	(0.00000)	(0.00000)	(0.00000)
ONGC	-18.17572	-18.17138	-18.18018
	(0.00000)	(0.00000)	(0.00000)

Before	-16.50153	-16.49366	-16.51117
	(0.00000)	(0.00000)	(0.00000)
After	-15.32205	-15.32205	-15.33271
	(0.00000)	(0.00000)	(0.00000)
Reliance Capital	-20.85790	-20.85308	-20.86276
	(0.00000)	(0.00000)	(0.00000)
Before	-16.85464	-16.85386	-16.86341
	(0.00000)	(0.00000)	(0.00000)
After	-14.53347	-14.52374	-14.54324
	(0.00000)	(0.00000)	(0.00000)
Rolta	-21.41862	-21.41397	-21.42337
	(0.00000)	(0.00000)	(0.00000)
Before	-15.13945	-15.13150	-15.14767
	(0.00000)	(0.00000)	(0.00000)
After	-14.80737	-14.79697	-14.81684
	(0.00000)	(0.00000)	(0.00000)
Titan	-25.68269	-25.67621	-25.68889
	(0.00000)	(0.00000)	(0.00000)
Before	-15.69922	-15.69214	-15.70770
	(0.00000)	(0.00000)	(0.00000)
After	-15.52993	-15.51869	-15.50793
	(0.00000)	(0.00000)	(0.00000)
Voltas	-22.21237	-22.20681	-22.21768
	(0.00000)	(0.00000)	(0.00000)
Before	-18.43588	-18.42527	-18.44585
	(0.00000)	(0.00000)	(0.00000)
After	-15.46932	-15.45867	-15.47991
	(0.00000)	(0.00000)	(0.00000)
S&P CNX NIFTY	-21.31160	-21.30613	-21.31680
	(0.00000)	(0.00000)	(0.00000)
Before	-17.22881	-17.21698	-17.24010
	(0.00000)	(0.00000)	(0.00000)
After	-16.79693	-16.78545	-16.80861
	(0.00000)	(0.00000)	(0.00000)

Figures in ( ) represent p value

Table 2 shows the descriptive statistic of returns of individual stock and S&P CNX Nifty for pre derivatives & post derivatives period. The mean value of all stock except Rolta in post future period is improved. The volatility can be expressed in form of standard deviation of return. The standard deviation of non derivative stock is higher than derivative stock for both the period. It has decreased for both derivative and non derivative stock as well as for S&P CNX Nifty in post derivative period which shows reduction in volatility. Out of 10, 7 stocks are positively skewed & S&P CNX Nifty is also negatively skewed. All the stocks and S&P CNX Nifty has fat tail as kurtosis is greater than 3.

Table 2: Descriptive Statistic

COMPANY	MEAN	STANDARD DEVIATION	SKEWNESS	KURTOSIS
BHEL	0.000434	0.030982	-0.205395	6.097188
Before	-0.001086	0.034293	-0.011184	3.915366
After	0.001908	0.023673	-0.987519	18.17252
BPCL	$-2.23x10^{-5}$	0.035493	-3.610178	72.91172
Before	-0.000714	0.033616	0.068012	3.877429
After	$4.95x10^{-5}$	0.027306	-0.571488	11.41691
Glaxo	0.000478	0.024030	0.197151	5.476427
Before	0.000299	0.029055	0.175986	3.959234
After	0.000979	0.017732	0.155878	6.532972
Hind Motors	0.000380	0.053867	0.806597	8.600414
Before	-0.000784	0.066874	0.530951	7.333635
After	0.001982	0.042300	0.938030	6.261954
M&M	0.000201	0.031087	-0.115135	4.876610
Before	-0.000303	0.035396	-0.003636	3.686554
After	0.001956	0.023831	-0.039769	5.768897
ONGC	0.000688	0.029478	0.107410	6.291429
Before	-0.000578	0.034336	-0.018277	3.808434
After	0.001305	0.023878	-0.447421	7.794848
Reliance Capital	0.000564	0.034867	0.042039	4.916792
Before	0.000876	0.041042	0.274807	3.362520
After	0.001612	0.027531	-0.187246	10.11999
Rolta	0.000721	0.041253	0.032928	4.688804
Before	0.002822	0.045972	-0.092658	2.968834
After	-0.000440	0.032831	0.292978	8.033002
Titan	0.000620	0.037794	0.417638	5.055795
Before	0.000182	0.041309	0.211669	3.997909
After	0.001923	0.035248	0.909813	7.036927
Voltas	0.000999	0.035821	0.271783	4.496470
Before	0.000213	0.042506	0.122381	2.620684
After	0.002057	0.028716	0.867268	8.324974
S&P CNX NIFTY	0.000370	0.016255	-0.433957	3.679313
Before	0.000608	0.017771	0.000681	5.307151
After	0.000767	0.013874	-1.307640	16.10848

4.1 GARCH Analysis

The issue of the impact of futures trading on spot market volatility is investigated by GARCH (1, 1). The GARCH has two effects: one is ARCH and another is GARCH. ARCH coefficient shows the effect of news on the market and GARCH coefficient shows the effect of old news on the market. The coefficient of constant is measure of unconditional volatility. Table 3 shows the coefficient of constant, ARCH & GARCH. For the S&P CNX Nifty, coefficient of ARCH was 0.118592 before introduction of derivative trading and it increased to 0.170222 after introduction which indicates that there is an increase in the impact of the recent news on spot

market volatility in the post-futures regime. The ARCH coefficient has increased for all the individual stock except for Hind Motors, ONGC, Reliance Capital & Rolta. For S&P CNX Nifty, the GARCH coefficient increased from 0.729716 to 0.769215 in post future period which indicates that the effect of old news has increased in the post-futures period. The GARCH coefficient has declined for all the stocks except for Hind Motors, ONGC and Reliance Capital.

In order to measure the impact of the introduction of future contracts, a dummy variable is introduced in the conditional variance equation. A significant positive (negative) coefficient is an indication of increase (decrease) in the volatility as a result of introduction of derivatives. For S&P CNX Nifty, the coefficient of dummy variable is -0.000817 which indicates that introduction of future trading reduces the volatility, but it has negligible impact. Moreover, the ARCH and GARCH coefficients add up to 0.9503 which shows persistence in volatility. The coefficient of dummy variable is positive for all individual stock except for BPCL, Glaxo, Rolta but it has negligible impact on all the individual stocks.

Table 3: Test for ARCH/GARCH

COMPANY	CONSTANT	ARCH	GARCH	DUMMY
BHEL	$2.41x10^{-5}$	0.107477	0.872296	0.001449
	4.895252	14.30151	90.51095	1.157785
Before	0.000139	0.130422	0.753879	
	3.083969	4.872536	14.07112	
After	$5.40x10^{-5}$	0.174362	0.720810	
	3.484384	8.457917	15.67310	
BPCL	0.000283	0.566481	0.361268	$-5.84 x10^{-5}$
	12.86167	34.35743	15.74713	-0.046292
Before	$6.14 x10^{-6}$	0.056343	0.941798	
	1.873029	4.312098	70.17583	
After	0.000156	0.166459	0.642953	
	4.589235	5.938946	9.975335	
Glaxo	$3.41 x10^{-5}$	0.106774	0.836449	-0.001096
	7.904446	9.873469	58.37781	-1.185012
Before	$7.82 x10^{-5}$	0.088567	0.817075	
	2.929107	4.277103	17.77188	
After	$9.75 x10^{-5}$	0.222559	0.476917	
	5.805544	5.785949	6.875231	
Hind Motors	$5.57 x10^{-5}$	0.085552	0.894818	0.002254
	7.174902	12.24721	111.6699	1.338758
Before	$4.46 x10^{-5}$	0.114815	0.882136	
	4.401127	9.133931	72.83462	
After	0.000106	0.049705	0.892919	
	4.895019	3.914195	42.47516	
M&M	$3.42 x10^{-5}$	0.108360	0.858443	0.000911
	4.734775	8.685405	52.93325	0.757364
Before	$2.00 x10^{-5}$	0.049875	0.936002	
	2.093763	3.776704	52.29329	
After	$5.65 x10^{-5}$	0.202653	0.704442	
	3.647688	5.600480	14.32315	

ONGC	3.74×10^{-5}	0.176156	0.796365	0.000471
	7.843888	11.37940	52.80852	0.456486
Before	0.000103	0.184989	0.735982	
	4.662916	5.659532	19.28103	
After	2.02×10^{-5}	0.150692	0.825310	
	3.965198	6.829276	38.63911	
Reliance Capital	9.94×10^{-5}	0.185828	0.737474	0.000560
	7.081861	11.00827	32.00664	0.455034
Before	0.000176	0.185371	0.714795	
	3.850512	5.256983	14.43414	
After	5.10×10^{-5}	0.120100	0.814655	
	3.684988	6.598686	26.18636	
Rolta	7.75×10^{-5}	0.118596	0.836586	-0.002813
	7.002481	11.00780	63.59827	-1.812208
Before	2.88×10^{-5}	0.080440	0.908071	
	2.866336	4.768535	50.39664	
After	5.73×10^{-5}	0.076766	0.870692	
	5.395752	7.102125	71.69478	
Titan	0.000105	0.110622	0.820101	0.001607
	0.820101	7.640632	42.05742	0.972253
Before	7.54×10^{-5}	0.145075	0.817247	
	3.904540	5.898955	30.30076	
After	0.000890	0.272856	0.044753	
	6.750486	6.321331	0.380827	
Voltas	7.25×10^{-5}	0.058001	0.938328	0.002191
	3.832676	10.06650	174.6731	1.550697
Before	7.64×10^{-5}	0.061694	0.896712	
	1.712098	2.778977	21.78271	
After	0.000126	0.083327	0.763892	
	3.332315	3.787527	12.57234	
S&P CNX NIFTY	1.50×10^{-5}	0.167687	0.782613	-0.000817
	6.623996	11.01359	45.46878	-1.326661
Before	4.82×10^{-5}	0.118592	0.729716	
	3.132223	3.667140	10.36290	
After	1.12×10^{-5}	0.170222	0.769215	
	3.196677	6.489883	20.63509	

5. Conclusion

We have studied the behavior of volatility of stock market after introduction of future by using GARCH (1, 1) model. We have considered S&P CNX Nifty and 10 individual stocks of which 5 are derivative stock and another 5 are derivative stocks. In case of index future, the volatility in the S&P CNX Nifty has declined after the introduction of S&P CNX Nifty future but the magnitude of dummy variable is very low which shows decline in volatility is very low. In case of 7 individual stocks, it shows a increase in volatility but there are 3 stocks which shows reduction in the volatility. There is, thus, mixed results regarding the impact of introduction of future on the underlying spot market volatility. Nifty shows contradictory pattern

of increase in its unconditional GARCH volatility. This may be due to bundling effect of constituent stocks of Nifty.

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