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A STUDY OF CHANGES IN VOLATILITY STRUCTURE AND LEVERAGE EFFECT DURING POST DERIVATIVE PERIOD

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Abstract
A lot of new and complex derivative products were developed in the market during the past decades and a lot of concerns also emerged about their economic impacts. A general apprehension about these products is that they increase the volatility in the spot market. On one hand, many studies report a positive relationship whereas on the other hand almost equal number of studies report negative relationship. Not only this, some researchers also report mixed results or insignificant relationship. The main objective of the present paper is to do a comparative analysis of the structure of volatility during post derivative period. The impact of derivative trading on spot return and volatility has been studied through GARCH model. One significant limitation of the GARCH model is that it fails to take into account the crucial stylized fact called Asymmetric (leverage) effect. Hence, in the present study, the structure of volatility in Indian market is also tested using asymmetric models TGARCH and EGARCH. Followings are the equations of these asymmetric GARCH models.

1. Introduction

During the past many years, new and complex derivative products were developed in the market and a lot of concerns also emerged about their economic impacts. A general apprehension about these products is that they increase the volatility in the spot market. Financial derivatives have two very significant roles i.e. insurance role and informational role. The former role emerges from the fact that derivatives are instruments of risk-management and hence risk-averse market participants can do hedging through them. It safeguards them from adverse market fluctuations and facilitates risk sharing. Sufficient evidence is available that hedging reduces volatility in the underlying cash market. This is because hedged positions are less sensitive to demand and supply shocks. In case of informational role of derivatives two possibilities are there: First, when speculators increase the amount of available information and thus reduce the uncertainty about future outcomes. This results in reduction of financial market volatility. Second, when speculators are prone to estimation errors and lower the informational content, volatility

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increases.

The theoretical literature on the volatility impact of derivatives trading is quite extensive hence a comprehensive overview is not possible. Therefore, we restrict ourselves to central articles for describing the basic ideas.

2. Review of Literature

A number of studies have examined the effect of futures trading on the volatility of the underlying market. Duc Hong (2017); Ryoo and Smith (2004); Pok and Poshakwale (2004); Gulen and Mayhew (2000); Antoniou and Holmes (1995); Kamara, Miller and Siegel (1992); Lee and Ohk (1992); Brorsen et.al. (1991); Schwert (1990); Damodaran (1990); Harris (1989); Stein(1987) and Figlewsky (1981); among others, report a positive relation between derivative trading and variances of the stock returns, implying that volatility has increased after derivative trading began. According to Ryoo and Smith (2004), the increase in volatility could be due to destabilizing effects of futures trading associated with speculation whereas Pok and Poshakwale (2004) attribute it to increase in flow of information to the underlying market.

The advocates of the first school perceive derivatives market as a market for speculators. Traders with very little or no cash or shares can participate in the derivatives market, which is characterised by high risk. Thus, it is argued that the participation of speculative traders in systems, which allow high degrees of leverage, lowers the quality of information in the market. These uninformed traders could play a destabilising role in cash markets.

On the contrary, Gakhar (2016); Alexakis (2011), Liu (2009), Drimbetas, Sariannidis, Porfiris (2007), Maniar (2007), Baklaci and Tutek (2006), Raju and Karande (2003), Sri vastava, Yadav and Jain (2003), Hetamsaria and Swain (2003), Gupta and Kumar (2002), Bologna and Cavallo (2002), Pilar and Rafael (2002), Pericli and Koutmos (1997), Brown-Hruska and Kuserk (1995), Schwarz and Laatsch (1991) and Santoni (1987), found that the spot volatility has reduced post introduction of futures. The reasons cited behind decrease in volatility are: improvement in quality and speed of information flow (Alexakis, 2011; Baklaci and Tutek, 2006); migration of speculative traders to derivative market (Liu, 2009); and liquidity of underlying asset (Floros and Vougas, 2006).

It has been argued that the introduction of derivatives would cause some of the informed and speculative trading to shift from the underlying cash market to derivative market given that these investors view derivatives as superior investment instruments. This superiority stems from their inherent leverage and lower transaction costs. The migration of informed traders would reduce the information asymmetry problem faced by market makers resulting in an improvement in liquidity in the underlying cash market. In addition, it could also be argued that the migration of speculators would cause a decrease in the volatility of the underlying cash market by reducing the amount of noise trading.

Further, there are studies which report insignificant impact of derivative trading on spot market volatility (Yuan Wen (2020); Rao and Tripathy; 2009; Debasish, 2009; Mallikarjunappa and Afsal, 2008; Kumar and Mukhopadhyay, 2007; Spyrou, 2005; Shenbagaraman, 2003; Rahman, 2001; Board, Sandman, and Sutcliffe, 2001; Hwang and Satchell, 1999; Dennis and Sim, 1999; Jochum and Kodres, 1998; Galloway and Miller, 1997; Darrat and Rahman, 1995; Chatrath,

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Ramchander and Song, 1995; Becketti and Roberts, 1990 and Conrad, 1989). These studies accept the stabilization hypothesis and support the view that futures markets play an important role of price discovery, and have a beneficial effect on the underlying cash markets. According to Gulen and Mayhew (2000), the effect of futures trading on volatility of spot market may be varying because of difference in time period, model specification, and/or structure of the markets examined and other macroeconomic factors.

Many previous studies have pointed towards significant expiration effects in terms of high volume and volatility. Dobano (2011); Debasish (2010); Tripathy (2010); Fung and Yung (2009); Bodla and Kiran (2008); Alkebck and Hagelin (2004); Mayhew (2000); Stoll and Whaley (1997);Schlag (1996); Swidler, Schwartz, and Kristiansen (1994) and Pope and Yadav (1992); found significant volume affects on account of expiration days. Apart from higher volume Stoll and Whaley (1991, 1990, 1987 and 1986) also found evidence of a reversal of the Index. Maniar, Bhatt, and Maniyar (2009); Lien and Yang (2005); Then Chow et.al. (2003) and Stoll and Whaley (1997) found increased volatility in individual stock returns. Chamberlain, Cheung, and Kwan (1989) for TSE 300 Index; Illueca and Lafuente (2006) for Spanish Exchange found that price reversals, higher trading volume, and higher volatility are associated with expiration days. On the other hand, Lien and Yang (2003); Corredor, Lechon, and Santamaria (2001) in Spain; Gannon (1994) in US; Bacha and Vila (1994) in Japan; found no significant expiration-day effect on cash-market volatility. This indicates that, world over researchers are unanimous about the volume effect of expiration day.The impact on returns and volatility, however, is not clear. Some studies show return reversal whereas others do not. Similarly, some researchers report high volatility and others find it insignificant.

Many studies have found the evidence of positive relation between the mean and variance of market returns which supports the basic prediction of several asset pricing models (Leon, Nave and Rubio, 2007; Lanne and Luoto, 2007; Maheu and McCurdy, 2007; Pastor, Sinha and Swaminathan, 2006; Bali and Peng, 2006; Yakob and Delpachitra, 2006; Guo and Whitelaw, 2006; Ghysels, Clara and Valkanov, 2005; Bansal and Lundblad, 2002; Campbell and Hentschel, 1992; Chou, 1988; and French, Schwert and Stambaugh, 1987). This implies that changing conditional variances directly affect the expected return on a portfolio. This variance is termed as risk and the profit gained through investments in securities is called return. The direct relationship between the two means that if an investor decides to invest in a security that has a relatively low risk, the potential return on that investment is typically fairly small.

Conversely, an investment in a security that has a high risk factor also has the potential of higher returns. In contrast, Mandimika and Chinzara (2010); Nelson (1991), Breen, Glosten and Jagannathan (1989); Fama and Schwert (1977); Black (1976); and Cox and Ross, (1976) found a negative association. Kumar and Dhankar (2010) found a significant and negative risk-return relationship between stock returns and conditional volatility whereas a significant and positive relation was found between returns and standardized residuals, i.e., investors expect extra risk premium for unexpected volatility. Yakob and Delpachitra (2006) found it significant and positive in only two countries, i.e., China and Malaysia, out of 10 countries that they studied. Turner et al. (1989) found both a positive and a negative relation depending on the method

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used. Baillie and DeGennaro (1990) found it to be insignificant in seven out of their eight specifications.
This shows that the results are not conclusive. On one hand, many studies report a positive relationship whereas on the other hand almost equal number of studies report negative relationship. Not only this, some researchers also report mixed results or insignificant relationship.

3. Objective of the Study

The main objective of the present paper is to do a comparative analysis of the structure of volatility during post derivative period. For this purpose, the post derivatives period has been divided into sub periods on the basis of structural breaks.

4. Methodology

4.1 Data Collection

NSE started equity trading in 1994 and derivative trading in 2000. Since the inception of derivative trading NSE established itself as the market leader in the futures and options segment.
Its benchmark Index, S&P CNX Nifty, is a well diversified index consisting of 50 liquid stocks; hence the study considers Nifty as a proxy for the Indian stock market and uses its time series data to see the impact of derivative trading on stock market volatility. Daily closing prices for a total period of 21 years from 2000-2021 have been collected from the website of NSE.

4.2 Method used

The impact of derivative trading on spot return and volatility has been studied through GARCH model. In case of spot market volatility, the impact of derivatives trading needs to be separated from the impact of other market wide factors. For this, the GARCH variance equation needs to be extended. Some of the studies filtered out the factors which lead to market wide volatility by regressing the spot market returns against a proxy variable for which there was no related futures contract(Antonium and Holmes (1995), Kamara, et.al (1992), and Greoge, et. al.). In Indian stock market, Nifty Junior Index consists of stocks for which no futures contracts are traded. Hence, it may be used as a control variable to separate market wide factors and in so doing focuses on the residual volatility in Nifty as a straight consequence of derivatives contracts. To eliminate the effects of world wide price fluctuations on the spot market volatility, the lagged S & P 500 index returns have been considered.
One significant limitation of the GARCH model is that it fails to take into account the crucial stylized fact called Asymmetric (leverage) effect. Due to this effect, the returns of the observed asset becomes negatively correlated with changes in volatility. In some cases, volatility rises in response to lower than expected returns and falls in response to higher than expected returns. Hence, some GARCH models that include an asymmetric response to positive and negative impulses should be used. In the present study, the structure of volatility in Indian market is also tested using asymmetric models TGARCH and EGARCH. Followings are the equations of these asymmetric GARCH models.

GARCH(1,1) Return Equation

$$Rtn_t^{nfty} = a + bRtn_{t-1}^{nfty} + \varepsilon_t \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots (1.1)$$

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GARCH Volatility Equations

$$\sigma_t^2 = \phi + \sum_{k=1}^{q} \beta_k \sigma_{t-k}^2 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \delta_1 Rtn_{t-1}^{nftynxt} + \delta_2 Rtn_{t-1}^{s\&p50} \quad \ldots..(1.2)$$

EGARCH Volatility Equation

$$\log(\sigma_t^2) = \phi + \sum_{k=1}^{q} \beta_k \log(\sigma_{t-k}^2) + \sum_{i=1}^{p} \alpha_i \left|\frac{\varepsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{j=1}^{r} \gamma\, j \frac{\varepsilon_{t-j}}{\sigma_{t-j}} + \delta_1 Rtn_{t-1}^{nftynxt} + \delta_2 Rtn_{t-1}^{s\&p500}$$

TGARCH Volatility Equation

$$\sigma_t^2 = \phi + \sum_{k=1}^{q} \beta_k \sigma_{t-k}^2 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{r} \gamma j\, \varepsilon_{t-j}^2 I_{t-j} + \delta_1 Rtn_{t-1}^{nftynxt} + \delta_2 Rtn_{t-1}^{s\&p500}$$

PGARCH Volatility Equation

$$\sigma_t^{\forall} = \phi + \sum_{k=1}^{q} \beta_k \sigma_{t-k}^2 + \sum_{i=1}^{p} \alpha_i \left((\varepsilon_{t-i}) - \gamma_i\, \varepsilon_{t-i}\right)^{\forall} + \delta_1 Rtn_{t-1}^{nftynxt} + \delta_2 Rtn_{t-1}^{s\&p500}$$

5. Empirical Results and Discussion

5.1 Comparison of Pre-Derivative (1995-2000) and Post-Derivative Period (2000-2021)

Volatility structure comparison during pre and post derivative period has been done using both symmetric and asymmetric GARCH models. The results are contained in Tables 1.1 and 1.2. During pre derivatives period, all the models are giving significant values with T-distribution. The lagged Nifty had put pressure on Nifty while GARCH lag coefficient describes that volatility is persistent during this period.

Table 1.1 Volatility Structure (pre- Derivative Period 1995-2000)

	GARCH(1,1) T Dist.	TGARCH(1,1) T Dist.	EGARCH(1,1) T Dist.	PGARCH(1,1) T Dist.
Nifty(-1)	0.1457***	0.1466***	0.1494***	0.1450***
Alpha	0.0984***	0.0795***	0.2237***	0.1172***
Gamma	-	0.0748*	-0.0549*	0.2474*
Beta	0.7694***	0.8738***	0.9575***	0.9439***
Nifty next (-1)	-0.0651*	-0.06962**	-0.05488*	-0.05305*
S&P 500 (-1)	-0.07956**	-0.06245**	-0.06516**	-0.07716**
LogL	4454.77	3978.51	4309.16	3973.16
RMSE	0.019672	0.019673	0.019675	0.019670
MAE	0.013586	0.013585	0.013585	0.013582
MAPE	115.86	114.74	113.5	112.88

Source: own computations

Note: *** denotes significant at 1 p.c. level of significance
** denotes significant at 5 p.c. level of significance
* denotes significant at 10 p.c. level of significance

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Table 1.2 Volatility Structure (Post- Derivative Period 2000-2021)

	GARCH(1,1) T Dist.	TGARCH(1,1) T Dist.	EGARCH(1,1) T Dist.	PGARCH(1,1) T Dist.
Nifty(-1)	0.0575***	0.0583***	0.0367*	0.0543***
Alpha (ARCH TERM)	0.1612***	0.0808**	0.2311***	0.1523***
Gamma (LEVERAGE EFFECT)	–	0.2548***	-0.0482***	0.6192***
Beta (GARCH TERM)	0.7240***	0.7408***	0.9129***	0.7895***
Nifty next (-1)	-0.05629**	-0.05827**	-0.0456*	-0.0442*
S&P 500 (-1)	-0.08884***	-0.08382***	-0.08605***	-0.08809***
LogL	7277.15	7293.75	7264.18	7306.92
RMSE	0.021562	0.021550	0.021557	0.021547
MAE	0.011262	0.011259	0.011261	0.011256
MAPE	159.88	154.09	155.67	152.94

Source: own computations

Note: *** denotes significant at 1 p.c. level of significance
** denotes significant at 5 p.c. level of significance
* denotes significant at 10 p.c. level of significance

Some important results have been noticed in post derivative period. Firstly, the impact of lagged Nifty is quite low as compared to the pre derivative period. Second, large GARCH lag coefficients (0.72 - 0.91) have been noticed which indicate that shocks to conditional variance get a long time to die out and therefore volatility is persistent. Third, greater impact of S&P 500 lagged returns has been seen on volatility during post derivative period which shows the influence of US markets on Indian stock markets.

Fourth, the comparison of the two periods reveals that in post-derivative period, α has increased while β has decreased. This phenomenon shows a decrease in financial market volatility and it can be regarded as an improvement in the fundamental price building process which indicates an increase in market efficiency in terms of the pace at which fresh information is incorporated in asset prices. This shows that derivative trading has contributed towards the stability in the underlying market.

Fifth, during the pre derivative period, the leverage coefficient is significant at 10% whereas it

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is highly significant at 1% in post derivative period. The magnitude of this coefficient is also higher in post-derivative period thereby indicates that asymmetric effect is more pronounced in post-derivative period, i.e., the impact of negative shocks amplify the volatility in a much greater way than positive shocks. The LB Q-test applied to the residuals in both pre-derivative and post-derivative periods accept the null of no autocorrelation and LM test accepts the null of no ARCH effect. This shows that all models are efficient estimators and the statistical inferences drawn from them are correct. Finally, based on least values of RMSE, MAE and MAPE in the tables 1.1 and 1.2 we select the PGARCH (1,1) under T-distribution as the best model in both pre-derivative period and post-derivative period.

5.2 Structural changes in Volatility during Post-Derivative Period

Chows test has been applied to identify the structural breaks in the data series in post derivative period. The Null hypotheses that there is no break points at May 18, 2004 and September 11, 2008 are both rejected at 1% level. Hence the post derivative period is divided into three sub periods. The descriptive statistics are mentioned in table 1.3. followed by the estimation of various GARCH models as per equations mentioned above for all the three sub-periods to gain insight into changes in structure of volatility during these periods. The results of applying the models on these periods are presented in Tables 1.4, 1.5 and 1.6 respectively.

Table 1.3 Descriptive Statistics (three sub post derivative periods)

	Period I (12.06.00-17.05.04)	Period II (19.05.04-10.09.08)	Period III (12.09.08-31.08.21)
Mean	-4.32E-05	0.0012	0.0005
Std.Dev.	0.0124	0.0144	0.0205
Skewness	-2.1413	-0.9809	0.3238
Kurtosis	20.0522	10.0739	14.8566
Jarque Bera	15180.73***	3217.30***	3471.88***
Q(36)	68.85**	51.93	79.62***
Adf			
Constant, No trend	-24.67***	-39.74***	-25.27***
Constant, trend	-28.57***	-37.43***	-25.10***
PP			
Constant, No trend	-31.77***	-42.40***	-26.15***
Constant, trend	-28.74***	-32.53***	-22.15***
No. of Obs.	974	1084	3209

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Source: own computations

Note: *** denotes significant at 1 p.c. level of significance

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* denotes significant at 10 p.c. level of significance

The first sub period has recorded negative mean, minimum unconditional volatility, high negative skewness, greater than 3 kurtosis and a very high JB statistics thereby revealing highly leptokurtic returns. there seems to be a possibility of earning high returns but due to immature derivative market participants could not take advantage of that and hence, the mean of returns is negative. However, being the initial period of derivative trading, the spot volatility is low. During the second sub period, the mean is positive and highest, unconditional volatility is higher than first period, skewness is negative but magnitude is less than first period, Kurtosis and JB statistics are lowest. All these findings reveal that this period is comparatively a stable period. There was the probability of earning high returns and increase in price series indicate that investors earn good returns.

Finally in third period, the mean is positive but less than second period, volatility is highest, skewness is positive, Kurtosis and JB statistics is higher than second period. This implies that this period saw a decline in price series and increase in probability of earning low returns. Volatility was highest due to the impact of global financial crisis. The null hypothesis of the ADF and PP test, assuming a unit root in Nifty returns, is rejected at 1% significance level for the samples in all the three sub periods implying that the series is stationary in these periods. The correlation coefficient at lag 36 for Nifty returns shows rejection of null hypothesis of no auto correlation, hence we use GARCH (p,q) model for evaluation of conditional volatility in these sub-periods.

3.1.7.1 Volatility Structure during First Sub-period

Table 1.4 Volatility Structure (Ist sub post derivative period)

	Garch(1,1) T Dist.	TGarch(1,1) T Dist.	EGarch(1,1) T Dist.	PGarch(1,1) T Dist.
Nifty(-1)	0.1317***	0.1384***	0.1344***	0.1309***
Alpha	0.2327***	0.0462	0.2731***	0.1916***
Gamma	–	0.3763***	-0.1778***	0.6349***
Beta	0.6878***	0.6233***	0.8170***	0.6962***
Nifty next (-1)	-0.06201**	-0.06832*	-0.0649*	-0.0577*
S&P 500 (-1)	0.07905*	0.06437*	0.06723*	0.07976*
LogL	2949.60	2960.65	2956.85	2961.71
RMSE	0.018086	0.018077	0.018069	0.018068
MAE	0.012382	0.012389	0.012387	0.012389
MAPE	144.09	137.40	138.07	136.76

Source: own computations

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Note: *** denotes significant at 1 p.c. level of significance
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All the coefficients in table 1.4 are highly significant under T distribution. The coefficient of lagged Nifty shows the impact on nifty returns. However, the small values of the coefficients suggests limited participation by both domestic investors. Beta coefficients are quite high during this period thereby indicating persistence of volatility. Asymmetric effect of volatility is highly significant during this period. Nifty next and S&P 500 coefficients are not high but significant at 10 p.c level. However, nifty next has inverse relation with the volatility of nifty but S&P 500 is positively affecting the volatility of the underlying index.

The log likelihood ratios suggest that all the models are best at lag 1. According to RMSE, MAE and MAPE measures, the PGARCH (1,1) model with power=1 is best during this period.

Table 1.5 Volatility Structure (2nd sub post derivative period)

	Garch(1,1) T Dist.	TGarch(1,1) T Dist.	EGarch(1,1) T Dist.	PGarch(1,1) T Dist.
Nifty(-1)	0.0154	0.0175	0.0306	0.0466***
Alpha	0.1198***	0.0438	0.2134***	0.1394***
Gamma	–	0.1433***	-0.1392***	0.6821***
Beta	0.8772***	0.8683***	0.9657***	0.8559***
Nifty next (-1)	-0.08334**	-0.06948**	-0.0799*	-0.0612
S&P 500 (-1)	0.08755***	0.07907***	0.08823***	0.09376***
LogL	3090.21	3095.93	3095.12	3096.34
RMSE	0.017990	0.017950	0.017922	0.017906
MAE	0.012368	0.012332	0.012318	0.012306
MAPE	214.24	204.90	202.57	199.29

Source: own computations

Note: *** denotes significant at 1 p.c. level of significance
** denotes significant at 5 p.c. level of significance
* denotes significant at 10 p.c. level of significance

The results reveal that the lagged Nifty coefficients are insignificant in this period and are too low as compared to the ist period. The beta coefficient is again high during this period which indicates that volatility is persistent. α is decreased and β has increased in second sub period which means that the speed with which new information is impounded into the prices has decreased and persistence of volatility has increased. This combined with the fact that unconditional volatility during this period is high shows that factors other than derivative trading are affecting the volatility process during this time. It is very much evident from the significant values of niftynext and S&P 500 lagged coefficients. Asymmetric effect of volatility is highly significant during this period. According to RMSE, MAE and MAPE measures, the

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PGARCH (1,1) model with power=1 is best for this period also.

Table 1.6 Volatility Structure (3rd sub post derivative period)

	Garch(1,1) T Dist.	TGarch(1,1) T Dist.	EGarch(1,1) T Dist.	PGarch(1,1) T Dist.
Nifty(-1)	0.0623	-0.0338	-0.0389	-0.0327
Alpha	0.0744***	0.0281	0.1765***	0.0938***
Gamma	–	0.1559***	-0.1066***	0.6512***
Beta	0.9482***	0.9117***	0.9994***	0.9278***
Nifty next (-1)	-0.08842***	-0.07768***	-0.08226***	-0.08349***
S&P 500 (-1)	0.09025***	0.08767***	0.08993***	0.09836***
LogL	1926.22	1934.60	1935.19	1935.97
RMSE	0.019716	0.019702	0.019710	0.019702
MAE	0.013185	0.013175	0.013178	0.013175
MAPE	169.34	164.83	165.55	164.78

Source: own computations

Note: *** denotes significant at 1 p.c. level of significance

** denotes significant at 5 p.c. level of significance

* denotes significant at 10 p.c. level of significance

The results in above table show that the lagged Nifty coefficient is not only insignificant during this period but has also become negative. The comparison with second period reveals that α has

decreased and β has increased from second period which means that the speed with which new information is impounded into the prices has decreased and persistence of volatility has increased further. This combined with the fact that unconditional volatility during this period is highest shows that factors other than derivative trading are affecting the volatility process during this time also. This is again clear from the highly significant values of the coefficients of niftynext and S&P 500. Asymmetric effect of volatility is highly significant during this period. According to RMSE, MAE and MAPE measures, the both TGARCH (1,1) and PGARCH (1,1) model with power=1 are best for this period.

6. Conclusion

The analysis of structure of volatility during three sub-periods of post-derivative period reveals that lagged Nifty which was significant in first period became negative and insignificant in third period and lagged S&P500 was significant throughout, it increased from first period to second and then it decreased in third period. The first period was the initial period of derivative trading and regulators had taken a cautious approach and thus market was range bound. During this time

domestic and US markets exerted equal pressure on spot market. Spot volatility was lowest due to beneficial impact of derivative trading. Due to liberalization and globalisation moves taken

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by Indian Government there was a rapid increase in FII volumes during second period. This was the boom period and all market participants earned good returns. Volatility increased marginally compared to first period. During third period, India was affected by Global financial crisis and volatility was very high. Weak global economic prospects during this time and continuing uncertainties in the international financial markets reduced the FII volumes, thereby, their influence and domestic market was down. Returns in the spot market were low and volatility was higher than first and second period. The comparison of α and β during three periods reveals that α of recent news is continuously decreasing while β of old news is continuously increasing. This implies that as we move from first period to third period the persistence of volatility is increasing. We have also seen in descriptive statistics that unconditional volatility is also continuously increasing from first to third period. This implies that the stabilizing influence of derivative trading which we observed in first period continuously declined due to factors mentioned above. The leverage coefficient is highly significant in all the three periods which shows presence of strong asymmetric effect in volatility during these periods. Finally, PGARCH (1,1) model with power=1 came out to be the best model in all the three periods.

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