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Effect of Equity Derivatives Trading on Spot Market Volatility in India: An Empirical Exploration

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Abstract

The present paper examines the impact of equity derivatives trading on spot market volatility, particularly the effect of equity derivatives introduction on spot market volatility in Indian stock market by using daily returns of seventy three companies from April 01, 1998 to March 31, 2008 excluding holidays when there were no transactions. The GARCH (1, 1) model that captures the heteroscedasticity in returns has been applied to study market volatility. However, all the companies under study showed asymmetric response and, accordingly the GJR GARCH model that captures the asymmetric response has been applied by using CNX Nifty index return as the independent variable in order to remove the influence of market-wide factors on equity returns. The results indicate that the coefficient of the dummy variable is significant and negative. Thus, it can be said that introduction of equity derivatives trading has reduced spot market volatility.

Keywords: Equity Futures, Market Volatility, Asymmetric Response, GARCH

1. Introduction

The proliferation of stock derivatives trading has shown tremendous growth in securities markets worldwide. In consonance with the international practice, market regulators introduced trading in option on individual stock in July 2001 followed by futures on individual stock in November 2001. Since its inception, Indian stock market has shown commendable growth in stock derivatives trading. Like other securities markets of developed and developing countries, Indian Stock market has also evidenced the growth by showing highest turnover in stock derivatives in recent years. During the year 2007-08, stock futures itself accounts for forty eight percent of the total turnover in F&O segment of National Stock Exchange, the premier exchange for derivatives trading in India. With the introduction of stock derivative instruments, it is anticipated that speculative trading, which currently take place in the spot market, can be diverted towards the derivatives segment of the stock market. Moreover, introduction of derivative instruments would also facilitate investors to select the level of portfolio risk that they are capable to bear and any risk beyond this level can be hedged away.

Having the capability of stock futures to influence market volatility, what impact the stock derivatives would have on the underlying market volatility, has received considerable and increasing attention in the recent years, after the introduction of stock derivatives in Indian stock market. To examine the impact of stock derivatives trading on spot market volatility in a manner that accommodates asymmetric response to news not only provide important guidance but also yield insights into the reasons why asymmetries exist in stock market. If market dynamics are the cause of asymmetries, then structural innovation such as the onset of stock derivatives trading may be capable of influencing not only the level of volatility in the underlying market but also the structure and characteristics of volatility.

The aforementioned fact instigated researchers to undertake empirical investigation into the issue of what impact, stock derivatives would have, on the underlying volatility. Different studies executed in developed markets connotes that even when one group of researchers accept the fact that stock derivatives trading influence the spot market volatility and reduce the underlying volatility, the other group assert a contradictory conclusion of an increase in the volatility of spot market with the onset of stock derivatives trading. Further, some researchers find that stock derivatives trading do not influence the volatility of spot market. Researchers like Ma and Rao (1988) and Bessembinder and Seguin (1992) found that the volatility of underlying market increases after the introduction of equity derivatives. Watt, Yadav and Draper (1992) and Dennis and Sim (1999) concluded that equity derivatives does not influence the spot market volatility and the impact is statistically insignificant.

On the other hand, Stucki and Wasserfallen (1994), Kumar, Sarin and Shastri (1995) and Conrad (1989) found that there is a decline in spot market volatility with the onset of equity derivatives trading. The issue remains inconclusive and seems to be far from settled yet in the international markets. Taking on the polemic issue emanating from the divergent conclusions about the impact of equity derivatives on spot market volatility in different international markets, Indian researchers tried to arrive at a conclusion with regard to the impact of equity derivatives in Indian stock market. There are not many studies that analyze the impact of derivatives trading in individual stocks on the volatility of the underlying. One significant study was done by Vipul (2006) using few scrips and the study reported a reduction in unconditional volatility and persistence in

volatility in the post derivative period.

At the backdrop of typical characteristics possessed by developing markets, it is pertinent to unfold the said issue empirically. The present paper examines the effect of stock futures trading on the volatility of spot market in India. In particular, whether stock futures contract increases spot market volatility. The rest of the paper is as follows: Section two discusses the existing literature; Section three specifies the data; Section four deliberates on methodological issues; Section five analyses the data and interprets the result of analysis followed by Section six where conclusions and possible implications have been documented.

2. Review of literature

Ma and Rao (1988) found that option trading does not have a uniform impact on volatility of underlying stocks. There is an increase in the volatility of some sample stocks in the underlying market where as in case of some stock, the volatility decreases after the introduction of derivatives trading. Conrad (1989) studied the impact of option trading on stocks traded on the CBOE and AMEX, during 1974 to 1980 and found a permanent price increase and decline in excess return volatility in the underlying securities. Skinner (1989) constructed a sample of 362 CBOE and AMEX option listings for the period April 1973 to December 1986 in order to study the impact of option listing. He found that the volatility of returns on stocks that had call options listed on them, declined after option listing.

Detemple and Jorion (1990) studied the impact of option introduction on stocks that were traded on the CBOE, NYSE and AMEX during April 1973 to December 1986 and found significant price increase around the listing date of the option and a decrease in volatility after the introduction of options. Bessembinder and Seguin (1992) investigated whether greater futures trading activity is associated with greater equity volatility by using the S&P 500 index prices from January 1978 to September 1989 and documented that while equity volatility covaries positively with unexpected futures-trading volume; it is negatively related to forecastable futures-trading activity. Further, though futures trading activity is systematically related to the futures contract life cycle, they find no evidence of a relation between futures life cycle and spot equity volatility.

Watt, Yadav and Draper (1992) studied the stocks on which options were listed by the London Traded Options market and found that option listing had no effect on beta, but unsystematic risk and total risk was found to have declined. Stucki and Wasserfallen (1994) studied the impact of option introduction on different categories of shares on the Swiss Options and Financial Futures Exchange and reported a permanent and significant price increase and a reduction in volatility post introduction. Kumar, Sarin and Shastri (1995) compared the volatility of individual stocks within the index to a control sample of stocks that are not in the index after the introduction of index futures in Japan and found that in Japan, the volatility of indexed stocks decreased relative to non-indexed stocks with the listing of index futures.

Bollen (1998) used a sample comprises of 745 NYSE and 265 NASDAQ stocks, and compared the changes in return variance of optioned stocks to those of controlled group (non-optioned stocks) and reported that there is no significant difference between the groups and hence concluded that option introduction does not significantly affect stock return variance. Dennis and Sim (1999) investigated changes in volatility of nine stocks on which futures were traded in the Australian stock markets. The results of the study indicate that share futures trading has not had any significant effect on the volatility of the underlying share prices for most of the stocks analyzed. Even in the case of stocks on which futures trading have had an impact, the results are mixed. Vipul (2006) analyzed the impact of introduction of derivatives trading on six equity shares (selected on the basis of liquidity). The study reports a reduction in, unconditional volatility and persistence in volatility in the post derivative period. The study reasons this phenomenon to a general stabilization of a post derivative cash market. Afsal and Mallikarjunappa (2007) attempted to study the volatility implications of the introduction of futures for the stock market in India by using market returns of nine individual stocks for the period October 1995 through June 2006. The study finds persistence and clustering of volatility in general and little or no impact of the futures trading on the market volatility in majority of the cases. But the volatility is found mean reverting in all the stocks examined.

Owing to the aforementioned deliberations, it can be concluded that the impact of introduction of equity derivatives trading has been different in different markets with respect to different span of time. And, it is difficult to arrive at a consensus with respect to the impact of equity derivatives introduction on the volatility. Particularly in Indian context, different studies show different conclusions. Further, the two studies have been done by taking a very small sample and do not test for asymmetric response. This in turn, necessitates further empirical investigation on the impact of equity derivatives trading on spot market volatility. The present paper examines the impact of introduction of equity derivatives trading on the volatility of spot market in India. In particular, whether, trading of equity derivatives reduce spot market volatility.

3. Data

The data employed in this paper comprises of daily close prices of all those stocks on which derivative trading has commenced by March 31, 2006. Only those companies with a minimum of two years of data prior to introduction of derivatives trading on the underlying have been included in the analysis. Based on the above criteria, finally seventy three companies have been identified and analyzed (List of companies given in Appendix).The data spans from April 01, 1998 to March 31, 2008 excluding holidays when there were no transactions. The period of the study is so chosen to restrict the influence of global financial crisis on stock market activities.

4. Methodological Issues

Since, the data used in the paper are time series, it becomes essential to unfold the typical characteristics of time series in order to specify the model to explore the objectives of the study legitimately. In general, financial time series depicts a stochastic trend and non-stationary in nature which makes it difficult to model the time series data. Natural logarithm transformation is a commonly used transformation technique to convert a non-stationary time series into a stationary series. Log transformation is likely to render the stock price changes to be homoscedastic and thereby make the series stationary. The first difference of log prices referred to as log returns have been used throughout the study. The logarithmic return has been applied in all the empirical tests in the study. Unless otherwise specified, the returns used from now are logarithmic returns.

The return (R) is measured as:

$$R_t = \log {}^{p_t}/_{p_{t-1}} \; where, t = 1, 2, 3 \ldots\ldots\ldots n$$

Where R_t is the rate of return for the period t, and p_{t-1} and p_t are the prices for the two successive periods t-1 and t.

The methodology starts with the computation of descriptive statistics such as skewness, kurtosis and Jarque-Bera that provides elementary idea about the characteristics of time series that return series are not normally distributed. Further, to know whether the series are stationary or there is the presence of unit root, Augmented Dickey Fuller (ADF) test has been applied by using the following equations:

$$\Delta Y_t = \alpha_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \qquad \textbf{\textit{Eq.1}}$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \qquad \textbf{\textit{Eq.2}}$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 t + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \qquad \textbf{\textit{Eq.3}}$$

Further, the underlying asset being analyzed are scrips, the probability of the series being characterized by heteroscedasticity is very high (Mandelbrot, 1963; Fama, 1965, Kamaiah and Amanulla, 1988). Hence, the present study examines the presence of heteroscedasticity in the scrip return series by applying Lagrange Multiplier (LM) test. The results indicated presence of heteroscedasticity in the time series and calls for the use of ARCH family of models to study volatility. As a consequence, it is hypothesized that the scrips return series follows a GARCH process.

The standard GARCH (p, q) model introduced by Bollerslev (1986) suggests that conditional variance of returns is a linear function of lagged conditional variance and past squared error terms. A model with errors that follow the standard GARCH (1, 1) model can be expressed as follows:

$$R_t = c + \varepsilon_t \; where, \; \varepsilon_t/\psi_{t-1} \sim N\,(0, h_t) \qquad \textbf{\textit{Eq. 4}}$$

$$and \; h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} \qquad \textbf{\textit{Eq. 5}}$$

The mean return equation, given in (4) is written as a function of exogenous variable and the error term ε_t. R_t is the daily return on the underlying scrips calculated as the first difference of the log of the underlying scrip price for the period t and ε_t is the error term. ψ_{t-1} is the information set available at time $t-1$. The variance equation given in (5) is the one period ahead forecast of variance based on past information and hence called conditional variance. In equation (5), α_0 represents the mean, ε_{t-1}^2 is a measure of news about volatility from the previous period, measured as the lag of squared residuals from the mean equation (ARCH term), h_{t-1} represents the last periods forecast variance (GARCH term). Further, to isolate market wide factors other than those which are associated with the introduction of equity derivatives, CNX Nifty is used as the independent variable in mean return equation, and the equation is specified as follows:

$$R_{scrip,t} = \gamma_0 + \gamma_1 R_{nifty,t} + \varepsilon_t \qquad \textbf{\textit{Eq.6}}$$

However, the standard GARCH models assume symmetry in the response of volatility to information. In other words, the models assume that the response of volatility, to 'bad' news as well as 'good' news, is similar. If the response is asymmetric, then the standard GARCH models will end up mis-specifying the relationship and further, inferences based on this model may be misleading. However, the standard GARCH model can be easily extended to include asymmetric effects (Glosten, Jagannathan and Runkle, 1993). In the model, the asymmetric response of conditional volatility to information is captured by including, along with the standard GARCH variables, squared values of ε_{t-1} when ε_{t-1} is negative. In other words, the model allows for asymmetries by augmenting the standard GARCH model with a squared error term following 'bad' news. In doing so, it allows the negative return shocks to generate greater volatility than positive return shocks. Hence, equation (1) is extended as follows:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \lambda_1 S_{t-1}^- \varepsilon_{t-1}^2 \qquad \textbf{Eq.7}$$

Where $S_{t-1}^- = 1$ if $\varepsilon_{t-1} < 1$

In studying the impact of equity derivatives, firstly, the existence of asymmetric response is tested individually for each scrips, for all the three periods. Test of asymmetry in the period pre and post introduction of derivatives, reveals the impact that introduction of derivatives trading has had on the response of volatility to new information generated. The test of asymmetric response for the full period helps in identifying the GARCH model to be specified while analyzing the impact of equity derivatives trading on spot market volatility. For this purpose, a dummy variable is added while specifying the volatility dynamics with the dummy taking a value of zero before introduction of equity derivatives trading and one for the period after introduction. For all the scrips that demonstrate asymmetric response, for the full period of analysis, the GJR model along with a dummy is specified as follows:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \lambda_1 S_{t-1}^- \varepsilon_{t-1}^2 + \alpha_3 D_{Scrip,t} \qquad \textbf{Eq.8}$$

In the case of scrips that do not demonstrate asymmetry, the standard GARCH (1, 1) along with the dummy variable as specified before in equation (5) is applied.

5. Empirical Results

The descriptive statistics of each scrips for period under study are presented in Table 1 and Table 2. The Jarque-Bera (JB) test statistics which examines the normality of the data is based on the result that a normally distributed random variable should have a skewness equal to zero and kurtosis equal to three. The test statistic follows a chi-square distribution. The results indicate that, in almost all the scrips analyzed, the skewness is non-zero and the kurtosis is in excess of three. The Jarque-Bera (JB) test indicates that the assumption of normality is violated by log return series of all the scrips analyzed.

Also, given the fact that the presence of a stochastic trend or deterministic trend in a financial time series or its stationary or non-stationary in levels is a prerequisite for conducting any analysis, the study begins with testing of return series for a unit root using Augmented Dickey Fuller (ADF) test. The coefficients are statistically significant and indicate the absence of unit root in daily return of equity shares under study (outputs of ADF test not shown in brevity).

Another characteristic of time series that needs attention is the heteroscedasticity. The Lagrange Multiplier (LM) test is used to reject the null hypothesis of no ARCH effect, which is indicative of the fact that equity return series are heteroscedastic. The Lagrange Multiplier (LM) test for no ARCH effect of equity returns is significant with a zero probability, implying that there is a significant ARCH effect in equity returns. The result of LM test indicates that equity returns series are heteroscedastic. Consequently, in order to study the impact of information on volatility of stock returns, a GARCH measure of volatility was deemed fit. However, as discussed earlier, the standard GARCH models assume symmetry in the response of volatility to information, which may not be the case always. Hence, the study first tests for existence of asymmetric response by specifying the GJR GARCH (1, 1) specification of volatility dynamics. The outcomes as reported in Table 3 indicate a mixed response. In case of almost forty five percent of the companies' analyzed, the result displayed an increase in the coefficient of asymmetric response in the post equity derivatives period where as rest of the companies showed a decline in the coefficient. Further, about a tenth of the companies' analyzed, the result displayed statistically insignificant asymmetric response in the total period under study. Overall, it can be said that introduction of derivatives trading has had a negligible impact in resolving the asymmetric response of volatility to information in the market.

In the case of scrips which demonstrated asymmetric response, the GJR GARCH model has been specified and for scrips that did not demonstrate asymmetric response, the GARCH (1, 1) model has been specified. Finally, the impact of introduction of equity derivatives on the conditional volatility is analyzed. In order to isolate the effect of market pervasive

factors on scrip returns, the returns on nifty have been introduced in the mean equation. As documented earlier, in order to analyze the overall impact of introduction of equity derivatives on spot market volatility, a dummy has been introduced in the variance equation. The dummy would take a value 'zero' in the pre introduction period and 'one' in the post introduction period. The results as reported in Table 4 indicate that in the case of about ninety per cent of the scrips analyzed, the coefficients of the dummy variable are significant and negative. Thus, it can be said that introduction of derivatives trading has an influence and there is reduction in spot market volatility.

6. Conclusion

The Indian capital market has been witnessing major operational and structural changes as a result of ongoing financial sector reforms initiated by the Govt. of India. The major activities of these reforms have been to improve market efficiency, enhancing transparency and bringing the Indian capital market up to international standards. In addition to these developments, India is perhaps one of the real emerging market in South Asian region that has introduced derivative products in June 2000 to provide tools for risk management to investors and to facilitate an efficient price discovery process with respect to different financial instruments by inculcating informational efficiency into the market. Since the introduction of index derivatives, what impact the equity derivatives trading would have on the underlying spot market volatility, has attracted the attention of researchers all over the world to unfold the issue and received renewed focus. Many theories have been propounded explaining contradictory conclusions. Two main bodies of theories exist in the literature about the relationship between derivatives market and the underlying spot market. The theoretical literature proposes both a 'destabilizing force' hypothesis that predicts increased volatility and a 'market completion' hypothesis in which decreased volatility is predicted.

The aforementioned fact instigated researchers to undertake empirical investigation so as to universalize the impact of equity derivatives on the underlying volatility. The present paper examines the impact of equity derivatives trading on spot market volatility, particularly the effect of equity derivatives introduction on spot market volatility and informational efficiency in Indian stock market by using daily return of seventy three companies from April 01, 1998 to March 31, 2008 excluding holidays when there were no transactions. A combination of GARCH and GJR GARCH model that captures the heteroscedasticity in returns and asymmetric response has been applied by introducing CNX Nifty index return as the independent variable in order to remove the influence of market-wide factors on equity returns.

The outputs of asymmetric response suggest a mixed response. In case of almost forty five percent of the companies' analyzed, the result displayed an increase in the coefficient of asymmetric response in the post equity period where as rest of the companies showed a decline in the coefficient. Further, about a tenth of the companies' analyzed, the result displayed statistically insignificant asymmetric response in the total period under study. Overall, it can be said that introduction of derivatives trading has had a negligible impact in resolving the asymmetric response of volatility to information in the market. Further, the results pertaining to the effect of equity derivatives indicate that in the case of about ninety per cent of the scrips analyzed, the coefficient of the dummy variables are significant and negative. Thus, it can be said that introduction of equity futures trading has an influence and there is reduction in spot market volatility.

The implication of the result might be that speculative traders migrate from spot to derivatives market with the introduction of derivatives trading in order to take advantage of lower capital requirement and lower transaction cost. Further, derivatives markets provide a mechanism for those who buy and sell the actual asset to hedge themselves against unfavorable price movement and spreads risk across a large number of investors, the risk is transferred away from those hedging spot position to professional speculators who are willing and able to bear it. The availability of risk transference afforded by the derivatives market reduces the spot price volatility because it eliminates the need to incorporate risk premium in the spot market transaction to compensate the risk of price fluctuations. Finally, derivatives trading might attract more traders to spot market and thereby making it more liquid and less volatile. However, the effect of equity derivatives trading can be further refined with the use of participant-wise high frequency data on stock market.

References

Afsal, E.M. and Mallikarjunappa, T., (2007), Impact of Stock Futures on the Stock Market Volatility, *Icfai Journal of Applied Finance*, Vol. 13:9, pp. 54-75.

Amanulla, S. and Kamaiah, B., (1997), Asset Price Behaviour in Indian Stock Market: Is Conditional CAPM Relevant? *Artha Vijnana*, Vol. 34, pp. 421-56.

Bessembinder, H. and Seguin, P.J., (1992), Futures-trading activity and stock price volatility, *Journal of Finance*, Vol. 47, pp. 2015-2034.

Bollen, Nicolas P.B., (1998), A note on the impact of options on stock return volatility, *Journal of Banking and Finance*, Vol. 22, pp.1181-1191.

Bollerslev, T., (1986), "Generalised Autoregressive Conditional Heteroscedasticity," *Journal of Econometrics*, Vol. 33, pp. 307-27.

Conrad, J., (1989), The price effect of option introduction, *Journal of Finance*, Vol. 44, pp. 487-498.

Dennis, S.A. and Sim, A.B., (1999), Share Price Volatility with the Introduction of Individual Share Futures on the Sydney Futures Exchange, *International Review of Financial Analysis*, Vol. 8, pp. 153- 63.

Detemple, Jerome and Philippe Jorion, (1990), Option Listing and Stock Returns, *Journal of Econometrics*, Vol. 31, pp. 307-328.

Fama, E.F., (1965), The Behaviour of Stock Market Prices, *Journal of Business*, Vol. 38, pp. 34-105.

Glosten, L.R., Jagannathan, R. and Runkle, D.E., (1993), On the Relations between the Expected Value and the Volatility of the Nominal Excess Returns on Stocks, *Journal of Finance*, Vol. 48, pp. 1779-91.

Kumar, Raman, Atulya Sarin and Kuldeep shastri, (1995), The impact of the listing of index options on the underlying stocks, *Pacific-Basin Finance Journal*, Vol. 3, pp. 303-317.

Ma, C. K. and Rao, R. P., (1988), Information Asymmetry and Option Trading, *Financial Review*, Vol. 23, pp. 39-51.

Mandelbrot,B., (1963), The variation of certain speculative prices, *Journal of Business*, Vol. 36, pp. 394-419.

Skinner, D. J., (1989), Options markets and stock return volatility, *Journal of Financial Economics*, Vol. 23, pp. 61-78.

Stucki, T. and Wasserfallen, W., (1994), Stock and Option Market: The Swiss Evidence, *Journal of Banking and Finance*, Vol. 18, pp. 881-893.

Vipul, (2006), Impact of Introduction of Derivatives on Underlying Volatility: Evidence from India, *Applied Financial Economics*, Vol. 16, pp. 687-97.

Watt, W., Yadav, P. and Draper, P., (1992), The Impact of Option Listing on Underlying Stock Returns: The UK Evidence, *Journal of Business Finance & Accounting*, Vol. 19:4, pp. 485-501.

Table 1: Descriptive Statistics of Daily Returns of Scrips for the Total Period

Descriptive Statistics of Daily Returns of Scrips for the Total Period						
Sr. No. of Company	**Mean**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**Prob.**
1	0.000134	0.01699	-23.71999	925.6847	89343219	0
2	-8.28E-05	0.02371	-31.0747	1327.543	1.84E+08	0
3	0.000658	0.0128	-0.185073	8.572523	1744.042	0
4	-5.39E-05	0.02374	-10.5621	353.7753	12462154	0
5	0.000464	0.01261	-0.065048	8.04921	1864.461	0
6	-0.000101	0.01559	0.290651	7.747626	2394.55	0
7	-2.33E-05	0.0249	-26.02515	1051.573	1.15E+08	0
8	0.000198	0.01694	-4.530429	76.4518	573287.2	0
9	0.000176	0.01396	0.010797	7.056504	1722.363	0
10	0.00031	0.01408	0.188295	5.899498	894.7856	0
11	0.000631	0.01577	0.324277	4.839537	396.9378	0
12	0.000215	0.01919	-17.35216	614.2374	39230690	0
13	2.33E-05	0.01486	-3.197077	69.21118	463129.7	0
14	0.000397	0.01526	0.578375	6.121179	1159.689	0
15	0.000253	0.01268	0.057929	21.70369	36616.75	0
16	0.00049	0.01359	0.10624	11.42911	5681.673	0
17	-0.000193	0.02127	-19.84665	565.37	33266795	0
18	0.000144	0.01366	0.208585	5.993088	955.8797	0
19	-0.000136	0.02401	-27.74954	1096.78	1.26E+08	0
20	0.000753	0.02355	-19.70237	582.3121	17855181	0
21	9.97E-06	0.01563	0.050977	5.785238	813.0452	0
22	0.00048	0.01961	0.856946	12.56463	9882.572	0
23	0.000191	0.01732	-7.302786	197.7758	3993131	0
24	0.000219	0.01226	0.052075	11.49241	7549.81	0
25	0.000161	0.00997	0.143574	5.883136	878.6691	0
26	0.000301	0.01389	0.292839	6.351878	1211.841	0
27	0.000367	0.01215	0.069144	5.295218	553.3881	0
28	-0.000362	0.01828	-5.415301	89.53386	589736.3	0
29	0.000508	0.01104	0.30354	10.08079	5286.312	0
30	-4.75E-05	0.02296	-31.5578	1317.717	1.81E+08	0
31	-3.85E-05	0.01868	-21.33201	755.707	59491275	0
32	-9.38E-05	0.01372	-0.815323	16.7338	20020.26	0
33	1.09E-05	0.01558	-0.621832	16.70521	19821.71	0
34	0.000172	0.01432	-5.781185	124.6966	900361.1	0
35	-0.000289	0.02235	-34.37743	1519.582	2.41E+08	0
36	0.000209	0.0161	0.074916	5.408991	609.7552	0

Source: Computed Output

Table 2: Descriptive Statistics of Daily Returns of Scrips for the Total Period

Descriptive Statistics of Daily Returns of Scrips for the Total Period						
Sr. No. of Company	**Mean**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**Prob.**
37	0.000154	0.01563	0.272251	6.523861	1330.741	0
38	-4.33E-05	0.02059	-13.25043	329.3452	11220630	0
39	0.000586	0.01276	-0.187597	7.692594	1690.716	0
40	-4.60E-05	0.01312	-4.590927	92.69116	850815.4	0
41	-0.000214	0.02488	-38.1368	1745.846	3.19E+08	0
42	1.43E-05	0.02571	-13.96381	353.8445	10162648	0
43	0.000935	0.02245	28.94597	1193.078	1.44E+08	0
44	0.000531	0.0243	-19.55089	659.9709	38621625	0
45	0.000265	0.01722	-6.071838	120.9332	1158425	0
46	0.00032	0.01253	0.327342	10.74412	6321.874	0
47	0.000162	0.01411	-3.896082	83.74214	688707.7	0
48	0.000245	0.01637	0.73482	12.47647	9625.501	0
49	-0.000173	0.01318	-0.028203	5.632246	725.5389	0
50	0.00011	0.01589	0.1081	11.89712	8290.17	0
51	0.000546	0.0138	0.069416	6.821259	1367.091	0
52	0.000701	0.01687	-0.11247	12.91946	7830.576	0
53	0.000219	0.012	-0.903952	20.12916	31039.78	0
54	0.000116	0.01566	-1.341322	22.87534	42099.61	0
55	0.000175	0.01248	-0.226299	10.24451	5514.66	0
56	-0.000465	0.02034	-1.660196	23.21066	36635.95	0
57	-7.87E-05	0.01439	-8.311524	169.3352	2924778	0
58	0.000515	0.01558	-0.070493	6.301313	1142.808	0
59	0.000443	0.01071	-0.564077	13.57379	11835.46	0
60	8.61E-05	0.02235	-12.33997	344.1617	12246043	0
61	0.000302	0.01093	-0.114668	5.435027	626.1111	0
62	0.000292	0.01603	0.265458	8.055728	2634.834	0
63	0.000176	0.01989	-20.74101	722.0672	54298803	0
64	-0.000575	0.01853	-0.144998	10.41839	3798.456	0
65	0.000257	0.01793	-11.57844	284.1551	8329836	0
66	0.000309	0.01311	-0.185435	14.28101	10998.75	0
67	0.000112	0.01188	-0.069385	6.192377	1068.702	0
68	0.000396	0.0124	-0.098204	9.137268	3946.418	0
69	0.000119	0.0113	0.177782	5.931194	912.5181	0
70	-0.000425	0.02764	-28.14388	999.7226	66026356	0
71	0.000315	0.0138	-0.263735	11.66886	5694.761	0
72	-9.31E-05	0.02332	-13.42519	344.3544	12266628	0
73	-0.000272	0.01434	-14.57154	452.0916	17147756	0

Source: Computed Output

Table 3: Results of Asymmetric Response for Pre and Post Period

Sr. No.	Pre-Period		Post-Period		Sr. No.	Pre-Period		Post-Period	
	Asymmetric Response	Prob.	Asymmetric Response	Prob.		Asymmetric Response	Prob.	Asymmetric Response	Prob.
1	0.451609	0	0.648516	0.1583	38	0.202778	0	0.572798	0.3468
2	0.362825	0	0.847207	0	39	0.864093	0	0.828596	0
3	0.808204	0	0.57533	0	40	0.759353	0	0.916959	0
4	0.587728	0	0.941249	0	41	0.905471	0	0.59874	0.2016
5	0.804038	0	0.585384	0	42	0.01327	0.1483	0.473886	0
6	0.723746	0	0.772025	0	43	0.948732	0	0.655871	0
7	0.439715	0.0307	0.951984	0	44	0.100955	0.0004	0.778902	0
8	0.570934	0	0.494703	0	45	-0.005615	0.6215	0.758729	0
9	0.840129	0	0.739031	0	46	0.856479	0	0.806328	0
10	0.822835	0	0.755716	0	47	0.721713	0	0.584777	0.3496
11	0.959131	0	0.474657	0	48	0.799487	0	0.948451	0
12	0.955319	0	0.67196	0.1368	49	0.933149	0	0.667417	0
13	0.096036	0.0139	0.857163	0	50	0.710162	0	0.65563	0
14	0.54974	0	0.747945	0	51	0.70831	0	0.879036	0
15	0.687276	0	0.738369	0	52	0.794931	0	0.760474	0
16	0.668164	0	0.1631	0.0134	53	0.756963	0	1.002159	0
17	0.031377	0.024	0.596245	0.2043	54	0.821953	0	1.002159	0
18	0.675294	0	0.928975	0	55	0.839808	0	0.900129	0
19	0.581344	0.309	0.605097	0.0862	56	0.830065	0	0.37127	0
20	0.845679	0	0.598652	0.2536	57	0.038234	0.0258	0.502389	0.0378
21	0.931698	0	0.30732	0.0364	58	0.862232	0	0.543972	0
22	0.909085	0	0.483042	0	59	0.853596	0	0.356644	0
23	0.591899	0.2271	0.284334	0.0003	60	-0.000419	0.9645	0.56891	0.2784
24	0.796395	0	0.78803	0	61	0.842085	0	0.857465	0
25	0.654977	0	0.832073	0	62	0.688117	0	0.903725	0
26	0.627544	0	0.944751	0	63	0.917032	0	0.59547	0
27	0.944729	0	0.530658	0.0006	64	0.986819	0	0.422143	0
28	-0.009082	0	0.204307	0	65	-0.001809	0.0006	0.785836	0
29	0.800593	0	0.124533	0.2	66	0.744472	0	0.624178	0
30	0.593269	0	0.998243	0	67	0.876197	0	0.753197	0
31	0.404489	0.1006	0.389338	0.0001	68	0.79963	0	0.930345	0
32	0.928191	0	0.867337	0	69	0.920108	0	0.840948	0
33	0.259206	0.0001	0.554565	0	70	0.79009	0	0.343691	0.004
34	0.70303	0.0026	-0.000735	0.9383	71	0.718915	0	-0.047185	0.6855
35	0.729506	0	0.597245	0.1892	72	0.185236	0	0.94628	0
36	0.869375	0	0.637396	0	73	-0.001304	0.9319	0.622357	0
37	0.786341	0	0.952069	0					

Source: Computed Output

Table 4: Estimates of GJR GARCH Model of Companies for the Total Period

Estimates of GJR GARCH Model of Companies									
Sr. No	**Variables**	**Co-efficient**	**Z-Stat.**	**Prob.**	**Sr. No**	**Variables**	**Co-efficient**	**Z-Stat.**	**Prob.**
1	$\alpha_{4(Dummy)}$	-0.000394	-13.13	0	**38**	$\alpha_{4(Dummy)}$	-0.000108	-4.354	0
2	$\alpha_{4(Dummy)}$	-3.34E-05	-7.333	0	**39**	$\alpha_{4(Dummy)}$	-8.22E-07	-1.359	0.1742
3	$\alpha_{4(Dummy)}$	-7.73E-06	-3.648	3E-04	**40**	$\alpha_{4(Dummy)}$	-7.42E-07	-1.44	0.1499
4	$\alpha_{4(Dummy)}$	-0.001128	-118.4	0	**41***	$\alpha_{4(Dummy)}$	0.000125	0.7939	0.4273
5	$\alpha_{4(Dummy)}$	-4.47E-06	-3.926	1E-04	**42**	$\alpha_{4(Dummy)}$	-2.23E-05	-48.75	0
6	$\alpha_{4(Dummy)}$	-1.01E-05	-6.176	0	**43**	$\alpha_{4(Dummy)}$	-0.000462	-4.959	0
7	$\alpha_{4(Dummy)}$	-0.000778	-177.3	0	**44**	$\alpha_{4(Dummy)}$	-2.20E-05	-5.994	0
8	$\alpha_{4(Dummy)}$	-1.14E-05	-5.82	0	**45***	$\alpha_{4(Dummy)}$	-0.000115	-29.3	0
9	$\alpha_{4(Dummy)}$	-2.11E-06	-3.506	5E-04	**46**	$\alpha_{4(Dummy)}$	-2.22E-06	-4.113	0
10	$\alpha_{4(Dummy)}$	1.47E-06	1.265	0.206	**47**	$\alpha_{4(Dummy)}$	-1.77E-06	-0.688	0.4913
11	$\alpha_{4(Dummy)}$	-2.19E-05	-7.531	0	**48**	$\alpha_{4(Dummy)}$	-2.73E-06	-5.895	0
12	$\alpha_{4(Dummy)}$	-3.72E-05	-18.61	0	**49**	$\alpha_{4(Dummy)}$	-3.48E-06	-3.46	0.0005
13	$\alpha_{4(Dummy)}$	-7.63E-05	-9.006	0	**50**	$\alpha_{4(Dummy)}$	9.30E-06	5.3321	0
14	$\alpha_{4(Dummy)}$	-3.34E-05	-7.798	0	**51**	$\alpha_{4(Dummy)}$	-8.08E-06	-6.784	0
15	$\alpha_{4(Dummy)}$	-2.30E-08	-0.1556	0.8763	**52**	$\alpha_{4(Dummy)}$	-6.67E-06	-5.113	0
16	$\alpha_{4(Dummy)}$	-5.81E-06	-3.5278	0.0004	**53**	$\alpha_{4(Dummy)}$	-1.29E-05	-3.837	0.0001
17	$\alpha_{4(Dummy)}$	-0.000288	-3.5002	0.0005	**54**	$\alpha_{4(Dummy)}$	-3.40E-05	-12.78	0
18	$\alpha_{4(Dummy)}$	-3.54E-06	-1.7608	0.0783	**55**	$\alpha_{4(Dummy)}$	9.73E-07	2.1091	0.0349
19*	$\alpha_{4(Dummy)}$	-0.000239	-0.816	0.4145	**56**	$\alpha_{4(Dummy)}$	-0.000186	-11.57	0
20*	$\alpha_{4(Dummy)}$	0.000218	1.3189	0.1872	**57***	$\alpha_{4(Dummy)}$	-3.04E-05	-1.704	0.0884
21	$\alpha_{4(Dummy)}$	1.84E-06	2.8023	0.0051	**58**	$\alpha_{4(Dummy)}$	1.83E-06	3.3219	0.0009
22	$\alpha_{4(Dummy)}$	-2.87E-06	-4.443	0	**59**	$\alpha_{4(Dummy)}$	-1.52E-05	-8.859	0
23	$\alpha_{4(Dummy)}$	-0.000469	-88.83	0	**60***	$\alpha_{4(Dummy)}$	0.000192	35.774	0
24	$\alpha_{4(Dummy)}$	-1.17E-06	-1.92	0.055	**61**	$\alpha_{4(Dummy)}$	-2.05E-06	-4.109	0
25	$\alpha_{4(Dummy)}$	-2.46E-06	-3.347	8E-04	**62**	$\alpha_{4(Dummy)}$	-7.41E-06	-6.752	0
26	$\alpha_{4(Dummy)}$	-3.91E-06	-4.544	0	**63**	$\alpha_{4(Dummy)}$	-7.47E-05	-17.05	0
27	$\alpha_{4(Dummy)}$	-4.98E-07	-2.6899	0.0071	**64**	$\alpha_{4(Dummy)}$	-5.47E-07	-2.58	0.0099
28	$\alpha_{4(Dummy)}$	-0.000251	-25.69	0	**65**	$\alpha_{4(Dummy)}$	-0.000397	-79.12	0
29	$\alpha_{4(Dummy)}$	-2.99E-06	-3.6994	0.0002	**66**	$\alpha_{4(Dummy)}$	-1.33E-05	-6.036	0
30	$\alpha_{4(Dummy)}$	-0.00033	-4.7024	0	**67**	$\alpha_{4(Dummy)}$	-2.38E-06	-4.719	0
31	$\alpha_{4(Dummy)}$	-4.31E-05	-9.4186	0	**68**	$\alpha_{4(Dummy)}$	-2.05E-06	-3.745	0.0002
32	$\alpha_{4(Dummy)}$	-5.68E-06	-4.8124	0	**69**	$\alpha_{4(Dummy)}$	-3.52E-06	-5.201	0
33	$\alpha_{4(Dummy)}$	-3.81E-05	-9.1071	0	**70***	$\alpha_{4(Dummy)}$	-0.001038	-16.52	0
34*	$\alpha_{4(Dummy)}$	-3.81E-06	-0.4746	0.6351	**71**	$\alpha_{4(Dummy)}$	-1.57E-05	-6.229	0
35	$\alpha_{4(Dummy)}$	-0.000159	-7.118	0	**72**	$\alpha_{4(Dummy)}$	0.000147	18.344	0
36	$\alpha_{4(Dummy)}$	-1.84E-06	-2.1718	0.0299	**73***	$\alpha_{4(Dummy)}$	-2.33E-05	-10.05	0
37	$\alpha_{4(Dummy)}$	3.64E-06	2.8199	0.0048					

*indicate that GARCH model has been applied.

Source: Computed Output

Appendix

List of Companies

Sr. No.	Name of the Company	Sr. No.	Name of the Company
1	ABB Ltd.	38	Infosys Technologies Ltd.
2	Associated Cement Co. Ltd.	39	Indian Overseas Bank
3	Allahabad Bank	40	Indian Oil Corporation Ltd.
4	Alok Industries Ltd.	41	ITC Ltd.
5	Andhra Bank	42	IVRCL Infrastructure & Projects Ltd.
6	Arvind Mills Ltd.	43	J & K Bank Ltd.
7	Ashok Leyland Ltd	44	Jindal Steel & Power Ltd
8	Aurobindo Pharma Ltd.	45	The Karnataka Bank Ltd.
9	Bank Of Baroda	46	LIC Housing Finance Ltd
10	Bank Of India	47	Mahindra & Mahindra Ltd.
11	Bharat Electronics Ltd.	48	Mangalore Refinery And Petrochemicals Ltd.
12	Bharat Forge Co Ltd	49	Mahanagar Telephone Nigam Ltd.
13	Bharat Petroleum Corporation Ltd.	50	Nagarjuna Fertiliser & Chemicals Ltd.
14	CESC Ltd.	51	National Aluminium Co. Ltd.
15	Chambal Fertilizers Ltd.	52	Neyveli Lignite Corporation Ltd.
16	Chennai Petroleum Corporation Ltd.	53	Oil & Natural Gas Corp. Ltd.
17	Cipla Ltd.	54	Orchid Chemicals Ltd.
18	Corporation Bank	55	Oriental Bank Of Commerce
19	Dabur India Ltd.	56	Polaris Software Lab Ltd.
20	Divi'S Laboratories Ltd.	57	Ranbaxy Laboratories Ltd.
21	Escorts India Ltd.	58	Reliance Capital Ltd
22	Essar Oil Ltd.	59	Reliance Industries Ltd.
23	Federal Bank Ltd.	60	Satyam Computer Services Ltd.
24	GAIL (India) Ltd.	61	State Bank Of India
25	Glaxosmithkline Pharma Ltd.	62	Shipping Corporation Of India Ltd.
26	Grasim Industries Ltd.	63	Siemens Ltd
27	Gujarat Narmada Fertilizer Co. Ltd.	64	Strides Arcolab Ltd.
28	HCL Technologies Ltd.	65	Sun Pharmaceuticals India Ltd.
29	HDFC Bank Ltd.	66	Syndicate Bank
30	Housing Development Finance Corp.Ltd.	67	Tata Chemicals Ltd
31	Hero Honda Motors Ltd.	68	Tata Power Co. Ltd.
32	Hindustan Petroleum Corporation Ltd.	69	Tata Tea Ltd.
33	Industrial Development Bank Of India Ltd.	70	TVS Motor Company Ltd.
34	I-Flex Solutions Ltd.	71	Vijaya Bank
35	Indian Hotels Co. Ltd.	72	Wipro Ltd.
36	India Cements Ltd.	73	Wockhardt Ltd.
37	Indusind Bank Ltd.