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Responsiveness of market volatility to equity futures trading in India: An analysis of select banks

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Abstract
The current study examines the effect of trading in equity derivatives on spot market volatility, specifically the effect of the introduction of equity derivatives on spot market volatility in the Indian stock market, using the daily returns of nine banks from April 1, 1998, to March 31, 2012, excluding holidays when no transactions took place. The market volatility has been studied using the GARCH (1, 1) model, which accounts for the heteroscedasticity in returns. It might be said that the introduction of trading in stock futures has decreased the volatility of the spot market. To exclude the impact of market-wide variables on equity returns, the CNX Nifty index return was used as the independent variable in the GJR GARCH model, which captures the asymmetric response, which was applied to all of the companies under consideration. The findings show that the dummy variable's coefficient is negative and significant. Therefore, it can be claimed that the introduction of trading in stock futures has decreased the volatility of the spot market.

Keywords: Spot market, consideration, stock market, select banks, responsiveness, market volatility

Introduction

The global securities markets have seen remarkable expansion due to the proliferation of stock derivatives trading. Market regulators implemented trading in individual stock options in July 2001 and individual stock futures in November 2001, in accordance with global standards. The Indian stock market has demonstrated impressive development in the trading of stock derivatives since its inception. The Indian stock market has demonstrated growth in recent years, as evidenced by the biggest turnover in stock derivatives, similar to other securities markets in both developed and developing nations. The National Stock exchange, India's leading derivatives trading platform, saw 48% of its overall volume in the F & O segment in 2007-2008 from stock futures alone. Speculative trading, which now occur s in the spot market, is expected to shift to the derivatives section of the stock market with the introduction of stock derivative instruments. Furthermore, the introduction of derivative instruments would make it easier for investors to choose the amount of risk in their portfolios that they can tolerate, with any excess risk being able to be hedged away.

The power of stock futures to affect market volatility and the effect that stock derivatives would have on the underlying market volatility have drawn a lot of attention in the years since the Indian stock market first introduced stock derivatives. In addition to offering crucial guidance, analysing how stock derivatives trading affects spot market volatility while accounting for asymmetric news responses can also shed light on the causes of stock market asymmetries. Structural innovation, like the introduction of stock derivatives trading, may be able to affect not just the degree of volatility in the underlying market but also its structure and features if asymmetries are caused by market dynamics.

The point noted above prompted scholars to do empirical research on the question of how stock derivatives might affect the underlying volatility. According to a thorough analysis of the literature, even when one group of researchers acknowledges that trading in stock derivatives affects spot market volatility and lowers underlying volatility, the other group claims that the start of stock derivatives trading causes the spot market's volatility to rise.

Additionally, some researchers discover that trading in stock derivatives has little effect on spot market volatility. Researchers such as Ma and Rao (1988) [12] and Bessembinder and Seguin [3] (1992) discovered that when equity derivatives were introduced, the underlying market's volatility increased. Dennis and Sim (1999) [7] and came to the conclusion that equity derivatives have a statistically negligible effect on spot market volatility.
Indian academics attempted to reach a conclusion regarding the influence of equities derivatives on the Indian stock market, tackling the contentious subject arising from the conflicting findings regarding the impact of equity derivatives on spot market volatility in several overseas markets. Studies examining the effect of trading derivatives in individual stocks on the underlying stock's volatility are scarce. Vipul (2006) [16] conducted a noteworthy study. Unconditional volatility decreased and volatility persisted throughout the post-derivative period, according to the study. Afsal and Mallikarjunappa conducted another investigation (2007) [1]. The study reveals that volatility generally persists and clusters, and that trading in stock futures typically has little to no effect on market volatility. The researchers' findings are consistent with the international literature but contradict each other.
The aforementioned discussions lead to the conclusion that the advent of trading in equity derivatives has had varying effects in different markets over varying time periods. Furthermore, opinions on how the introduction of equity derivatives affects volatility are hard to agree on. The results of several studies vary, especially in the Indian context. Additionally, the two studies did not test for asymmetric response. Therefore, more empirical research on how trading in stock futures affects spot market volatility is required particularly in different sectors of the industry.
The current study looks at how the advent of trading in equity derivatives has affected India's spot market volatility. Specifically, whether trading equity derivatives improves informational efficiency and lowers spot market volatility. The purpose of the study is to test the null hypothesis, which states that the introduction of equities derivatives contracts has no effect on the volatility of the spot market. The opposing theory is that the volatility of the spot market is impacted by the advent of stock derivatives contracts.

Data and Model Specification

The daily close prices of specific bank scrips on which derivative trading had started by March 31, 2006, make up the data used in this study. The investigation has only considered companies that had data for at least two years before the underlying began trading derivatives. Nine banks have been selected and examined for this investigation. With the exception of holidays when there were no transactions, the data covers the period from April 1, 1998, to March 31, 2012. There is a very high chance that the series will exhibit heteroscedasticity because the underlying asset under analysis is a stock (Mandelbrot, 1963; Fama, 1965 [13, 9]. Therefore, the current investigation starts by looking at whether the asset return series exhibits heteroscedasticity. The findings showed that heteroscedasticity was present. Consequently, a GARCH process is thought to be followed by the asset returns series.
The standard GARCH (p, q) model introduced by Bollerslev (1986) [5] 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:

$$\mathrm{R_t} = \mathrm{c} + \varepsilon_t \text{ where, } \varepsilon_t/\psi_{t-1} \sim \mathrm{N}\,(0, \mathrm{h_t}) \qquad \text{Equation 1}$$

$$\text{and } \mathrm{h_t} = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2 \mathrm{h_{t-1}} \qquad \text{Equation 2}$$

The mean return equation, given in (1) is written as a function of exogenous variable and the error term ε_t. R_t is the daily return on the underlying asset calculated as the first difference of the log of the underlying asset 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 (2), is the one period ahead forecast of variance based on past information and hence called conditional variance. In equation (2), 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:

$$\mathrm{R_{scrip,t}} = \gamma_0 + \gamma_1 \mathrm{R_{nifty,t}} + \varepsilon_t \qquad \text{Equation 3}$$

Nonetheless, the conventional GARCH models presume symmetry in the way volatility reacts to information. Put differently, the models imply that volatility reacts similarly to both "good" and "bad" news. The conventional GARCH models will ultimately misspecify the relationship if the response is asymmetric, and conclusions drawn from this model may also be deceptive. Nonetheless, it is simple to incorporate asymmetric effects into the conventional GARCH model (Glosten, Jagannathan, and Runkle, 1993) [10].
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:

$$\mathrm{h_t} = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2 \mathrm{h_{t-1}} + \lambda_1 \mathrm{S_{t-1}^-}\, \varepsilon_{t-1}^2 \qquad \text{Equation 4}$$

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

The first step in examining the effects of equity derivatives is to determine whether an asymmetric reaction exists for each asset, for each of the three periods. The impact of the introduction of derivatives trading on the volatility's reaction to newly created information is revealed by the test of asymmetry between the pre and post-introduction periods.
The full-period test of asymmetric response aids in determining which GARCH model should be used when examining how trading in equity derivatives affects spot market volatility. In order to do this, a dummy variable is included while defining the volatility dynamics. The dummy variable has a value of zero prior to the start of trading equity derivatives and one following the start. For all the equity

scrips that demonstrate asymmetric response, for the full period of analysis, the GJR model along with a dummy is specified as follows:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \lambda_1 S_{t-1}^- \varepsilon_{t-1}^2 + \alpha_3 D_{Scrip,t}$$
Equation 5

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 [2] is applied.

Empirical Results

Tables 1, 2, and 3 show the descriptive statistics for each scrip during the three time periods. According to the summary figures, seven banks have shown a decrease in standard deviation since the start of trading in equity derivatives. This could explain why volatility has slightly decreased since equity derivatives trading was introduced in the Indian stock market. It is still challenging to determine if the decrease in volatility following the introduction of equity derivatives is attributable to derivatives trading alone and not to other factors that affect market-wide movements.

Table 1: Descriptive statistics of daily returns of scrips for the total period

Company	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.
Allahabad Bank	0.000658	0.0128	-0.185073	8.572523	1744.042	0
Andhra Bank	0.000464	0.01261	-0.065048	8.04921	1864.461	0
Bank Of Baroda	0.000176	0.01396	0.010797	7.056504	1722.363	0
Bank Of India	0.00031	0.01408	0.188295	5.899498	894.7856	0
Federal Bank Ltd.	0.000191	0.01732	-7.302786	197.7758	3993131	0
HDFC Bank Ltd.	0.000508	0.01104	0.30354	10.08079	5286.312	0
State Bank of India	0.000302	0.01093	-0.114668	5.435027	626.1111	0
Syndicate Bank	0.000309	0.01311	-0.185435	14.28101	10998.75	0
Vijaya Bank	0.000315	0.0138	-0.263735	11.66886	5694.761	0

Source: Computed

Table 2: Descriptive Statistics of daily returns of scrips for the pre period

Company	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.
Allahabad Bank	0.001519	0.01438	-0.254765	8.047946	646.7522	0
Andhra Bank	0.000982	0.012601	0.491873	7.895026	623.226	0
Bank Of Baroda	0.000119	0.014179	0.320099	5.178071	291.622	0
Bank Of India	7.14E-05	0.013182	0.257821	5.348973	327.2531	0
Federal Bank Ltd.	0.000197	0.018992	-7.644317	190.9951	2651886	0
HDFC Bank Ltd.	0.000443	0.011864	0.321161	5.186724	293.9131	0
State Bank of India	-0.00013	0.013049	0.263528	3.748541	28.56525	0
Syndicate Bank	0.000203	0.012058	-0.36737	24.14191	17490.58	0
Vijaya Bank	0.000599	0.014384	-0.467856	12.75745	4295.728	0

Source: Computed

Table 3: Descriptive statistics of daily returns of scrips for the post period

Company	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob.
Allahabad Bank	-4.40E-05	0.01131	-0.17562	8.43029	911.7858	0
Andhra Bank	0.000194	0.0126	-0.35419	8.07037	1260.287	0
Bank Of Baroda	0.000244	0.01371	-0.3908	9.58185	2112.378	0
Bank Of India	0.000591	0.01506	0.118285	6.11259	468.5316	0
Federal Bank Ltd.	0.000177	0.01223	-1.21169	14.4582	4132.07	0
HDFC Bank Ltd.	0.000586	0.00999	0.268948	20.627	14953.86	0
State Bank Of India	0.000512	0.00975	-0.49405	7.04368	1223.047	0
Syndicate Bank	0.000397	0.01393	-0.09051	9.29522	1874.057	0
Vijaya Bank	-9.86E-05	0.0129	0.126301	8.95067	1092.313	0

Source: Computed

The behavior of equity returns must be further examined, and any predictability related to other factors that might be influencing the time series' volatility must be taken into consideration, before any meaningful conclusions can be drawn. Additionally, the tables present the statistics from the Jarque-Bera (JB) test, which looks at the data's normality. According to the results of the aforementioned test, a regularly distributed random variable should have a skewness of zero and a kurtosis of three. The distribution of the test statistic is chi-squared. The findings show that the skewness is non-zero and the kurtosis is greater than three for nearly all of the scrips examined and for each of the three time periods. The log return series of every scrip examined violates the premise of normalcy, according to the Jarque-Bera (JB) test.

The study starts by testing the return series for a unit root using the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests because any analysis must first determine whether a financial time series has a stochastic trend, deterministic trend, or stationary or non-stationary levels. The presence of a unit root in the daily return of the equity shares under investigation is indicated by the statistically significant coefficients for each of the three window periods.

Heteroscedasticity is another aspect of time series that requires consideration. The null hypothesis that there is no ARCH effect is rejected using the Lagrange Multiplier (LM) test, indicating that equity return series are heteroscedastic.

Table 4: Estimates of GJR GARCH (1, 1) Model of Companies

Estimates of GJR GARCH Model of Companies						
Company	**Variables**	**Description**	**Co-efficient**	**Standard Error**	**Z-Statistics**	**Probability**
Allahabad Bank	γ_0	Intercept	1.95E-05	0.000267	0.072856	0.9419
	γ_1	Nifty (R)	0.917436	0.036819	24.91721	0
	α_0	Constant	1.96E-05	3.35E-06	5.838033	0
	α_1	ARCH	0.173772	0.025911	6.706553	0
	α_2	GARCH	-0.043885	0.030445	-1.441445	0.1495
	α_3	Asymmetric response	0.710581	0.032982	21.54455	0
	α_4	DUMMY	-7.73E-06	2.12E-06	-3.648125	0.0003
Andhra Bank	γ_0	Intercept	4.33E-05	0.000238	0.182256	0.8554
	γ_1	Nifty (R)	0.902113	0.033014	27.32512	0
	α_0	Constant	1.73E-05	1.91E-06	9.07171	0
	α_1	ARCH	0.200413	0.023899	8.385679	0
	α_2	GARCH	-0.01548	0.027134	-0.570496	0.5683
	α_3	Asymmetric response	0.694355	0.024705	28.10534	0
	α_4	DUMMY	-4.47E-06	1.14E-06	-3.925807	0.0001
Bank of Baroda	γ_0	Intercept	1.72E-05	0.000223	0.077154	0.9385
	γ_1	Nifty (R)	1.064971	0.029465	36.14328	0
	α_0	Constant	8.86E-06	1.18E-06	7.47821	0
	α_1	ARCH	0.075789	0.009618	7.88007	0
	α_2	GARCH	-0.019352	0.012332	-1.569175	0.1166
	α_3	Asymmetric response	0.873561	0.013496	64.72919	0
	α_4	DUMMY	-2.11E-06	6.03E-07	-3.505565	0.0005
Bank of India	γ_0	Intercept	1.68E-05	0.000223	0.075504	0.9398
	γ_1	Nifty (R)	1.061613	0.028803	36.85743	0
	α_0	Constant	1.74E-05	2.37E-06	7.336179	0
	α_1	ARCH	0.155376	0.020192	7.694892	0
	α_2	GARCH	-0.070672	0.019519	-3.620728	0.0003
	α_3	Asymmetric response	0.747486	0.02761	27.07324	0
	α_4	DUMMY	1.47E-06	1.16E-06	1.265372	0.2057
Federal Bank Ltd.	γ_0	Intercept	-0.000105	0.000336	-0.312716	0.7545
	γ_1	Nifty (R)	0.849545	0.03852	22.0546	0
	α_0	Constant	0.000547	4.44E-06	123.1792	0
	α_1	ARCH	0.198463	0.014938	13.28612	0
	α_2	GARCH	-0.04132	0.037327	-1.106973	0.2683
	α_3	Asymmetric response	-0.015777	0.004534	-3.479786	0.0005
	α_4	DUMMY	-0.000469	5.28E-06	-88.83362	0

*indicate that GARCH model has been applied.

Table 5: 4C Estimates of GJR GARCH (1, 1) Model of Companies

Estimates of GJR GARCH Model of Companies						
Company	**Variables**	**Description**	**Co-efficient**	**Standard Error**	**Z-Statistics**	**Probability**
HDFC Bank Ltd.	γ_0	Intercept	0.000283	0.000172	1.651562	0.0986
	γ_1	Nifty (R)	0.759779	0.012132	62.62843	0
	α_0	Constant	1.00E-05	1.37E-06	7.288706	0
	α_1	ARCH	0.144983	0.019017	7.624024	0
	α_2	GARCH	-0.003577	0.022716	-0.157481	0.8749
	α_3	Asymmetric response	0.762333	0.018852	40.4374	0
	α_4	DUMMY	-2.99E-06	8.08E-07	-3.699408	0.0002
State Bank of India	γ_0	Intercept	0.000219	0.000145	1.505839	0.1321
	γ_1	Nifty (R)	1.045316	0.017101	61.12732	0
	α_0	Constant	5.24E-06	9.08E-07	5.769452	0
	α_1	ARCH	0.08484	0.011914	7.121104	0
	α_2	GARCH	-0.017919	0.015059	-1.189917	0.2341
	α_3	Asymmetric response	0.861155	0.017892	48.13062	0
	α_4	DUMMY	-2.05E-06	4.99E-07	-4.109002	0
Syndicate Bank	γ_0	Intercept	0.000117	0.000247	0.476248	0.6339
	γ_1	Nifty (R)	0.891816	0.02835	31.45722	0
	α_0	Constant	5.67E-05	4.24E-06	13.38127	0
	α_1	ARCH	0.227802	0.030441	7.483488	0
	α_2	GARCH	-0.013606	0.030399	-0.447567	0.6545
	α_3	Asymmetric response	0.414296	0.044846	9.238191	0
	α_4	DUMMY	-1.33E-05	2.20E-06	-6.03639	0
Vijaya Bank	γ_0	Intercept	-0.000116	0.000284	-0.4067	0.6842
	γ_1	Nifty (R)	0.968319	0.034213	28.30269	0
	α_0	Constant	3.94E-05	5.15E-06	7.643331	0
	α_1	ARCH	0.09953	0.013256	7.508567	0
	α_2	GARCH	0.185455	0.024228	7.654583	0
	α_3	Asymmetric response	0.602865	0.033879	17.7948	0
	α_4	DUMMY	-1.57E-05	2.52E-06	-6.229251	0

*indicate that GARCH model has been applied.

There is a considerable ARCH impact in equity returns, according to the Lagrange Multiplier (LM) test, which indicates that there is no ARCH effect of equity returns. Equity return series are heteroscedastic, according to the LM test result. Therefore, the Generalized ARCH measure of volatility was judged appropriate for examining the influence of information on stock return volatility. But as was previously said, the traditional GARCH models make the assumption that volatility responds to information symmetrically, which isn't necessarily the case. Therefore, by defining the GJR GARCH (1, 1) specification of volatility dynamics, the study first checks for the presence of an asymmetric response in each of the three time periods. The GJR GARCH model has been specified, and the result points to an asymmetric response.

Lastly, an analysis is conducted on how the introduction of stock derivatives affects conditional volatility. The returns on the nifty have been included to the mean equation in order to separate the impact of market-wide influences on asset returns. According to the analysis's findings, which are shown in Table 4, the Nifty has a large and positive impact on scrip returns in each instance, which is consistent with accepted theories of asset pricing. As previously mentioned, a dummy has been added to the variance equation in order to examine the overall effect of the introduction of equity derivatives on spot market volatility. In the pre-introduction phase, the dummy would take the value "zero", and in the post-introduction period, it would take the value "one".

The results as reported in Table 4 indicate that in the case of eight scrips analyzed out of nine, the coefficients of the dummy variable are significant and negative. Thus, it can be said that introduction of derivatives trading has resulted in reduction in spot market volatility.

Conclusion

The current paper uses the daily return of nine banks from April 1, 1998, to March 31, 2012, excluding holidays when there were no transactions, to investigate the effects of equity derivatives trading on spot market volatility, specifically the impact of equity derivatives introduction on spot market volatility and informational efficiency in the Indian stock market. The market volatility has been studied using the GARCH (1, 1) model, which accounts for the heteroscedasticity in returns. To exclude the impact of market-wide variables on equity returns, the CNX Nifty index return was used as the independent variable in the GJR GARCH model, which captures the asymmetric response, which was applied to all of the companies under consideration.

The findings show that the dummy variable's coefficient is negative and significant. Therefore, it can be claimed that the introduction of trading in stock futures has reduced the volatility of the spot market. Hence, the null hypothesis that the introduction of equity derivatives contract does not influence the spot market volatility is rejected.

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