An Empirical Investigation of Volatility of the Stock Market in India

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Abstract

Economies around the world have been easily affected by the volatility in stock markets. Volatility in cash market is being impacted and influenced by lot many factors out of which futures are considered to be the important one. The present paper is focused towards empirically testing the volatility of the Indian stock market owing to the selected variables like Nifty Index, Nifty Junior, One month Future on Nifty Index and Nifty Turnover. The volatility in Indian stock market is represented by VIX Index of National Stock Exchange. The other prime objective would be to analyze the impact of derivative trading on volatility of spot market for which the variable of one month Future on Nifty Index has been taken. The study also investigates the dynamic relationship between all the return series. The objectives of the study are examined by employing ADF test to check the stationarity, Johansen's co-integration test for examining the long term relationship, and Garch (1, 1) model to check the volatility due to Nifty Index, Nifty Junior, One month Future on Nifty Index and Nifty Turnover on VIX Index. The daily closing data is taken from last four years (November 2009 - March 2014) for the analysis. The findings of the study proved that the series derived from the VIX Index, Nifty Index, Nifty Junior, One month Future on Nifty Index and Nifty Turnover were not stationary in the level form, except VIX series, but there is evidence of stationarity in the first difference form for others. Long run relationship between the series is also observed. Empirical results found that one month futures do not bring volatility in the VIX. It is Nifty index that brings volatility in VIX.

Keywords:

Volatility, Nifty, VIX, Nifty Junior, ADF Test, Johansen's Co-Integration, GARCH, Futures, Turnover

Introduction

Lately it has been believed that the stock index futures are more volatile than the spot market because of their operational and institutional properties. There exist a close relationship between the two markets as a result of which the transfer of volatility is made possible between the future market and the spot market. As a result of which it may not be different to know that the inception of futures contract in the stock market have caught the attention of the researchers over the world and led them observe the volatility of the stock market trading. Studies have been conducted to assess the impact of derivatives on stock market majorly in the developed countries. Only few studies were attempted to know the impact of introduction of derivatives trading in emerging market economies like India. In order to understand for the same, both theoretical and empirical studies were carried out to identify the impact of listing of futures and options on the spot market. There are basically two major bodies of theory both of which stand on contradictory conclusions of derivatives trading on the spot market. One school of thought argues that the introduction of futures trading increases the spot market volatility and thereby, destabilizes the market **(Lockwood and Linn, 1990).** They describe that derivatives market provides an additional channel by which information can be transmitted to the cash markets. Rapid processing of information may cause an increase in the volatility in the spot market. Others argue that the introduction of futures actually reduces the spot market volatility and thereby, stabilizes the market (**Satya Swaroop Debasish, 2007**). **Kumar et al (1995)** argued that derivatives trading helps in price discovery, improve the overall market depth, enhance market efficiency, augment market liquidity, reduce asymmetric information and thereby reduce volatility of the cash market. Thus the overall impact of the derivative introduction on the spot market remains a debatable aspect with two different aspects one in favour and other against. This study seeks to examine the future trading impact on the volatility of the spot market. Some other selected variables, Like Nifty Index, Nifty Junior and Nifty Turnover, are also being used to judge their influence on volatility. To measure volatility in the markets, the VIX (Volatility Index) computed by the National Stock Exchange is used. The study has evaluated the trends in NSE for the cause of the turnover in NSE trades a large volume of derivatives market. We use Nifty Junior as an index to capture and study the market wide factors contributing to the changes in spot market volatility. This gives a clearer view of the fact that with the introduction of futures in itself cause a decline in the volatility of spot market or the overall market wide volatility has decreased, and thus, causing a decrease in volatility of indices on which derivative products have been introduced. The volume traded on NIFTY also has a large impact on the volatility, as a result of which volatility volumes are also taken as factor. We seek to compare this volatility with the volatility prevailing in the market before the index futures (i.e. Nifty futures) and check if it is statistically significant.

Literature Review

Thenmozhi (2002) understood the empirical relationship between the NSE 50 futures and the NSE 50 index by identifying change in the volatility of the underlying index due to the introduction of derivatives. He identified whether movements in future prices provide predictable information for the movements of the index. The finding of the study stated that the volatility of the spot market has decreased with introduction of futures.

Shenbagaraman (2003) undertook a study to evaluate the introduction of the derivatives, which is futures and options, to have any impact on the spot market volatility. The study explained that the increased volatility of the Indian stock market was due to the increase in the volatility of the US market.

Raju and Karande (2003) studied the concept of price discovery and volatility with the introduction of Nifty futures at NSE. Co-integration and GARCH techniques were used to study price discovery and volatility respectively. The major findings were that the market for the futures was affected by deviation from the equilibrium and the study of price discovery in both futures and spot market stands justified. The result also draws attention towards the decrease in the volatility in the spot market with futures introduction.

Nath (2003) studied the behavior of stock market volatility with the introduction of the derivatives in the market. Author derived a conclusion that the volatility of the market is a result of the indices like S&P CNX Nifty and S&P CNX Nifty Junior that has actually decreased the volatility during the post-derivatives period.

Samanta and Samanta (2007) studied the impact of index future and stock future on the volatility of the spot market by considering S&P CNX Nifty, Nifty Junior and S&P 500 of NSE. GARCH model was used for the study. The result stated that there was no major change in the volatility of the spot market rather identified few structural changes leading to a mixed result.

Vipul (2007) examined the change in volatility in Indian Stock market especially after the introduction of derivatives by making use of extreme value measure of volatility. It was indentified that there was reduction in volatility of underlying shares after the introduction of derivatives which could be attributed to a reduced persistence in previous day's volatility. However, it was found that Nifty showed contradictory pattern of increase in unconditional GARCH volatility & persistence.

Sibani and Uma (2007) found out the impact of introduction of futures trading by making use of OLS and GARCH techniques to capture the time-varying nature of volatility and volatility clustering phenomenon in case of CNX Nifty Index of NSE. The result was attributed in the sense that there was no change in the volatility of the spot market of nifty index. They also found that new information was associated with the prices more in comparison to before and there was a decline in persistence of volatility after the introduction of derivatives.

Whaley (2009) argues that an increased demand-to-buy index affects the level of the volatility index, and thus, the change in the volatility index is expected to rise at a higher absolute rate when the stock market falls than when it rises. Empirical evidence supports the volatility index as more a barometer of investors' fear of the downside than as a barometer of investors' excitement (greed) in a market rally.

Dhanaiah, Reddy and Prasad (2012) examined the behavior of India Volatility Index (India VIX). First, the negative correlation between changes in India VIX and market returns. Second, the asymmetric nature of the changes in India VIX with respect to market returns. S&P CNX NIFTY Index was used as a proxy for the market and the study period was from March 2009 through November 2011. Using OLS Regression method on daily data, this study found an inverse relation between movements in India VIX and movements in the NIFTY. The study reveals the asymmetric nature of the Volatility Index- Market Return relationship. This study was useful for understanding the behavior of India VIX and helped policymakers in the design of appropriate instruments based on India VIX for hedging and risk management.

Kumar (2012) studied the India VIX and its relationship with the Indian stock market returns. Result shows the negative association between the India VIX and stock market returns and the presence of leverage effect significantly around the middle of the joint distribution.

Thenmozhi and Chandra (2013) examined the asymmetric relationship between the India Volatility Index (India VIX) and stock market returns, and demonstrated that Nifty returns are negatively related to the changes in the India VIX levels; in the case of high upward movements in the market, the returns on the two indices tend to move independently. When the market takes a sharp downward turn, the relationship is not as significant for higher quantiles. Their analysis of timing strategy based on changes in the India VIX exhibits that switching to large-cap (mid-cap) portfolios when the India volatility index increases (decreases) by a certain percentage point can be useful in maintaining positive returns on a portfolio.

Objective of The Study

The objective undertaken in the study is as follows:

1. To examine the long term relationship between Nifty, One Month Nifty Future, VIX, Nifty Junior , Nifty Turnover
2. To study the derivatives trading impact on volatility of the stock market represented by VIX index along with influence by Nifty, Nifty Junior and Nifty Turnover

Hypotheses

The following hypotheses are formulated:

1. H_0: There is no long run relationship between NIFTY, FUT1, VIX, NIFJUN, TURNOVER
2. H_0: There is no significant volatility in VIX Index due to Nifty
3. H_0: There is no significant volatility in VIX Index due to One Month Nifty Future
4. H_0: There is no significant volatility in VIX Index due to Nifty Junior
5. H_0: There is no significant volatility in VIX Index due to Nifty Turnover

Data Collection

The secondary data has been used for the present paper. The data for the study had been collected for the last seven years, i.e. from November 2009 - March 2014, from www.nseindia.com. Collected data is based on the daily movements of NSE's indices such as S&P CNX Nifty, Nifty One month Futures, Nifty Junior, VIX (Volatility Index) and Nifty Turnover.

Research Methodology

Firstly for any time-series analysis, test for stationarity is to be undertaken, i.e. the price series of all variables (Nifty, Nifty One month Futures, Nifty Junior, VIX and Nifty Turnover) should be stationary. For this, Augmented Dickey Fuller Test and Phillips-Perron Tests are available. In this study, we would be using ADF Test. The second step is to check whether there exists a long-term relationship between the two variables or not which can be done using the Johansen Co- integration Test. Finally, Garch (1, 1) Model has been used to test for the volatility represented by VIX index. These entire tests have been carried on the E-views software.

For empirical analysis, raw series are converted into series of returns. As due to a number of statistical reasons, it is preferable not to work with the prices series directly. Returns have an additive advantage that they are unit-free. Returns are taken as continuously compounded returns as for log-returns frequency of compounding of the return does not matter, which makes the returns series more comparable. Also, compounded returns are time-additive. The returns series is calculated as follows:

$$r_t = 100\% * \ln\left(\frac{p_t}{p_{t-1}}\right)$$

Where, r_t is the continuously compounded return in time period t, p_t denotes the price at time t and ln represents the natural logarithm.

Testing For Stationarity of Series

Most of the financial series are non-stationary in the level form. The prior step to carry out any analysis in time-series is to test for stationarity. An examination of whether a series is stationary or not is essential for two reasons:

a) A stationary or otherwise of a series strongly influences its behavior and properties. For stationary series, shock or the error term dies away gradually while for a non-stationary series, the persistence of a shock will always be infinite.

b) The use of non-stationary data can lead to spurious regressions. It means that when the standard regression techniques are applied to non-stationary data, the end results could show a high R^2 and significant coefficient estimates but is valueless.

A stationary series can be defined as one with a constant mean, constant variance and constant covariance for each given lag (Brooks, 2008) and thus conventional statistical results are appropriate while a non-stationary series has time varying mean and variance. Testing for stationarity implies testing for the presence of unit roots. A non-stationary series, y_t must be differenced d times before it becomes stationary, then the series is said to be integrated of order d, i.e., if $y_t \sim I(d)$, then $\Delta^d y_t \sim I(0)$ implies that applying the difference operator, Δ, d times, leads to an I(0) process, i.e., presence of no unit roots. An I (0) is a stationary process while an I (1) is a non-stationary process with one unit root. Consider an AR (1) process-

$$Y_t = \emptyset\, Y_{t-1} + \mu_t$$

Where, μ_t is the error term that follows a white-noise process.

H_0: ø = 1 indicates the presence of unit root and thus the non-stationarity of the series.

H_1: ø < 1 indicates absence of unit roots and thus stationarity of the series.

Taking first difference of the above series i.e.,

$$Y_t - Y_{t-1} = (\emptyset - 1)\, Y_{t-1} + \mu_t$$

$$\Delta Y_t = \theta\, Y_{t-1} + \mu_t \qquad [\theta = \varphi\text{-}1]$$

Or,

Here, ø = 1 is equivalent to a test of $\theta = 0$ so that not rejecting $\theta = 0$ implies presence of unit root and of $\theta < 1$ implies stationarity of the series.

Augmented Dickey Fuller Test

Dickey and Fuller were the first to test for a unit root in a time-series analysis. The Augmented Dickey Fuller test uses the following regression-

$$\Delta y_t = a + \alpha y_{t-1} + \sum_{i=1}^{k} b_i\, \Delta y_{t-i} + \varepsilon_t \quad \text{...(1)}$$

$$\Delta y_t = a + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k} b_i\, \Delta y_{t-i} + \varepsilon_t \quad \text{...(2)}$$

The regression test for unit root in y_t, where Δy_{t-i} is the lagged difference to accommodate serial correlation in the errors, ε_t. k is the appropriate lag length.

The null and alternate hypotheses of the regression are

$H_0: \alpha = 0$

$H_1: \alpha < 0$

Not rejecting the null hypothesis indicates the presence of a unit root i.e., the series is non- stationary while rejecting the null implies a mean stationary process in case of equation (1) and a trend stationary process in case of equation (2). If ΔY_t is stationary, it is called a differenced stationary process. If ΔY_t is stationary while Y_t is not, then Y_t is called integrated of first order I(1). Presence of a unit root implies a permanent effect of random shocks and variance is time-dependent i.e., increases with time.

Test statistics = $\frac{\hat{\theta}}{s.e\,\hat{\theta}}$

The test statistics do not follow the usual t-distribution under the null hypothesis, since the null hypothesis is that of non-stationarity, but rather it follows a non- standard distribution. This test statistic is then compared to the value of Dickey Fuller test. If this test statistic is less than the critical value, then the null hypothesis is rejected confirming the absence of unit root and thus stationarity of the series. However, if this test statistic is greater than the critical value, presence of unit root and thus non-stationarity is confirmed.

Johansen's Co-integration Test

A set of variables is said to be co-integrated, if a linear combination of them is stationary. Spot and futures prices are expected to be co-integrated as they are the prices of the same asset in different points in time and hence will be affected by given any information. A co-integrating relationship may also be seen as a long-term or equilibrium phenomenon, since it is possible that co-integrating variables may deviate from their relationship in short run, but it will return in the long run. The aim of this test is to determine whether a long-term relationship exists between the variables or not. Johansen's methodology takes its starting point in the vector auto regression (VAR) of order p given by

$$y_t = \mu + A_1 y_{t-1} + \cdots \ldots \ldots + A_p y_{p-t} + \varepsilon_t$$

Where y_t is an n×1 vector of variables that are integrated of order one – commonly denoted

I(1) and ε_t is an n×1 vector of errors.

Maximum Eigen Value Test

The Eigen values are the squared canonical correlation between a linear combination of stationary ΔX_t and linear combination between non-stationary X_{t-1}. This interpretation is intuitively appealing because this correlation will be high only if the linear combination of X_{t-1} is itself stationary. Otherwise, a non-stationary variable cannot have a high correlation with a stationary variable. Therefore, higher the Eigen value, higher will be the stationarity of the particular linear combination of the non-stationary variable. Only those Eigen values indicate the co-integrating relationship among the variables which are significantly different from zero. The corresponding (normalized to a variable) Eigen vector of an Eigen value is the potential co-integrating vectorβ. However, this vector represents a co-integrating relationship only if its Eigen value is different from zero. Once the co-integrating vector (in the form of eigenvector) is known, the error-correction vector can easily be estimated using its OLS estimator.

Trace Test

Maximum likelihood estimator gives us k number of Eigen-values, but all of them will not be significantly different from zero. Let we assume only r Eigen values are different from zero. Now there are following possibilities:

i. r = 0, it means there is no co-integrating relationship among the variables. Therefore the VAR should be estimated without error correction term.

ii. r = k, this can happen only when X_t is stationary rather than non-stationary.

iii. r < k, then there are only r co-integrating relationship among the variables. This is the most obvious situation and in this case only r Eigen values are different from zero and remaining (k-r) Eigen values are non-distinguishable from zero.

Johansen suggests trace test (ML based test) to determine the number of non-zero Eigen values. Trace test examines the null hypothesis that the co-integration rank is *k* equal to *r* against the alternative hypothesis that co-integration rank is. The test is conducted in inverse sequence, x i.e., *r* = *k*, *k*-1, *k*-2....0 . The test statistic is computed as follows:

$$Trace = -T \sum_{i=r+1}^{k} \ln(1-\lambda_i)$$

Although both of these statistics are based on likelihood ratio approach, these do not follow the standard χ^2-distribution. Rather they have non-standard distribution. Before implementing Johansen's test we have to take two important decisions: (i) what should be the order of the VAR i.e. 'p', and (ii) should we include deterministic parameters with or without imposing co- integration restrictions.

Vector Error Correction Model

Once it is known that there exists a long-run relationship between the variables or not, the next step is to check the significance of the coefficients through Ordinary Least Square Method which will further determine the long-run causality between the variables. But if there is no co-integrating relationship between the variables, then standard Vector Autoregressive model is used to determine the causality.

Ordinary Least Square Method

Ordinary least squares (OLS) is a method for estimating the unknown parameters in a linear regression. The method minimizes the sum of squared vertical distances between the observed responses in the dataset and the responses predicted by the linear approximation. The OLS estimator is consistent when the regressors are exogenous and there is no multi-co-linearity, and optimal in the class of linear unbiased estimators when the errors are homosckedastic and serially uncorrelated. Under these conditions, the method of OLS provides minimum variance mean unbiased estimation when the errors have finite variances. Under the additional assumption that the errors be normally distributed, OLS is the maximum likelihood estimator. Suppose the data consists of n observation {yi,□xi}ni=1. Each observation includes a scalar response y_i and a vector of predictors (or regressors) x_i. In a linear regression model, the response variable is a linear function of the regressors:

$$y_i = x_i'\beta + \varepsilon_i,$$

where β is a p×1 vector of unknown parameters; ε_i's are unobserved scalar random variables (errors) which accounts for the discrepancy between the actually observed responses y_i and the "predicted outcomes" $x'_i\beta$ and so x′□β is the dot product between the vectors x and β. This model can also be written in matrix notation as

$$y = x\beta + \varepsilon$$

Where y and ε are n×1 vectors, and X is an n×p matrix of regressors, which is also sometimes called the design matrix.

As a rule, the constant term is always included in the set of regressors X, say, by taking x_{i1} = 1 for all i = 1… n. The coefficient $\beta_1$corresponding to this regressor is called the intercept.

The paper employs OLS Method to determine significance of coefficients. If the coefficient of the independent variable is significant then, it is concluded that long-run causality exists between the variables.

GARCH (1, 1) Model

Volatility, as measured by variance of returns, is a crude measure of total risk of financial assets. Since a financial time series does not have constant variance of errors, so a model that does not assume constant variance and which describes how variance of errors evolves overtime is required. An Auto Regressive Conditionally Heteroscedastic (ARCH) model developed by Engel in 1982 is one of those models. Under ARCH model, the conditional variance of the error term depends on the lagged values of the squared errors. (Brooks, 2008) Later the Generalized ARCH model (GARCH) was developed independently by Bollerslev (1986) and Taylor (1986) where conditional variance not only depends on lagged squared residuals but also on its own lagged values. The GARCH model is described by two equations:

Mean Equation: $Y = C + \varepsilon_t$

Variance Equation: $\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2$

Since it is a variance equation, its value must always be strictly positive. For an ARCH model, there has to be non-negativity constraints i.e., $\alpha_0 > 0$ $\alpha_1 > 0$.

σ_t^2 is known as the conditional variance. It is a one-period ahead estimate for the variance based on any relevant past information.

$\beta\sigma_{t-1}^2$ is the last period's variance which represents the GARCH term.

$\alpha_1\varepsilon_{t-1}^2$ is the information about volatility during the previous period – an ARCH term.

This is the GARCH (1, 1) model as only one lag of the error term and conditional variance is taken. Only one lag is taken because the more the parameters to be estimated, the large the conditional variance. Also, everything else equal, the more the parameters, the more likely it is that one or more of them will have negative estimated values. In general, a GARCH (1, 1) model is sufficient to capture volatility clustering in the data and any higher order model is rarely used in estimating volatility for financial series. A GARCH model is better than an ARCH model as the former is more parsimonious than the latter and avoids over-fitting.

Hence, the model explains the current period's conditional variance is the weighted function of a long-term average value (constant in equation), last period's forecasted conditional volatility and last period's squared residuals. The sum of the coefficients of ARCH and GARCH term is usually close to unity signifies that the volatility of asset returns is highly persistent. The effect of any shock in volatility dies out a rate of $(1-\alpha_1 - \beta)$. If $(\alpha_1 + \beta) \geq 1$, then the effect of shock is permanent and it is termed as 'non-stationarity in variance' and $(\alpha_1 + \beta) = 1$ is termed as 'unit root in variance'. The volatility will be defined only if $(\alpha_1 + \beta) <$ 1. Therefore, this condition is imposed while estimating the GARCH model.

Analysis and Findings

Stationarity of Series (ADF Test)

While testing for the stationarity of series using ADF test, the hypothesis is:

H_0: Presence of unit root i.e., non-stationary series.

H_1: No unit roots i.e., stationary series.

TABLE1: Mackinnon (1996) Critical Values

	1%	5%	10%
Critical Values	-3.436127	-2.863979	-2.568120

The NIFTY, FUT1, VIX, NIFJUN, NIFTY TURNOVER are tested for stationarity at levels first. The critical values of the ADF at levels are presented in Table 1. It was found that all the series are non-stationary at levels except VIX series. Therefore, to carry out any further analysis, it was necessary to make the series stationary. The results for stationarity at first difference are tabulated in Table 2.

TABLE 2: Results of Stationarity at first difference I (1)

	t-Statistic	Prob.*
D(NIFTY)	-31.02459	0.0000
D(FUT1)	-30.15122	0.0000
D(VIX)	-4.357161	0.0004
D(NIFJUN)	-28.24088	0.0000
D(TURNOVER)	-18.31681	0.0000

Comparing table 1 and 2 shows that the calculated ADF test statistics is less than the critical value, so the null hypothesis of presence of one unit root is rejected. This implies that all the series becomes stationary at first difference. Or, it can be said that the ADF test confirms the stationarity of return series. Now since the series are stationary, they can be used to carry out further analysis.

Johansen's Co-integration Test

Before testing for co-integration, it is necessary to determine the optimal lag length. As mentioned before, the starting point of the test is the vector auto regression (VAR) of order 'p'. This 'p' is the optimal lag length. The optimal lag length of VAR for the analysis is tabulated in Table 3.

TABLE 3: Results for optimal lag length

Lag	SBC
0	67.19859
1	53.39438*
2	53.42054
3	53.55507
4	53.65927
5	53.78248
6	53.91978
7	54.05323
8	54.19161

Note: * indicates the optimal lag length chosen by Schwartz Bayesian Criteria

As can be seen from table 3, the optimal lag length, 'p' is 1. The test requires maximization of Eigen value and trace test which will determine the number of co-integrating equations. The hypothesis used for the test is:

H_0: There is no long run relationship between NIFTY, FUT1, VIX, NIFJUN, and TURNOVER

H_1: There exists a long run relationship between NIFTY, FUT1, VIX, NIFJUN, and TURNOVER

TABLE 4: Unrestricted Co-integration Rank Test

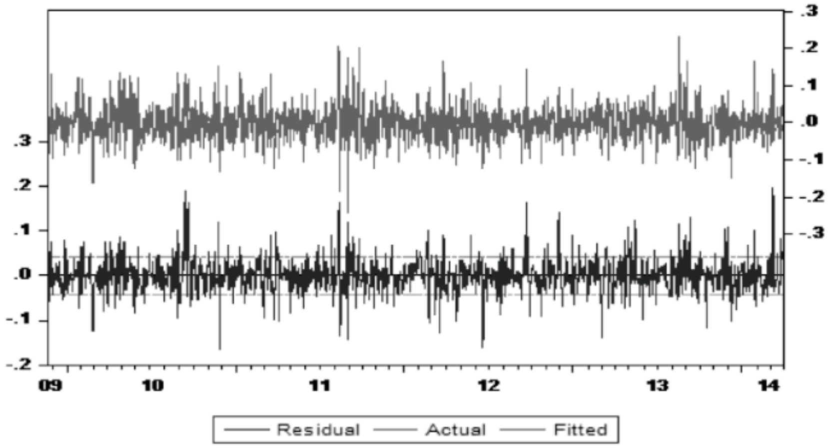
Number of Hypothesised equations	Maximum Eigen Statistics	Trace Statistics	p-value*
None	186.4824	249.5997	0.0000
At most 1	28.59747	63.11726	0.0010
At most 2	25.10610	34.51979	0.0133
At most 3	7.721613	9.413692	0.3285
At most 4	1.692079	1.692079	0.1933

*NOTE: MacKinnon-Haug-Michelis (1999) p-values

As can be seen from the above table 4, both maximum Eigen statistics and trace statistics have p-value less than 0.05, so the null hypothesis that there is no long run relationship between NIFTY, FUT1, VIX, NIFJUN and TURNOVER in logarithm is rejected, i.e., there exists a long-run relationship between the series. However, for the null hypothesis there exits at most two co-integration equations between the series. So, finally we conclude that there is only two co-integrating equation and hence there exists a long-run relationship between the series.

GARCH (1, 1) Model Results for Presence of Volatility

Before testing for the presence of volatility, it is necessary to check for volatility clustering which describes the tendency of large changes in asset prices to be followed by large changes and small changes by small changes.



Aforementioned the test of presence of volatility using GARCH (1, 1) consists of a mean equation and a variance equation.

Mean equation: $R_t = C + \varepsilon_t$

Variance equation: $\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2$

Where, R_{-t} is the returns series

In the first step, using mean equation, returns are regressed on the constant and then using the residuals from the mean equation, the forecast variance of the current time period is predicted using the variance equation. If ($\alpha_1 + \beta$) is close to unity, then it implies persistence of high volatility shocks. The results of GARCH (1, 1) model are tabulated in table 5.

TABLE 5: GARCH (1, 1)

Equation	Variable	Coefficient	Probability
MEAN	C(1)	-0.000148	0.9063
	C(2)	0.010103	0.9341
	C(3)	-0.167520	0.3926
	C(4)	-2.694818	0.0000
	C(5)	-0.001051	0.7450
VARIANCE	C(6)	0.000400	0.0003
	C(7)	0.097034	0.0000
	C(8)	0.863632	0.0000

The above can be explained using the following equation

H_t = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

GARCH = C(6) + C(7)*RESID(-1)^2 + C(8)*GARCH(-1)

Where, H_t is the variance of the residual term i.e., error term derived from the mean equation C(6) is the constant term. RESID(-1)^2 = previous period's squared residual (error derived from the mean equation). It is known as previous day's dependent variable information about volatility. This is the ARCH term.

In the table 5, C (2), C (3), C (4) and C (5) (coefficient of dependent variable) are the coefficients of the mean equation. The interest lies in the significance of the ARCH and GARCH coefficients. The coefficients, C (7) and C (8) i.e., ARCH and GARCH coefficients respectively are significant. This implies that both the last period's squared residuals and the conditional variance are internal shocks to the volatility of the dependent variable. In the analysis period, in the above mean equation C(2) variable refers to one month Future, C(3) refers to Nifty Junior, C(4) refers to Nifty and C(5) refers to Nifty Turnover.. We can observe that only nifty has significant impact over VIX. Volatility is due to Nifty. The sum of coefficients is 0.96 (approx) which is close to unity, implying persistence of high volatility during the analysis period. Results show that the volatility is present in the VIX index due to nifty. This implies that one month futures do not bring volatility in the VIX. It is nifty index that brings volatility in VIX.

Conclusion

This paper tested the volatility of the Indian stock market owing to the selected variables like Nifty Index, Nifty Junior, One month Future on Nifty Index and Nifty Turnover. Another major objective of the study was to judge the impact of futures index trading on the volatility of the spot market. The result implies that there is long term association between the Nifty, One Month Nifty Future, VIX, Nifty Junior, Nifty Turnover. Empirical results also found that in the period of study there is persistence of high volatility in stock market due to Nifty Index and also one month futures do not bring volatility in the VIX. Hence, it can be concluded that derivatives contribute towards stabilizing stock market. Derivatives trading helps in price discovery, improve the overall market depth, enhance market efficiency, augment market liquidity, reduce asymmetric information and thereby reduce volatility of the cash market. The results are of interest both for a contribution to an extensive financial literature on the interplay between spot and futures markets and for potential investors and speculators strategies.

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