Dynamics of FII Flows on Indian Stock Market Volatility: An Emprical Exploration Using Garch Approach

Haritika Arora*
Garima Baluja**

*Research Fellow
Department of Commerce and Business Management, Guru Nanak Dev University, Amritsar, Punjab, India- 143005

**Research Fellow,
Department of Commerce and Business Management, Guru Nanak Dev University Amritsar, Punjab, India- 143005

Abstract

The increasing interest of foreign investors in the emerging markets such as Indian stock market demands for an intensive research by various academicians, researchers and financial econometricians on various market properties particularly the volatility. With the growth of FII flows in the Indian market and their enormous trades, market volatility has amplified with time. In this paper, we examine dynamics of FII flows on Indian stock market volatility using the daily movements of foreign institutional investment (FII) in India from 1st January 2001 till 31st December 2011. The empirical analysis has been done by using Augmented Dickey Fuller test, Heteroscedasticity test, ARMA model, Autoregressive conditional heteroscedasticity model (ARCH) and Generalised autoregressive conditional heteroscedasticity (GARCH) model. Findings reveal the presence of volatility clusters in both Sensex and S&P CNX Nifty. This study provides evidence that FII outflows accelerates the volatility of Indian stock market. Thus market regulators need to take care of greater market uncertainty associated with an increase in the volume of trades by FII.

Keywords:

ARCH, ARMA model, FII, GARCH, Volatility

Introduction

Flows of capital by individual or institutional investors across a national border which creates international diversified portfolio flow for them are commonly known as Foreign Institutional Investment (FII) flows. In India, FII have substantial impact on India Stock market. Various financial performance variables such as share returns and earnings per share are significant factors to captivate foreign investors in their investment decision (Prasanna (2008)). Global stock return performance is also very important factor and is positively related to foreign equity flows (Griffin et. al (2002)). Roy (2007) empirically analysed the foreign capital flows in India. The study explored that foreign capital flows are driven primarily due to the capital gains motive and further causality test revealed that stock prices are causing the net foreign portfolio flows and not vice versa. Various legislation pertaining to foreign investments, led to a significant impact on the level of FII flows. Bose and Coondoo (2004) revealed that liberalisation policies had a significant impact on FII flows. The mean level of FII inflows was increased with expansionary policies and the restrictive policies did not show any significant negative impact on the net inflows.

Whether FII flows affect stock market returns or vice-versa is a matter of a

serious issue. Chakraborty (2007) empirically investigated the direction of causation between FII flows and Indian stock market returns for the time period of April 1997- March 2005 and results exhibited that FII flows are caused by rather than causing the national stock market returns. However, Goudarzi and Ramanarayanan (2011) found bilateral co-integration and causal relationship between BSE500 and FII series. Further, Kumar (2007) claimed that the market movement can be explained using the direction of the funds flow from Foreign institution investors and markets could become efficient with presence of these institutional investors, who principally go by fundamentals. Trades by foreign investors had no destabilizing effect on Korea's stock market for the sample period of November 30, 1996, to the end of 1997, which include period of before and during Korea's economic crisis (Choe et. al (1999)). Similar results were corroborated by Batra (2003) in case of Indian equity market.

FIIs are significant factor clinching the liquidity and volatility in the stock market prices. (Chittedi, 2008). Rao et al (1999) observed patterns of FII investment profile and trading pattern at the BSE. Coondoo and Mukherjee (2004) explored volatility of the day-to-day movements of foreign institutional investment (FII) in India using Vector Autoregression (VAR) model. Study enunciated that FII and stock market returns in India exhibit quite high volatility and are positively correlated related with each other. Bansal and Pasricha (2009) examined the impact of market opening to FIIs on Indian stock market and found no significant changes in the Indian stock market average returns but volatility is significantly reduced after India unlocked its stock market to foreign investors.

Various recent developments in the Indian securities market have drawn attention of researchers to look at the stock price behaviour and its volatility. The literature revealed that very few attempts have been made to empirically investigate the volatility in Indian stock market on account of foreign institutional flows specifically using the advance volatility models. Hence in this paper, we endeavour to develop a dynamic relationship between net foreign institutional flows and volatility in Indian stock market. The study aims to capture their influence, if any, on the market volatility. This study focus on the Indian capital market, namely the Bombay Stock Exchange (BSE) and National Stock Exchange (NSE), where the association between foreign institutional investment and security returns is intense and significant. Empirical estimation is done with help of advanced volatility models given by Bollerslev, 1986.

Data Base and Methodology

To examine the nexus between FII and Indian stock market, daily data for market index BSE Sensex (Index of Bombay Stock Exchange) and S&P CNX NSE Nifty (Index of National Stock Exchange) has been taken from their official websites and the data on FII on daily basis has been obtained from ACE Equity. In order to capture the activity of the FIIs in India, we have considered their daily net trade. The study has covered the span of 10 years i.e. from 1st January 2001 till 31st Dec 2011.

The daily return is computed as the first difference of the natural logarithm as follows.

$$r_t = (\log p_t - \log p_{t-1})$$

where,

r_t = Market return at the period t

P_t = Price index at day t

P_{t-1} = Price index at day t–1 and

log = Natural log

Firstly, Augmented Dickey and Fuller (ADF) test has been applied to check the stationarity in series. An augmented Dickey-Fuller test is a test for a unit root in a time series sample. The null hypothesis for testing for stationarity is that the series has unit root (Series is non-stationary), against the alternative that Series is stationary.

Augmented Dickey and Fuller (ADF) Model:

$$\Delta Y(t) = \rho_0 + \rho Y(t-1) + \sum_{i=1}^{m} \Delta Y(t-i) + \varepsilon_t$$

Presence of auto-correlation (ACF) and partial auto correlation (PACF) functions in stock market returns form a part of identification of a suitable ARIMA (Autoregressive Integrated Moving Average) model. When error terms of this developed Autoregressive Integrated Moving Average model for stock returns does not exhibit constant variance and the period of high volatility followed by the period of high volatility and the period of low volatility followed by the period of low volatility, this suggests that the residuals or error terms is conditionally heteroscedastic and can be represented by ARCH and GARCH model.

ARCH models were introduced by Engle (1982) and generalized as GARCH (Generalized ARCH) by Bollerslev (1986). Under the ARCH model, the 'autocorrelation in volatility' is modelled by allowing the conditional variance of error term, σ^2_t, to depend on the previous lagged value of squared error.

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 + \alpha_3 u_{t-3}^2 + \alpha_4 u_{t-4}^2 \ldots\ldots + \alpha_q u_{t-q}^2$$

Where,

$\alpha_0, \alpha_1 \ldots \alpha_q$ = parameters of estimators

σ_t^2 = Conditional Variance at time t

q= number of lag included in the model

u_t = innovation in return at time t

A natural extension of an ARCH(q) model is a GARCH model, which is widely employed in practice, as it overcomes problems associated with ARCH model. GARCH model allows the conditional variance to be dependent upon previous own lags.

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2$$

This is a GARCH(1,1) model where σ^2_t is called as conditional variance. This model focuses on the time-varying variance of the conditional distributions of returns. Using the GARCH model it is possible to interpret the current fitted variance, σ_t^2, as a weighted function of a long-term average value dependent on α_0,

information about volatility during the previous period ($\alpha_1 u^2_{t-1}$) and the fitted variance from the model during the previous period ($\beta \sigma^2_{t-1}$). GARCH model can be expressed in a form that shows that it is effectively an ARMA model for the conditional variance. The advanced volatility models like GARCH capture the financial market volatility that appears in clusters and persist over the time. This feature of volatility clustering or volatility persistence went unequipped in traditional volatility models, which assumed market volatility to be constant.

Results and Discussions

In order to examine the relationship between foreign institutional investments with Indian stock market, two major indices have been used i.e S&P CNX Nifty of National Stock Exchange and SENSEX for Bombay Stock Exchange. Log returns of these two indices have been taken from January 2001 till December 2011.

Table 1 exhibits the descriptive statistics for the log returns of S&P CNX Nifty and SENSEX. Here, the mean, standard deviation, minimum, maximum, range, skewness, kurtosis and statistics are reported.

Table 1: Descriptive Statistics

	NIFTYR	SENSEXR
Mean	0.000481	0.000502
Median	0.001215	0.001126
Maximum	0.163343	0.159900
Minimum	-0.130539	-0.118092
Std. Dev.	0.016674	0.016609
Skewness	-0.259286	-0.110256
Kurtosis	11.06248	9.930609
Jarque-Bera	7381.236	5437.269
Probability	0.000000	0.000000
Sum	1.304747	1.362927
Sum Sq. Dev.	0.754284	0.748372
Observations	2714	2714

Mean of Nifty and Sensex log returns are 0.0481% and 0.0502% respectively. The standard deviation of returns is 0.016674 for Nifty and 0.016609 for Sensex. The maximum return of 16.3343% and 15.9900% is observed in Nifty and Sensex respectively and minimum is -13.0539% and -11.8092% for Nifty and Sensex respectively.

We can observe that the return series is negatively skewed with value of -0.259286 for Nifty and -0.110256 for Sensex. Kurtosis is more than 3 that is 11.06248 for Nifty and 9.930609 for Sensex which means distribution is peaked i.e. leptokurtic relative to normal distributions of returns in both indices that demonstrate extremely high positive kurtosis. Jarque-Bera (JB) statistics reject the null hypothesis of normal distribution at the 1% level of significance for both indices. This fat-tailed character is consistent with earlier studies (Huisman and Huurman (2002), Higgs and Worthington (2005) and Wolak (2000) and is driven by the prevalence of extremely large spikes in returns.

Table 2: Unit Root Test (ADF Test)

	Nifty returns	Sensex Returns
Augmented Dickey -Fuller test statistic	-37.59570	37.48339
	0.0000	0.0000
Test critical values:		
1% level	-3.432569	-3.432569
5% level	-2.862406	-2.862406
10% level	-2.567276	-2.567276

Augmented Dickey –Fuller (ADF) test is used to test the stationarity of a time series. A non-stationary process has infinite memory as it does not exhibit decay in a shock that takes place in the process. Every random shock carries away the process from its earlier level not to return back again unless another random shock push it towards its previous level. Therefore, it behaves like AR (1) process with $r=1$. Dickey Fuller test is designed to examine if $r=1$. Table 2 of Augmented Dickey-Fuller (ADF) test clearly reject the hypothesis of a Unit Root at the 1% level of significance for both indices.

Autoregressive Integrated Moving Average Model

For identification of suitable ARIMA model, we examined the auto-correlation (ACF) and partial auto correlation (PACF) functions from correlogram. An ARIMA model is a special type of regression model in which the dependent variable has been stationarized and the independent variables are all lags of the dependent variable and/or lags of the errors. According to ARIMA model, the best fit model for S&P CNX Nifty is AR(1). Similar model has been observed for Sensex also. Table 3 exhibits significant auto-regressive model at first lag order for both Nifty returns and Sensex returns. This process reflects the dynamics in the distribution of future values that can depend upon current values which is represented by autocorrelation parameter i.e. 0.075244 for Nifty returns and 0.079794 for Sensex returns.

Table 3. Auto-regressive model

	Dependent Variable: NIFTY Returns	Dependent Variable: SENSEX Returns
AR(1)	0.075244 3.929310* (0.0001)**	0.079794 4.168491* (0.0000)**
R-squared	0.005663	0.006369
Adjusted R-squared	0.005296	0.006002
Durbin-Watson stat	1.991182	1.990703
F-statistic	15.43948 (0.000087)**	17.37632 (0.000032)

*p value at 5% significance level
** t value at 5% significance level

The basic assumption for the modelled error terms is that they are uncorrelated, normally distributed and their variances do not vary with the effects being modelled. If error terms do not have constant variance, they are said to be heteroscedastic. Table 4 represents that residuals of this model are heteroscedastic in nature as they have obtained values below 0.05. Hence, the null hypothesis is rejected for residuals of both Nifty and Sensex returns that the disturbance term is not homoscedastic.

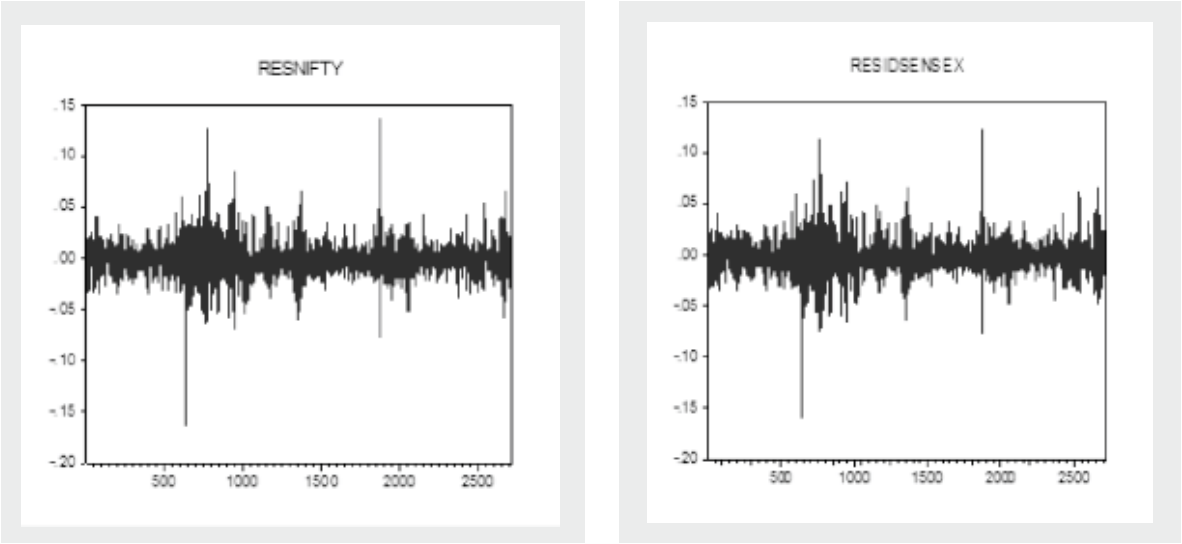
Table 4: Heteroscedasticity Test: ARCH

	Nifty Residuals	Sensex Residuals
F-statistic	143.6029	113.9847
Prob. F(1,2711)	0.0000	0.0000
Obs. R-squared	136.4795	109.4663
Prob. Chi-Square(1)	0.0000	0.0000

The heteroscedaticity in residuals of Sensex and Nifty returns can be observed from figure 1. When the period of high volatility followed by the period of high volatility and the period of low volatility followed by the period of low volatility, this suggests that the residuals or error terms is conditionally hetroscedastic, can be represented by ARCH and GARCH model.

Figure 1 depicts the persistence of low volatility from day1 till day 490 and afterwards similar pattern of this high and low volatility clustering has been observed.

Figure 1: Residuals of Nifty and Sensex Returns



The Generalized Auto Regressive Conditional Heteroskedasticity Model

The Generalized ARCH or the GARCH (r,m) model proposed by Bollerslev (1986) is amongst the most popular models of conditional volatility. This model is equivalent to infinitive order ARCH model (that is why it gets its name the generalized ARCH model). Our model for the stock returns can be presented as follows:

$$\sigma_t^2 = \omega + \alpha u_{t-1}^2 + \beta \sigma_{t-1}^2 + 8\text{FII}$$

where, σ_t^2, as a weighted function of a long-term average value dependent on ω, info about volatility during the previous period (αu^2_{t-1}) and the fitted variance from the model during the previous period ($\beta \sigma^2_{t-1}$). ($\alpha + \beta$) is a measures the persistence of volatility. 8 measures the effect of foreign institutional investments on Indian stock market volatility.

We fit a GARCH(1,1) model to the first difference of log daily S&P CNX Nifty and Sensex using backcast values for the initial variances and Bollerslev-Wooldridge standard errors. In order to test whether the foreign institutional flows influences the volatility of the Indian stock market, we have included foreign institutional flows (as an exogenous variable) in the variance equation of competing GARCH models.

Table 5: GARCH (1,1) for Nifty and Sensex

	GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6)*FII	
	Dependent Variable: Residuals of Nifty Returns	Dependent Variable: Residuals of Sensex Returns
Variance Equation		
Constant	$9.26e^{-06}$ 0.0000**	$8.81e^{-06}$ 0.0000**
RESID(-1)^2	0.147985 0.0000**	0.145621 0.0000**
GARCH(-1)	0.823207 0.0000**	0.825361 0.0000**
FII	$-2.31e^{-09}$ 0.0217**	$-2.25e^{-09}$ 0.0213**

** p value at 5% significance level

Table 5 reports the results of GARCH (1,1) specification. The sum of the coefficients of the ARCH and GARCH in equation without a constant term is near to one (0.97 for both Nifty and Sensex), which are positive and statistically significant. As GARCH coefficient is greater than ARCH coefficient, it represents conditional variance is more dependent on last period's forecast variance. Further it can be observed from ARCH and GARCH coefficients that volatility dies out at a rate of 0.029 for Nifty and Sensex. The coefficient of foreign institutional investments (FII) in GARCH models is significantly different from zero. Statistical values ($-2.31e^{-09}$, 0.0217) shows negative and significant affect of foreign institutional investments on S&P CNX Nifty. Similar significant statistical values has been observed for Sensex ($-2.25e^{-09}$, 0.0213). It exhibits that net outflows of foreign institutional investments accelerates the volatility in Nifty and Sensex.

The negative coefficient of FII indicates that higher the outflow of their investment larger is the variance i.e. more the impact on the market volatility. With the growth in the FII in the Indian bourses and their enormous trades, market volatility has increased with time. Hence, the study provides evidence that FII outflow produce high volatility in market. Market regulator need to further strengthened their market surveillance and risk management practices using various criteria such as exit charges, lock in period etc. should be introduced, so as to take care of greater market uncertainty associated with an increase in the volume of trades by FII.

Figure 2: Conditional Variance- Nifty and Sensex

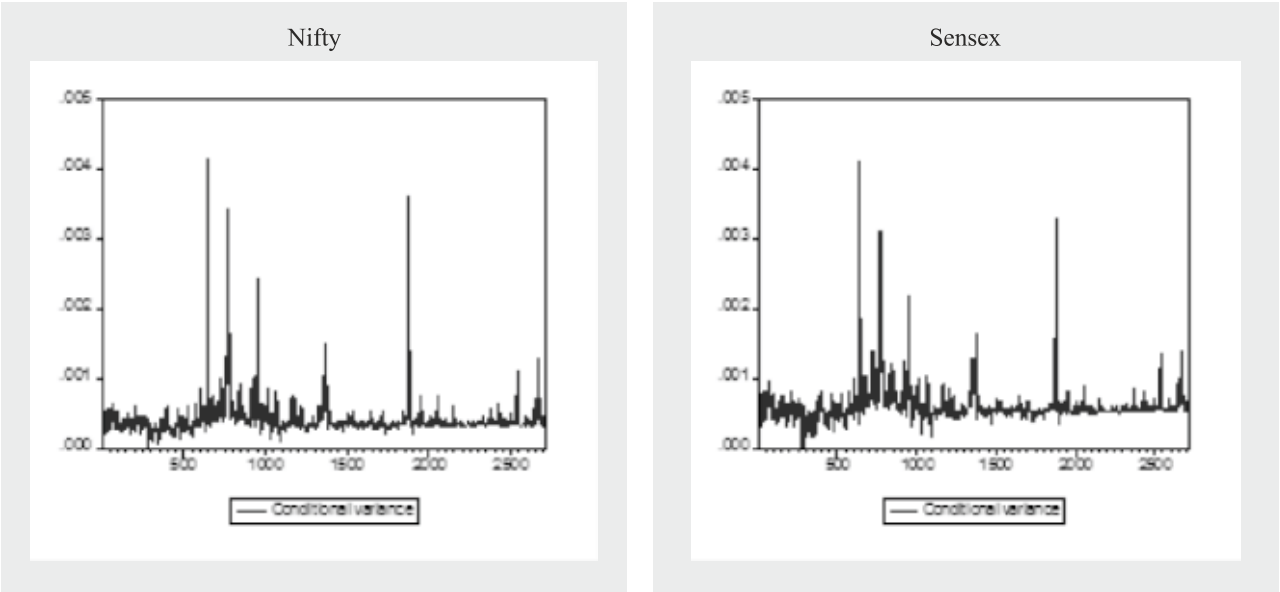


Figure 2 exhibits the conditional variance graph shows the periods of high volatility. Significant spikes can be observed in conditional variance of Nifty as well as Sensex.

Conclusion

With the growth in the FII and their enormous trades in the Indian bourses, market volatility has increased with time. Massive involvement of capital in FII's trades has generated interest of researcher to explore such substantial impact on stock market volatility. Empirical results also show that FII flows have significant impact on Indian stock market volatility for period of 10 years i.e. from 1st January 2001 to 31st December 2011. Descriptive statistics (kurtosis and skewness) and heteroskedsticity test for return series allow to use non linear model for analysis. By augmenting GARCH model, results depicted that tendency of volatility to increase more by FII outflows than by FII inflows. So, market regulator require to take stringent steps to control high fluctuation in prices due to FII outflows. There is need to further strengthened market surveillance and risk management practices using various criteria such as exit charges, lock in period etc. should be introduced, so as to take care of greater market uncertainty associated with an increase in the volume of trades by FII.

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