

ANALYZING THE VOLATILITY OF NSE RETURNS AND MODEL SELECTION: A GARCH-TARCH-EGARCH APPROACH

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Abstract

The Volatility of stock returns becomes vital to analyze considering the fluctuations occurring in Indian stock market. As market discounts everything, any event, incident or activity happening in Indian Economy gets reflected through these fluctuations. The present study attempts to analyze this volatility by selecting the appropriate model amongst GARCH, TARCH and EGARCH. The study also checked for the normality, Autocorrelation and Heteroscedasticity for the select data. For the purpose of the study daily returns are considered of Nifty 50 and returns of five randomly selected banks listed on Nifty 50. The present study also shows if there exists any significant impact of these bank stock returns on the Nifty 50 returns. All these stock returns are converted into log form for normality purpose. The period of the study is restricted to five years i.e. 2011-2015. The results evidenced that the returns are Homoscedastic and does not contain any Autocorrelation. Also there exists a significant impact of returns of banks on the Nifty 50 returns. The study also proved that to analyze the volatility of Nifty 50 returns, TARCH model is better than GARCH or EGARCH.

Key Words: Volatility, Model Selection, GARCH, TARCH, EGARCH

Introduction:

The return is normally the main factor for any investor to involve in any investment activity so as in the case of stocks. The return from a stock indicates both current income and capital gains generated by the appreciation of the stock. The income and capital gain are expressed as a percentage of money invested in the beginning. The historical returns or ex-post returns are derived from the cash flows received as well as the price changes that occur during the period of holding the stock or any asset. The income flow is the dividend an investor receives during the holding period. The period may be days, months, years or even just a single day. Usually this is presented in the form of percentages.

Annualized returns give the rate of return of a security or portfolio over a given period on an annual basis. Many times the rate of

return may be on a daily, weekly, monthly and quarterly basis. Yet the investor may need to know it on an annual basis. In such a case, the monthly or quarterly rate has to be converted into an annual rate of return. In finance, volatility is the degree of variation of a trading price series over time as measured by the standard deviation of returns. Historic volatility is derived from time series of past market prices. An implied volatility is derived from the market price of a market traded derivative. Stock Returns are subject to risk but now days there are many derivative instruments like futures, options, etc. for hedging the risk associated with such investments. These tools can also be utilized by many speculators for leverage and speculative purposes. Derivatives are used by many for arbitraging by utilizing the price discrimination between different markets. Hedging and Arbitraging don't give higher returns but do help in minimizing losses and in protecting the capital.

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Stock markets can be volatile, and the reasons particular stocks rise and fall can be complex. More often than not, stock prices are affected by a number of factors and events, some of which influence stock prices directly and others that do so indirectly. Developments that can occur within companies will affect the price of its stock, including mergers and acquisitions, earnings reports, the suspension of dividends, the development or approval of a new innovative product, the hiring or firing of company executives and allegations of fraud or negligence. Stock price movements will be most drastic when these internal developments are unexpected.

Company stock prices, returns and the stock market in general can be affected by world events such as war and civil unrest, natural disasters and terrorism. These influences can be direct and indirect, and they often occur in chain reactions. The social uncertainty and fear generated by the terrorist attacks on Sept. 11, 2001, affected markets directly as they caused many investors in the United States to trade less and to focus on stocks and bonds with less risk. An example of an indirect influence on markets is the announcement of a new military venture by a country in response to the outbreak of civil unrest or conflict abroad. This announcement likely would cause the price of the stocks of military equipment and weapons manufacturers to rise due to an expected increase in defense contracts, which in turn can raise the value of stocks for companies that supply military equipment parts and technology. It likely would raise the demand for, and price of, natural resources used to make these parts, which would raise the price of stocks representing particular mining and natural resource processing companies.

Review of Literature:

Du & Hu (2014) analysed the cross-sectional pricing power of foreign exchange volatility. For the purpose of study, the researchers decomposed the returns of US-Stock market into short run and long run

components. The study found the evidence that, the long run components of foreign exchange volatility is priced in US stock market.

Cao & Han (2013) provided a robust new study which showed that delta-hedged equity option return decreases monotonically with an increase in the idiosyncratic volatility of the underlying stock. The return volatilities of four metals i.e. copper, gold, platinum and silver were examined by **Cochram, Mansur & Odusami (2012)**. The study used the daily returns and the results showed that VIX is crucial in the determination of metal returns and return volatility.

Arouri, Lahiani & Nguyen (2011) investigated the volatility transmission and return links between stock markets and oil in the GCC countries. The period of study was 2005-2010. The researchers employed the GARCH Approach to analyse the return volatilities. The study found the evidence of existence of substantial return and volatility spillovers between oil prices and GCC stock markets.

Haniff & Pok (2010) used the GARCH, EGARCH, and TARARCH model to select the best model for volatility. The results showed that EGARCH produced consistently superior results to other GARCH models. **Ang, Hodrick, Xing & Zhang (2009)** found that stocks with recent past high idiosyncratic volatility has low future average returns around the world. Across 23 developed markets, the difference in average returns between the extreme quintile portfolios sorted on idiosyncratic volatility is -1.31% per month, after controlling for world market, size, and value factors. The effect is individually significant in each G7 country.

Arin, Ciferri & Spagnolo (2008) investigated the effects of terrorism on the financial markets. Evidence from six different financial markets showed that terror has a significant impact on both stock markets and the stock market volatility, and

the magnitudes of these effects were larger in emerging markets.

Objectives of the Study:

1. To find out the relationship between selected bank stock returns with the Nifty 50 returns.
2. To analyze the impact of selected bank stock returns on the Nifty 50 returns.
3. To test for normality, autocorrelation and heteroscedasticity using econometric modeling.
4. To select the most appropriate model amongst GARCH, TARARCH and EGARCH for analyzing the volatility of Nifty 50 returns.

Research Methodology:

The present study is an analytical attempt to find out the best appropriate model for analyzing volatility. Study also analyses the impact and association between selected bank stock returns with the Nifty 50 returns. For the purpose of the study the data relating to Nifty 50 Index and the selected banks have been extracted from the official website of National Stock Exchange. The data is purely secondary in nature. Also the study has been conducted for a period of 5 years i.e. 2011-2015. Random Sampling technique has been used to select the sample banks for the purpose of study. The banks include Axis Bank, Bank of Baroda, HDFC Bank, ICICI Bank and IndusInd Bank. The stock returns used for the present study are in Log Normal form. This is to ensure that the returns are normally distributed. The following formula have been used to calculate log normal returns: $\ln(P_0/P_1)$, where P_0 is the today's price and P_1 is the yesterday's price. The lognormal returns are calculated on daily basis. Hence the data analysed in the present study is in the nature of Time Series.

To analyze the impact of selected bank stock returns on the Nifty 50 returns multiple regression have been used using OLS model.

To find out the relationship between selected bank stock returns with the Nifty 50 returns, Karl Pearsons Correlation Matrix have been developed. The normality, autocorrelation and heteroscedasticity have been tested using econometric modeling and tests including Histogram-Normality Test, Breusch-Godfrey Serial Correlation LM Test and Heteroskedasticity Test: Glejser respectively. All the statistical and econometric analysis has been performed using the software E-Views.

Hypotheses Development:

Following hypotheses have been framed for the purpose of study:

Hypothesis 1

H0: There exists no significant impact of selected bank stock returns on the Nifty 50 returns.

H1: There exists a significant impact of selected bank stock returns on the Nifty 50 returns.

Hypothesis 2

H0: The data selected for the study is not normally distributed

H1: The data selected for the study is normally distributed

Hypothesis 3

H0: The data selected for the study is serially correlated (Autocorrelation)

H1: The data selected for the study is not serially correlated (No Autocorrelation)

Hypothesis 4

H0: The data selected for the study is Heteroscedastic

H1: The data selected for the study is Homoscedastic

Results and Discussion:

**Descriptive Statistics:
Table 1**

	NIFTY_50_RETURNS	AXIS_BANK_RETURN	BOB_RETURNS	HDFC_BANK_RETURN	ICICI_BANK_RETURN	INDUSIND_BANK_RETURNS
Mean	0.038369	-0.059975	-0.111885	-0.051894	-0.089626	0.130530
Std. Dev.	1.068698	5.114004	5.098779	4.823652	4.997754	2.206495
Skewness	-0.012360	-25.45750	-25.84490	-29.89796	-26.57137	-0.009141
Kurtosis	3.853782	804.9417	819.8867	995.6167	851.6744	4.414864

(Source: Compiled using E-views)

Interpretation:

The above table depicts the performance and variability for the select banks and Nifty 50 index in terms of the stock returns. The average returns of IndusInd Bank shows that it has performed better than Axis Bank, Bank of Baroda, HDFC Bank and ICICI Bank. Also the IndusInd bank returns have been superior to the Nifty 50 returns. Standard

deviation measures the variability of the data. Lower the variability is treated to be positive for the company. From the above analysis it can be seen that the IndusInd Bank have the lowest standard deviation as compared to Axis Bank, Bank of Baroda, HDFC Bank and ICICI Bank. But its variability has been more as compared to Nifty 50 Index.

Correlation Analysis:**Table 2**

	NIFTY_50_RETURNS	AXIS_BANK_RETURNS	BOB_RETURNS	HDFC_BANK_RETURNS	ICICI_BANK_RETURNS	INDUSIND_BANK_RETURNS
NIFTY_50_RETURNS	1.000000	0.326582	0.237744	0.225484	0.320163	0.613616
AXIS_BANK_RETURNS	0.326582	1.000000	0.080655	0.083824	0.134210	0.255605
BOB_RETURNS	0.237744	0.080655	1.000000	0.050031	0.096082	0.198008
HDFC_BANK_RETURNS	0.225484	0.083824	0.050031	1.000000	0.066647	0.157010
ICICI_BANK_RETURNS	0.320163	0.134210	0.096082	0.066647	1.000000	0.234571
INDUSIND_BANK_RETURNS	0.613616	0.255605	0.198008	0.157010	0.234571	1.000000

(Source: Compiled using E-views)

Interpretation:

The above Karl Pearsons Correlation Matrix shows the relationship between the returns of

Axis Bank, Bank of Baroda, HDFC Bank, ICICI Bank and IndusInd Bank with the Nifty 50 Index returns. The above results depict a positive relation of the selected



banks with the Nifty 50 index. This is justified as all the selected banks are listed on the Nifty 50 Index. IndusInd Bank reveals the highest relationship of 0.61 with the

Nifty 50 Index. The relationship of Bank, Bank of Baroda, HDFC Bank and ICICI Bank is 0.32, 0.23, 0.22 and 0.32 respectively.

Regression Analysis:

Table 3

Dependent Variable: NIFTY_50_RETURNS
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.016069	0.022481	0.714758	0.4749
AXIS_BANK_RETURNS	0.033356	0.004554	7.324049	0.0000
BOB_RETURNS	0.022041	0.004494	4.904728	0.0000
HDFC_BANK_RETURNS	0.026183	0.004713	5.555309	0.0000
ICICI_BANK_RETURNS	0.035217	0.004636	7.596457	0.0000
INDUSIND_BANK_RETURNS	0.239656	0.010995	21.79623	0.0000
Adjusted R-squared	0.457926	Durbin-Watson stat		2.028280

(Source: Compiled using E-views)

Interpretation:

The above analysis reflect whether the returns of Axis Bank, Bank of Baroda, HDFC Bank, ICICI Bank and IndusInd Bank have significant impact on the returns of Nifty 50 index or not. Following equation can be developed from the above output.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n$$

Thus,

$$\begin{aligned} \text{NIFTY_50_RETURNS} &= \beta_0 + \beta_1 \\ \text{AXIS_BANK_RETURNS} &+ \beta_2 \\ \text{BOB_RETURNS} &+ \beta_3 \\ \text{HDFC_BANK_RETURNS} &+ \beta_4 \\ \text{ICICI_BANK_RETURNS} &+ \beta_5 \\ \text{INDUSIND_BANK_RETURNS} &+ \mu \end{aligned}$$

For the purpose of the study the value of μ is assumed to be 0.

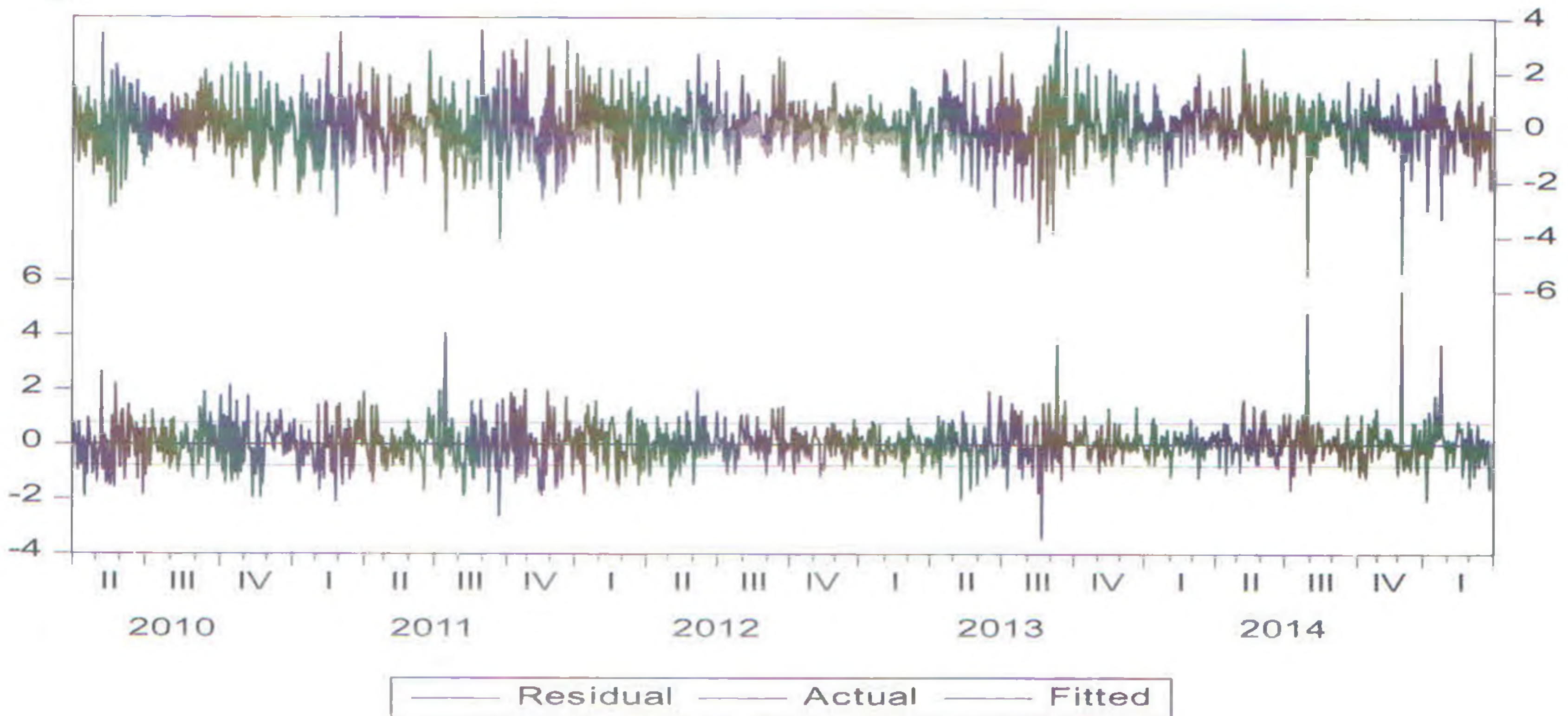
Hence the equation now will be,

$$\begin{aligned} \text{NIFTY_50_RETURNS} &= 0.01 + 0.03 \\ \text{AXIS_BANK_RETURNS} &+ 0.02 \end{aligned}$$

$$\begin{aligned} \text{BOB_RETURNS} &+ 0.02 \\ \text{HDFC_BANK_RETURNS} &+ 0.03 \\ \text{ICICI_BANK_RETURNS} &+ 0.23 \\ \text{INDUSIND_BANK_RETURNS} &+ \mu \end{aligned}$$

The results reveal that the beta coefficient is highest for the IndusInd Bank returns as compared to the other selected banks. This shows that a 1% change in Nifty 50 returns will have a 0.23% change in IndusInd Bank returns. This clearly shows the positive impact. The beta coefficient for Axis Bank, Bank of Baroda, HDFC Bank, and ICICI Bank have also been found positive. Also the statement can be evidenced using p-value. The p-value of IndusInd Bank returns, Axis Bank, Bank of Baroda, HDFC Bank and ICICI Bank is less than 0.05 at 5% level of significance. Thus the Null Hypotheses gets rejected. Hence there exists a significant impact of the returns of IndusInd Bank returns, Axis Bank, Bank of Baroda, HDFC Bank and ICICI Bank on the Nifty 50 returns.

Volatility Clustering
Figure 1



(Source: Compiled using E-views)

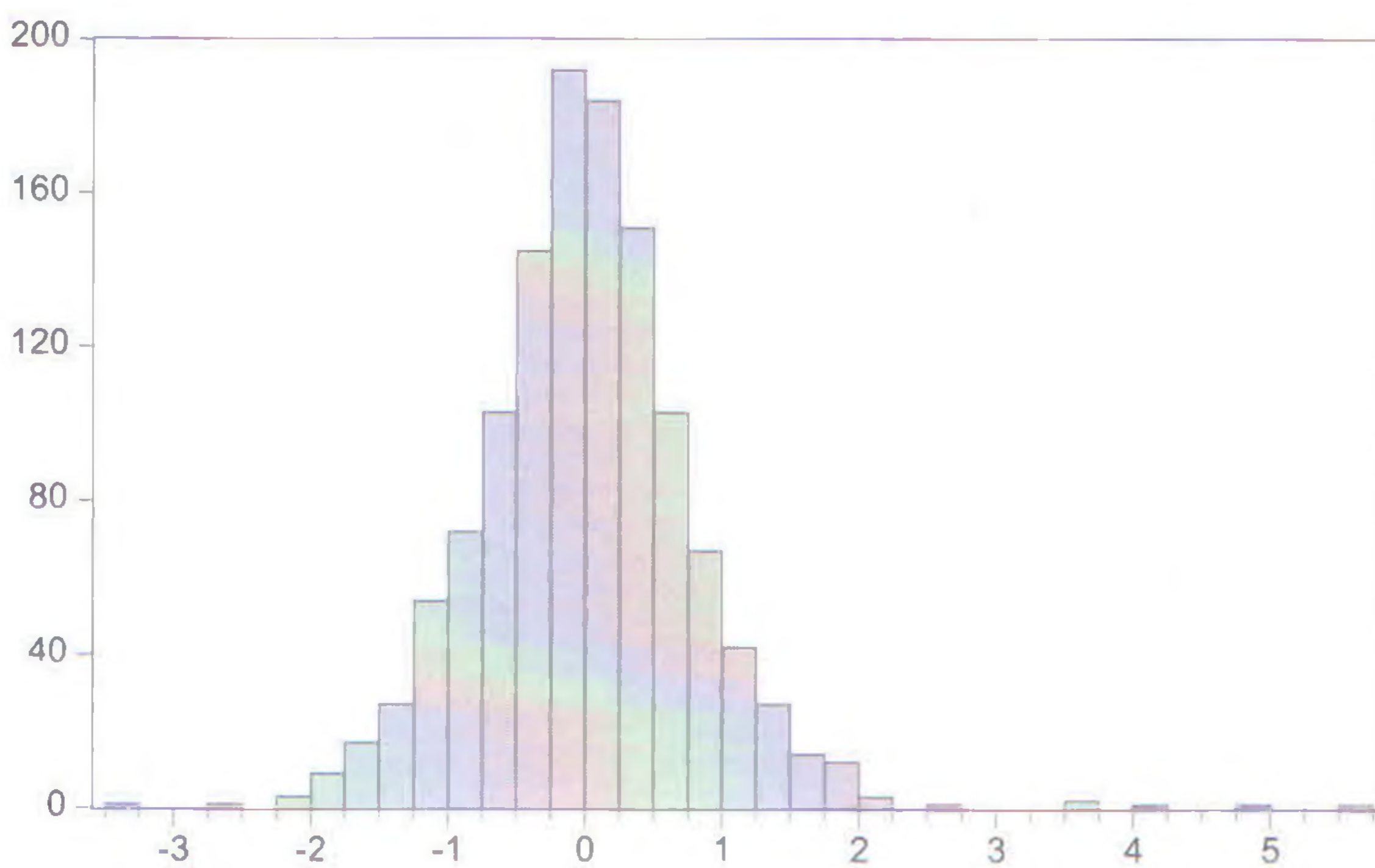
Interpretation:

The volatility clustering is one of the determinants to decide whether the ARCH, GARCH, TAR or EGARCH models can be used for the selected time series data. Volatility clustering can be identified when there are large fluctuations followed by large fluctuations for a smaller period of time and

small fluctuations are followed by small fluctuations for a larger period of time. From the above graph volatility clustering can be identified for said period of the study. The volatility being the highest for the years 2011 and 2013 and lowest for the year 2012. This gives a clear green signal to use any of the ARCH tests to measure the volatility.

Histogram- Normality Test

Figure 2



Series: Residuals	
Sample 4/01/2010 3/31/2015	
Observations 1233	
Mean	-5.87e-17
Median	-0.012730
Maximum	5.638663
Minimum	-3.431260
Std. Dev.	0.785237
Skewness	0.685150
Kurtosis	7.462641
Jarque-Bera	1119.609
Probability	0.000000

(Source: Compiled using E-views)

Interpretation:

The normality of data is very important for all types of statistical analysis. The present study found the probability value of 0.0000 using the Histogram Normality Test. The results reveal that as the p-value is less than 0.05 at 5% level of significance, thus the null

hypotheses is rejected. Hence it can be concluded that the data selected for the purpose of study relating to the returns of Axis Bank, Bank of Baroda, HDFC Bank and ICICI Bank, IndusInd Bank and the Nifty 50 returns is normally distributed. This also fulfills the assumption of normality of CLRM model.

Heteroskedasticity Test: Glejser**Table 4**

F-statistic	44.83061	Prob. F(5,1227)	0.0000
Obs*R-squared	190.4559	Prob. Chi-Square(5)	0.0000
Scaled explained SS	236.2626	Prob. Chi-Square(5)	0.0000

(Source: Compiled using E-views)

Interpretation:

The presence of Heteroscedasticity in any data is treated negatively. As per CLRM model the data should be Homoscedastic. The present study framed the necessary hypotheses to test the presence of

Heteroscedasticity in the data. The probability chi square value of 0.0000 reveals that the null hypothesis is rejected at 5% level of significance. Hence the data is Homoscedastic and fulfills the assumption of CLRM model.

Breusch-Godfrey Serial Correlation LM Test:**Table 5**

F-statistic	2.152090	Prob. F(8,1219)	0.0287
Obs*R-squared	17.17192	Prob. Chi-Square(8)	0.0284

(Source: Compiled using E-views)

Interpretation:

The Autocorrelation or Serial Correlation is one of the violations of CLRM (Classical Linear Regression Model). The residuals in the study should not be auto-correlated. The present study framed the following hypotheses to check if there exist autocorrelation in the data. From the

Breusch-Godfrey Serial Correlation LM test, the probability chi-square value is revealed to be 0.0284 which is less than 0.05 at 5% level of significance. Hence the Null Hypotheses is rejected. Thus the data selected for the study is not serially correlated. In other words, the data does not contain Autocorrelation.

Model Selection:**Table 6**

<i>Model</i>	<i>Akaike info criterion</i>	<i>Schwarz criterion</i>
ARCH	2.3662	2.3787
GARCH	2.3306	2.3679
TARCH	2.3162	2.3577
EGARCH	2.3174	2.3589

(Source: Compiled using E-views)

Interpretation:

The above results were obtained after regressing the dependent variable i.e. Nifty 50 returns with the independent variables i.e. the returns of Axis Bank, Bank of Baroda, HDFC Bank and ICICI Bank and IndusInd Bank with each of the model being the basic ARCH model, GARCH model, TARCH model and the EGARCH model. The Akaike info criterion and Schwarz criterion is used to choose among the best model of volatility for the time series data selected for the study. The model with lowest Akaike info criterion and Schwarz criterion value is treated to be the best model. The results evidenced that the Akaike info criterion value of 2.3162 and Schwarz criterion value of 2.3577 were found to be the lowest for TARCH model. Hence it can be concluded that for the time series data pertaining the selected bank returns and Nifty 50 returns, the TARCH model is most appropriate than basic ARCH, GARCH or EGARCH model.

Conclusion:

The return is normally the main factor for any investor to involve in any investment activity so as in the case of stocks. The Volatility of stock returns becomes vital to analyze considering the fluctuations occurring in Indian stock market. As market discounts everything, any event, incident or activity happening in Indian Economy gets reflected through these fluctuations.

The present study was an analytical attempt to find out the best appropriate model for

analyzing volatility. Study also analyzed the impact and association between selected bank stock returns with the Nifty 50 returns. For the purpose of the study the data relating to Nifty 50 Index and the selected banks had been extracted from the official website of National Stock Exchange. The data was purely secondary in nature. All these stock returns are converted into log form for normality purpose. The period of the study was restricted to five years i.e. 2011-2015. The results evidenced that the returns are Homoscedastic and does not contain any Autocorrelation. Also there exists a significant impact of returns of banks on the Nifty 50 returns. The study also proved that to analyze the volatility of Nifty 50 returns, TARCH model is better than GARCH or EGARCH. The present study is in contrast with Haniff & Pok (2010) where EGARCH provided superior results. But this can be justified as the data selected by Haniff & Pok and also the methodology varies from the present study.

As the data selected for the present study is restricted to only 5 years and also only few banks were selected, this can act as one of the limitation of the study. Also the study only attempts to select the best model amongst GARCH, EGARCH and TARCH and does not interpret these models. Hence these exist an ample scope of further research.

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