

## Modelling Volatility of Daily Stock Returns: Evidence from Select Banking and Finance Companies in India

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### Abstract

This study empirically explores the volatility pattern of NSE listed banking and finance companies based on time series dataset taking into consideration of daily closing adjusted stock price from 2001-02 to 2015-16. The objective of this paper is to study volatility design of daily stock returns. The application of GARCH, T-GARCH models provides the evidence of the persistence of time varying asymmetric volatility. Time based volatility behaviour of Indian stock market happened due to recent global financial meltdown which is originated from US sub-prime crisis. Also, effect captured by different models show that negative shocks have significant effect on conditional volatility.

**Key Words:** Asymmetric volatility, Conditional volatility, financial meltdown

**JEL Classification:** C32, C53, G28

### 1. Introduction

Volatility measures the changing amount of uncertainty or risk in securities price. It is becoming crucial and important due to growing linkages of national market in currency, different economic events, commodity and stocks with rest of the world markets. Exotic of capital market always needs with high macro fundamentals like relevant corporate information. After liberalization, privatization and globalization, financial markets have entered into a new segment of global integration and liberalization with lots of new and innovative financial instruments like derivatives, etc. Derivative trading in India have started to control over the fluctuations in the stock and commodity prices. It also regarded that now a days the trading volume in the stock market and cash flows in India are increasing (Yadav, 2016). After the liberalization, privatization and globalization, volatility has become an important area and it has gained attention from academicians, researchers and others stakeholders. Stock return volatility is variability in stock price returns which is usually measured by standard deviation

(S.D.) of the stock price returns. For the benefit of research, we have done log transformation of stock price return series. Volatility is considered superior returns and higher volatility due to risk (Kumar, 2016). Stock price returns are essentially non-linear system in nature, because it derives from a stochastic process. However, past researchers have used both linear and non-linear model. Modelling volatility are beneficial due to several reasons such as investment decision making, assets pricing calculation, expected returns calculation etc. There are different divisional properties in case of financial time series, such as leptokurtosis and volatility (Tsay, 2016). As volatility is not apparent, it throws a challenge both for Autoregressive conditional heteroskedasticity (ARCH) as well as Generalized Autoregressive conditional heteroskedasticity (GARCH) model and searching right model of ARCH and GARCH model become matter of crucial significance. Searching exact set of reasons of stock returns volatility out of huge no of observable and as well as unobservable variables namely e.g., changes in economic policy situation, different shocks in the capital market, psychological facts and different rumors which are not easily observable. Against this backdrop, the paper seeks to quantify stock returns volatility of select stock of NSE listed banking sector companies using daily adjusted closing stock price return.

## **2. Past studies and Research Gap**

Researchers and scholars across the globe have contributed in the study of measurement of stock returns volatility of select companies long time since. A few of such representative works are reviewed in this segment. In one of the earlier studies, Ali (2016) in his research paper '*Stock market volatility and returns: A study of NSE & BSE in India*' has examined relationship between returns and volatility and persistence of volatility in Indian stock market. This study shows that there exists a significant presence of volatility clustering and degree of volatility in daily return series and existence of leverage effect indicating that negative shocks or bad news have more impact on volatility than the positive shocks or good news this study also exhibits that the relation between returns and volatility at the return series were statistically insignificant. Bhowmik (2013) in the research paper '*Stock market volatility: An evaluation*' has proposed a descriptive study on stock market volatility in Indian stock exchanges and used seven case studies. He emphasized on political factors behind volatility and attempted to relate economic growth with stock market volatility in the long run process after reviewing a few econometric models and concludes that political instability and depression catapulted the stock market volatility. Banumathy et al. (2015) in the research paper '*Modelling stock market volatility: Evidence from India*' have studied volatility pattern of Indian stock market based on index data using both symmetric and asymmetric models. The study has also argued that

increased risk did not increase the returns. Eryilmaz (2015) in the research paper '*Modelling stock market volatility: The case of BIST – 100*' has investigated stock return volatility for BIST –100 indices. He has divided study period into three different time periods using ARCH, GARCH, EGARCH and TGARCH models. According to this study, most suitable volatility model for return series is EGARCH (1,1) and negative news have more effect to the stock market. Kumar (2009) in the research paper '*Volatility in the Indian Stock Market: A Case of Individual Securities*' has investigated volatility in the individual stocks listed at NSE using daily closing prices of 29 selected companies from the S&P NIFTY from 1996- 97 to 2006 - 07. Major findings are negative stock returns during 2000-01 followed by 2002-03, 2006-07 and 1998-99. Particularly 1999-00 has been highly volatile year for 20 securities out of 29 securities followed by 1998-99, 2000- 01 and 1997-98. Kumar & Singh (2014) in the research paper '*Volatility modeling, seasonality and risk return relationship in GARCH- in- mean framework: the case of Indian stock and commodity markets*' have examined volatility and seasonality in Indian stock and commodity markets. Their study concluded that stock returns have shown persistence in the volatility clustering and asymmetric properties. Also, concluded that conditional volatility structure GARCH (1, 1) is found to be more appropriate. Padhi (2006) in the research paper '*Stock Market Volatility in India: A Case of Select Scripts*' has investigated that market volatility at the individual script level and at the indices level to know how volatility changes in the same trend or it varies across the sectors and conducted that LM test is using to confirm the presence of ARCH effect. Different ARCH coefficients are found for different indices at different lag values and argued that many sectors showing the same trend for volatility characteristics. Naveen & Mallikarjunappa (2016) in the research paper '*A study on comparative analysis of risk and return with reference to stocks of CNX BANK NIFTY*' have examined the banking sector securities risk and return and their volatility. The study has initiate that some stocks move in the opposite direction to the market, some stocks move along with the market, some stock are less risky compared to the market and some stocks are riskier compared to the market. A few studies identify the reasons and factors for volatility in Indian stock market as well as different risk factors associated with sectorial indices and such volatility is how much important in Indian future stock indices market. Other studies have explored the relationship between return of the securities and market return like different indices and their co – movement.

In addition to previous studies, there is a need for further study on measurement of stock returns volatility in order to have perception of different companies listed in major stock exchanges in India like NSE and to explore how volatility of individual script changes with respect to

different time period in respect to different economic policies, incident, etc. and underlying different factors and shocks which can affect individual securities. Keeping in mind of this research gap, specific objectives of the current study are set.

### **3. Objectives**

The objectives of the present study are:

- (i) To study the stock returns volatility property of select stock of NSE listed banking sector companies using descriptive statistics;
- (ii) To know the presence of volatility in sample companies daily return series using ARCH (1) model;
- (iii) To analyse volatility in select NSE listed companies using GARCH and TGARCH Model.

### **4. Research Methodology**

#### ***Sample Design and Sources of data***

This study is considering fifteen years secondary data (daily closing adjusted prices) acquire from Capitaline corporate database from 2001-02 to 2015-16. Judgemental sampling has been used to investigate the volatility of select companies as sample for the study. With a focus on designing sample, at first market capitalisation has taken as parameter for sample selection and one sector namely banking and finance include of 18 companies are taken into reflection as final sample for this study.

#### ***Period of Study***

In our study, we have considered major financial changes in the global financial meltdown phenomena such as e.g., global financial crisis, rupee value uncertainty, US sub-prime crisis, borrowing price bubble in US financial markets etc. The total study period has been divided into two parts: pre-recession period (2001-2002 to 2006-2007) and post-recession period (2007-2008 to 2015-2016). The entire analysis has been conducted during 2001-2002 to 2006-2007, 2007-2008 to 2015-2016 and 2001-02 to 2015-16.

#### ***Statistical and Econometrics tools***

*Descriptive statistics:* Within the sphere of descriptive statistics, we have used mean, S.D., variance, skewness and kurtosis. The Jarque-Bera test is usually used to know whether normality exists in the data set.

*Test of Stationarity:* In order to persuade the fundamental situation time series econometrics, there is always need for testing unit root. In this paper Augmented Dickey-Fuller (ADF) test is used to know the Stationarity level. In general, the approaches to unit root test are

$$Y_t = D_t + Z_t + \varepsilon_t$$

Where,  $D_t$  is known the deterministic component;  $Z_t$  is also known the stochastic component and  $\varepsilon_t$  meant stationary error process. ADF test consists following regression equation:

$$\nabla Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^m \alpha_i \nabla Y_{t-1} + \varepsilon_t$$

Where  $\varepsilon_t$  are used as a pure noise error with the number of lagged differences. The main summary based on this test is known the ADF is statistically significant at 5% level or not. This specifies to reject null hypothesis and accept that the data series returns are stationary; hence, it is mean reverting and confirms the non-existence of autocorrelation.

*Test for Heteroscedasticity:* In order to know heteroscedasticity of our dataset, we have used ARCH model. ARCH model:  $\sigma_t^2 = a_0 + \sum_{i=1}^q a_i U_{t-1}^2$  (Where  $a_0$  is mean and  $a_1$  is conditional volatility and  $U_{t-1}$  is white noise representing residual of time series).

*Volatility Measurement Technique:*

*GARCH Model*

In this study, we have used GARCH (1, 1) model which is more superior to ARCH model. It happens both lagged squared residuals and lagged variances. This model is considered as generalized ARCH exercise to see the squared volatility ( $\sigma_t^2$ ) of the concerned time period is allowed to depend on previous squared volatilities, as well as previous squared values of the process.

Mean equation:  $r_t = \mu + \varepsilon_t$  and Variance equation:  $\sigma_t^2 = \alpha + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2$

Where  $\alpha > 0$ ,  $\alpha_1 > 0$ ,  $\beta_1 > 0$ , and  $r_t$  is expressed as the return of the asset at the time t,  $\mu$  is the average return, and  $\varepsilon_t$  is the residual return and estimate ( $\beta$ ) shows the persistence of volatility of a shock.

*TGARCH model*

Again, TGARCH model is used to express positive and negative shocks of equal magnitude have a different impact on stock returns volatility, which may be describe to a ‘leverage effect’.

The conditional variance for the simple TGARCH model is defined follows-

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^s (\alpha_i + \gamma_i N_{t-1}) a_{t-1}^2 + \sum_{j=1}^m \beta_j \sigma_{t-j}^2$$

Where  $N_{t-1}$  is known as negative indicator,  $a_{t-1}$  and  $\alpha_i, \gamma_i, \text{ and } \beta_j$  are used nonnegative parameter fulfilling conditions similar to those of GARCH model. This model also considers zero as its threshold to separate the impact of past shocks.

## **5. Results and Discussion**

An important observation in our article is in relation to changes squeeze from pre to post global financial recession. Mean returns of selected stock price are establish almost low in all three study periods. S.D. and variances of stock price return series are beginning to be low but significant in pre-global financial recession period (shown in Table – 1.11) and the standard deviation of return is found to be significant (3.4% S.D. in case of Kotak Mahindra Bank) during the pre-global financial meltdown period, which is comparatively lower than other study periods (Post global financial recession period and overall period). The null hypothesis (Ho: Return series are normal) of JB test was rejected for all cases and does not follow a normal distribution. Normality test results exhibited in Table 1.21.

### *Test of Stationarity*

The summary of ADF tests at level are shown in Table- 1.31. We have studied the complete dataset are Stationary for all select companies return data series as test statistics is lower than all critical values.

### *ARCH test*

In our investigation about heteroscedasticity of stock price return series of eighteen stocks, we found ARCH effect in all stock during pre global financial recession time period shown in Table- 1.41. However, the same test is conducted during post global recession period exhibited non existence of heteroscedasticity only in State Bank of India (SBIN) and Bajaj Holdings stock price return series, which supports presence of ARCH effects in the residuals.

### *GARCH test*

During pre-global financial recession period, the highest and lowest ARCH and GARCH combined effect was found to be .984 (Federal Bank script return series) and .757 (ICICI Bank script return series), while such values of seven companies in banking and financial sector are near to one during post global financial recession period. Again, in overall study period, average value of ARCH and GARCH are ranges between .992 and .798. Out of eighteen companies seventeen companies' average value of ARCH and GARCH is unity shown in 1.71. This result apparently points out that global financial meltdown shocks have persistent for future periods.

*T-GARCH test*

T-GARCH model is run on daily stock return series to understand the asymmetric coefficient effect. After conducting TGARCH test during different study period and in different dataset. Test results concluded that coefficient of leverage ( $\gamma$ ) is positive in maximum scripts returns series. It is also noticed that negative shocks or bad news have a greater effect on the conditional variance than the positive shocks or good news;

**6. Conclusions**

Housing price bubble in USA in 2008 was one of the major findings for financial meltdown around the world over time. Its effect has been found not only in all segment of financial markets but also in every outlook of socio-economic life. Measurement of volatility is important for determining cost of capital for financial assets, also for leverage and investment. There has been a matter of time varying volatility from stock price return of select companies that exhibited the sign of clustering, high persistence, and predictability in India stock market. The other important result is that returns acknowledge differently to the arrival of negative and positive shocks. The primary empirical findings of bank and financial stock price return series are far from normality. In maximum cases in GARCH (1, 1) model, the sum of the coefficient ( $\alpha + \beta$ ) is near to one, which suggest that the volatility is highly persistent. The coefficient ( $\gamma$ ) measures TGARCH asymmetry or leverage parameter has exhibited that only four companies under banking and financial sector are found negative effect. According to TGARCH model in financial time series, it is concluded that good news has an impact on ARCH term, while bad news has impact on ARCH as well as GARCH term.

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Tables

**Table – 1.11**  
**Descriptive Statistics results of Daily Adjusted Return**

Company Name	Pre -Global recession Period				Post -Global recession Period			
	Mean	S. D.	Kurtosis	Skewness	Mean	S. D.	Kurtosis	Skewness
SBIN	0.001	0.022	6.13	-0.27	0.0042	0.19	2112.02	45.27
Kotak Mah. Bank	0.002	0.034	9.03	0.86	0.0011	0.027	8.35	0.075
Federal Bank	0.002	0.03	9.79	0.52	0.0007	0.023	5.82	0.2
Oriental Bank	0.001	0.029	9.93	-0.016	0.0001	0.03	5.23	0.14
HDFC Bank	0.001	0.021	19.38	0.81	0.0009	0.02	8.16	0.45
ICICI Bank	0.001	0.025	6.07	0.18	0.0005	0.028	8.84	0.26
IDBI Bank	0.001	0.035	8.62	0.52	0.0003	0.02	7.5	0.25
Corporation Bank	0.0009	0.028	7.67	0.43	6.47	0.022	7.9	0.4
Bank of Baroda	0.0011	0.031	7.87	0.09	0.0009	0.026	8.65	0.71
Axis Bank	0.0022	0.03	8.24	0.6	0.001	0.027	6.62	0.35
Syndicate Bank	0.0014	0.029	9.53	0.41	0.0004	0.026	5.81	0.02
Bank of India	0.0022	0.032	6.61	0.35	0.0002	0.03	7.38	0.357
<i>Bajaj Holdings</i>	0.0007	0.026	176.55	-7.37	0.0002	0.026	149.6	-5.94
<i>H D F C</i>	0.0013	0.022	6.67	0.33	0.0008	0.024	9.58	0.68
<i>Max Financial</i>	0.0017	0.033	9.73	1.21	0.0005	0.027	10.08	0.1
<i>Sundaram Finance</i>	0.0013	0.025	10.86	1.09	0.0013	0.02	7.46	0.53
<i>Reliance Capital</i>	0.002	0.033	8.92	0.21	0.0003	0.034	7.81	0.22
<i>Bajaj Fin.</i>	0.0013	0.029	9.93	0.82	0.0016	0.027	13.33	1.11

Source: Compilation of Stock price returns data using EViews 8.0

Table- 1.21

Descriptive Statistics and Normality Test results of Daily Adjusted Return

Company Name	Overall Period				Normality Test Result			
	Mean	S. D.	Kurt- osis	Skewness	J-B	Prob	Decision Rule – Ho Rejected when P value <5% (Ho: Return series are normal)	Data series normality
SBIN	0.003	0.147	3477	57.86	1.88	.000	Rejected	Not normal
Kotak Mah. Bank	0.0019	0.03	10.03	0.48	7984.7	.000	Rejected	Not normal
Federal Bank	0.0013	0.027	9.4	0.48	6411.1	.000	Rejected	Not normal
Oriental Bank	0.0006	0.029	7.48	0.091	3137	.000	Rejected	Not normal
HDFC Bank	0.001	0.0202	16.12	0.65	3.94	.000	Rejected	Not normal
ICICI Bank	0.0008	0.026	8.22	0.26	4295.6	.000	Rejected	Not normal
IDBI Bank	0.0007	0.031	8.6	0.52	5070.4	.000	Rejected	Not normal
Corporation Bank	0.0004	0.024	8.56	0.49	4961.6	.000	Rejected	Not normal
Bank of Baroda	0.001	0.028	8.95	0.38174	5626.8	.000	Rejected	Not normal
Axis Bank	0.0016	0.028	8.05	0.51	4140.7	.000	Rejected	Not normal
Syndicate Bank	0.0009	0.027	8.08	0.2	4311.1	.000	Rejected	Not normal
Bank of India	0.001	0.3	6.79	0.31	2308.5	.000	Rejected	Not normal
<i>Bajaj Holdings</i>	0.0008	0.024	130.8	-4.62	255651	.000	Rejected	Not normal
<i>H D F C</i>	0.001	0.022	9.19	0.63	6217.6	.000	Rejected	Not normal
<i>Max Financial</i>	0.0012	0.03	10.98	0.87	10413. 6	.000	Rejected	Not normal
<i>Sundaram Finance</i>	0.0013	0.022	10.88	0.98	10266. 8	.000	Rejected	Not normal
<i>Reliance Capital</i>	0.001	0.033	8.55	0.27	4844.4	.000	Rejected	Not normal
<i>Bajaj Fin.</i>	0.0019	0.028	11.92	1.07	13069. 9	.000	Rejected	Not normal

Source: Compilation of Stock price returns data using EViews 8.0

Table- 1.31

Stationarity Test Results using Augmented Dickey Fuller (At Level)

Compa nies Name	Intercept		Intercept & Trend		None		Decision Rule (Test statistics value is more negative than critical value, then we reject Null Hypothesis)	Decision on Ho (Ho: Unit root in Data series)	Data series stationarity
	Test Statistics	C.V. (5%)	Test Statis tics	C.V. (5%)	Test Statis tics	C.V. (5%)			
SBIN	-67.48	-2.86	-67.48	-3.41	-67.46	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
Kotak Mah. Bank	-26.96	-2.86	-27.04	-3.41	-56.04	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
Federal Bank	-18.09	-2.86	-18.21	-3.41	-17.85	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
Oriental Bank	-19.23	-2.86	-19.34	-3.41	-19.19	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
HDFC Bank	-27.78	-2.86	-27.78	-3.41	-30.06	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
ICICI Bank	-27.78	-2.86	-27.29	-3.41	-27.19	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
IDBI Bank	-19.09	-2.86	-19.11	-3.41	-19.05	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series	Stationary series

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								do not have any unit root	
Corporation Bank	-56.89	-2.86	-56.93	-3.41	-56.88	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
Bank of Baroda	-18.68	-2.86	-18.71	-3.41	-19.03	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
Axis Bank	-44.75	-2.86	-44.55	-3.41	-59.47	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
Syndicate Bank	-30.21	-2.86	-43.89	-3.41	-30.15	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
Bank of India	-28.35	-2.86	-26.45	-3.41	-28.27	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
<i>Bajaj Holdings</i>	-14.21	-2.86	-14.25	-3.41	-14.06	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
<i>H D F C</i>	-26.96	-2.86	-26.98	-3.41	-26.66	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
<i>Max Financial</i>	-22.6	-2.86	-22.62	-3.41	-22.47	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series

<i>Sundaram Finance</i>	-61.01	-2.86	-61.01	-3.41	-60.8	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
<i>Reliance Capital</i>	-33.99	-2.86	-34.02	-3.41	-33.94	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series
<i>Bajaj Fin.</i>	-59.9	-2.86	-59.89	-3.41	-59.64	-1.94	More negative test statistics (P=0.000)	Ho rejected & Return series do not have any unit root	Stationary series

Source: Compilation of Stock price returns data using EViews 8.0

**Table- 1.41**

**ARCH Test for Heteroskedasticity (Pre -Global recession Period)**

<b>Banking and Finance Companies</b>	<b>F-statistic</b>	<b>Prob. F</b>	<b>Obs* R-squared</b>	<b>Prob. Chi-Square</b>	<b>Decision on Ho</b> (Null hypothesis of homoskedasticity of residuals is rejected if P-Value<0.05)	<b>ARCH effects are present or not</b>
SBIN	222.6	0.000	194.09	0.000	Rejected	ARCH effects are present
Kotak Mah. Bank	162.53	0.000	146.83	0.000	Rejected	ARCH effects are present
Federal Bank	232.78	0.000	200.63	0.000	Rejected	ARCH effects are present
Oriental Bank	596.03	0.000	427.11	0.000	Rejected	ARCH effects are present
HDFC Bank	382.1	0.000	304.93	0.000	Rejected	ARCH effects are present
ICICI Bank	169.94	0.000	152.85	0.000	Rejected	ARCH effects are present

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IDBI Bank	152.48	0.000	138.59	0.000	Rejected	ARCH effects are present
Corporation Bank	68.57	0.000	65.66	0.000	Rejected	ARCH effects are present
Bank of Baroda	448.17	0.000	345.53	0.000	Rejected	ARCH effects are present
Axis Bank	92.27	0.000	87.04	0.000	Rejected	ARCH effects are present
Syndicate Bank	90.82	0.000	85.75	0.000	Rejected	ARCH effects are present
Bank of India	124.02	0.000	114.7	0.000	Rejected	ARCH effects are present
<i>Bajaj Holdings</i>	23.93	0.000	23.59	0.000	Rejected	ARCH effects are present
<i>H D F C</i>	55.32	0.000	55.43	0.000	Rejected	ARCH effects are present
<i>Max Financial</i>	74.46	0.000	71.03	0.000	Rejected	ARCH effects are present
<i>Sundaram Finance</i>	166.12	0.000	149.67	0.000	Rejected	ARCH effects are present
<i>Reliance Capital</i>	52.56	0.000	50.85	0.000	Rejected	ARCH effects are present
<i>Bajaj Fin.</i>	36.78	0.000	35.95	0.000	Rejected	ARCH effects are present

Source: Compilation of Stock price returns data using EViews 8.0

**Table- 1.51**

ARCH Test for Heteroskedasticity (Post -Global recession Period)

<b>Banking and Finance Companies</b>	<b>F-statistic</b>	<b>Prob. F</b>	<b>Obs* R-squared</b>	<b>Prob. Chi-Square</b>	<b>Decision on Ho</b> (Null hypothesis of homoskedasticity of residuals is rejected if P-Value<0.05)	<b>ARCH effects are present or not</b>
SBIN	.00044	.983	.00044	.983	Accepted	No ARCH effects

Kotak Mah. Bank	120.13	.000	114.09	.000	Rejected	ARCH effects are present
Federal Bank	39.19	.000	38.55	.000	Rejected	ARCH effects are present
Oriental Bank	36.76	.000	36.20	.000	Rejected	ARCH effects are present
HDFC Bank	34.75	.000	34.25	.000	Rejected	ARCH effects are present
ICICI Bank	164.72	.000	15.51	.000	Rejected	ARCH effects are present
IDBI Bank	213.08	.000	194.65	.000	Rejected	ARCH effects are present
Corporation Bank	33.68	.000	33.21	.000	Rejected	ARCH effects are present
Bank of Baroda	58.80	.000	57.34	.000	Rejected	ARCH effects are present
Axis Bank	130.50	.000	123.39	.000	Rejected	ARCH effects are present
Syndicate Bank	36.11	.000	35.62	.000	Rejected	ARCH effects are present
Bank of India	29.47	.000	29.11	.000	Rejected	ARCH effects are present
<i>Bajaj Holdings</i>	1.85	.1736	1.85	.173	Accepted	No ARCH effects
<i>H D F C</i>	37.05	.000	36.48	.000	Rejected	ARCH effects are present
<i>Max Financial</i>	27.33	.000	27.03	.000	Rejected	ARCH effects are present
<i>Sundaram Finance</i>	164.57	.000	153.38	.000	Rejected	ARCH effects are present
<i>Reliance Capital</i>	40.61	.000	39.92	.000	Rejected	ARCH effects are present
<i>Bajaj Fin.</i>	146.60	.000	137.67	.000	Rejected	ARCH effects are present

Source: Compilation of Stock price returns data using EViews 8.0

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**Table- 1.61**

ARCH Test for Heteroskedasticity (Overall Period)

<b>Banking and Finance Companies</b>	<b>F-statistic</b>	<b>Prob. F</b>	<b>Obs* R-squared</b>	<b>Prob. Chi-Square</b>	<b>Decision on Ho</b> (Null hypothesis of homoskedasticity of residuals is rejected if P-Value<0.05)	<b>ARCH effects are present or not</b>
SBIN	.00025	.98	.000256	.98	Accepted	No ARCH effects
Kotak Mah. Bank	331.17	0.000	304.34	0.000	Rejected	ARCH effects are present
Federal Bank	438.65	0.000	392.02	0.000	Rejected	ARCH effects are present
Oriental Bank	496.03	0.000	438.05	0.000	Rejected	ARCH effects are present
HDFC Bank	507.99	0.000	447.35	0.000	Rejected	ARCH effects are present
ICICI Bank	306.28	0.000	283.20	0.000	Rejected	ARCH effects are present
IDBI Bank	370.28	0.000	337.03	0.000	Rejected	ARCH effects are present
Corporation Bank	131.50	0.000	127.09	0.000	Rejected	ARCH effects are present
Bank of Baroda	488.39	0.000	432.09	0.000	Rejected	ARCH effects are present
Axis Bank	232.30	0.000	218.80	0.000	Rejected	ARCH effects are present
Syndicate Bank	173.29	0.000	166.15	0.000	Rejected	ARCH effects are present
Bank of India	119.40	0.000	115.76	0.000	Rejected	ARCH effects are present
<i>Bajaj Holdings</i>	4.75	.029	4.75	.029	Accepted	No ARCH effects
<i>H D F C</i>	77.76	0.000	76.22	0.000	Rejected	ARCH effects are present



<i>Max Financial</i>	134.13	0.000	129.54	0.000	Rejected	ARCH effects are present
<i>Sundaram Finance</i>	386.04	0.000	349.94	0.000	Rejected	ARCH effects are present
<i>Reliance Capital</i>	202.49	0.000	192.17	0.000	Rejected	ARCH effects are present
<i>Bajaj Fin.</i>	80.77	0.000	79.09	0.000	Rejected	ARCH effects are present

Source: Compilation of Stock price returns data using EViews 8.0

**Table-1.71 (GARCH Model)**

Company Name	Estimated Model with values				AIC	SIC	Log Likelihood	Decision (Decision Rule: Volatility of shocks is highly persistence when $\alpha_j + \beta_i = 1$ )
<b>First Period - Coefficients - GARCH (1, 1)</b>								
<b>Banking and Finance Sector</b>	$\alpha_0$	$\alpha_1$	$\beta_1$	$\alpha_j + \beta_i$				
State Bank of India	1.74	.088	.875	.963	-4.96	-4.94	3734.3	Very high persistence value
Kotak Mah. Bank	.0001	.227	.617	.844	-4.14	-4.12	3118.7	Comparatively low persistence value
Federal Bank	.0001	.163	.736	.899	-4.24	-4.22	3064.6	Comparatively low persistence value
Oriental Bank	2.22	.164	.820	.984	-4.58	-4.56	3451.7	Very high persistence value
HDFC Bank	4.44	.150	.748	.898	-5.02	-5.00	3780.4	Comparatively low persistence value
ICICI Bank	.0001	.178	.579	.757	-4.64	-4.62	3495.6	Comparatively low persistence value
IDBI Bank	.0001	.179	.675	.854	-4.05	-4.03	3050.4	Comparatively low persistence value
Corporation Bank	6.11	.161	.776	.937	-4.42	-4.40	3327.8	Comparatively low persistence value

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Bank of Baroda	4.68	.132	.821	.953	-4.29	-4.27	3229.4	Very high persistence value
Axis Bank	.0001	.143	.686	.829	-4.27	-4.25	3214.4	Comparatively low persistence value
Syndicate Bank	7.24	.188	.739	.927	-4.43	-4.41	3335.9	Comparatively low persistence value
Bank of India	.0001	.192	.645	.837	-4.18	-4.16	3148.2	Comparatively low persistence value
<i>Bajaj Holdings</i>	7.62	.121	.691	.812	-5.01	-5.00	3775.8	Comparatively low persistence value
<i>H D F C</i>	4.44	.150	.748	.898	-5.02	-5.00	3780.4	Comparatively low persistence value
<i>Max Financial</i>	6.90	.149	.802	.951	-4.13	-4.11	3113.8	Very high persistence value
<i>Sundaram Finance</i>	.0001	.209	.624	.833	-4.63	-4.61	3463.9	Comparatively low persistence value
<i>Reliance Capital</i>	.0001	.180	.682	.862	-4.29	-4.28	3236.0	Comparatively low persistence value
<i>Bajaj Fin.</i>	.0001	.223	.554	.777	-4.39	-4.34	3291.8	Comparatively low persistence value
<b>Second Period - Coefficients - GARCH (1, 1)</b>								
Kotak Mah. Bank	5.39	.063	.927	.99	-4.71	-4.70	5260.0	Very high persistence value
Federal Bank	1.04	.054	.927	.981	-4.73	-4.72	5287.4	Very high persistence value
Oriental Bank	.0001	.131	.685	.816	-4.21	-4.20	4702.5	Comparatively low persistence value
HDFC Bank	1.63	.046	.949	.995	-5.29	-5.28	5906.7	Very high persistence value
ICICI Bank	9.05	.067	.919	.986	-4.62	-4.60	5158.8	Very high persistence value
IDBI Bank	1.51	.089	.895	.984	-4.38	-4.37	4895.4	Very high persistence value
Corporation Bank	9.47	.080	.903	.983	-4.95	-4.94	5532.1	Very high persistence value
Bank of Baroda	2.66	.112	.856	.968	-4.54	-4.53	5071.2	Very high persistence value

IndusInd Bank	5.72	.073	.920	.993	-4.54	-4.53	5070.4	Very high persistence value
Axis Bank	1.23	.088	.894	.982	-4.58	-4.57	5118.3	Very high persistence value
Syndicate Bank	3.31	.069	.885	.954	-4.45	-4.44	5530.0	Very high persistence value
Bank of India	3.07	.123	.848	.971	-4.30	-4.29	4808.5	Very high persistence value
<i>H D F C</i>	4.47	.056	.934	.99	-4.90	-4.89	5475.6	Very high persistence value
<i>Max Financial</i>	3.35	.109	.851	.96	-4.51	-4.50	5039.0	Very high persistence value
<i>Sundaram Finance</i>	6.56	.188	.649	.837	-5.12	-5.11	5715.1	Comparatively low persistence value
<i>Reliance Capital</i>	2.00	.096	.890	.986	-4.11	-4.11	4598.4	Very high persistence value
<i>Bajaj Fin.</i>	1.91	.099	.880	.979	-4.57	-4.56	5106.0	Very high persistence value
<b>Overall Period - Coefficients - GARCH (1, 1)</b>								
<b>Banking and Finance Sector</b>	$\alpha_0$	$\alpha_1$	$\beta_1$	$\alpha_j + \beta_i$				
Kotak Mah. Bank	7.02	.058	.934	.992	-4.46	-4.47	8344.0	Very high persistence value
Federal Bank	5.23	.119	.810	.929	-4.53	-4.52	8323.3	Very high persistence value
Oriental Bank	2.43	.107	.869	.976	-4.34	-4.33	8122.0	Very high persistence value
HDFC Bank	1.77	.142	.819	.961	-5.19	-5.18	9704.5	Very high persistence value
ICICI Bank	1.77	.082	.891	.973	-4.62	-4.61	8631.4	Very high persistence value
IDBI Bank	5.84	.115	.826	.941	-4.23	-4.22	7911.3	Comparatively low persistence value
Corporation Bank	1.37	.099	.884	.983	-4.72	-4.72	8835.2	Very high persistence value
Bank of Baroda	3.32	.124	.840	.964	-4.44	-4.43	8297.0	Very high persistence value
Axis Bank	2.47	.090	.879	.969	-4.44	-4.43	8299.6	Very high persistence value
Syndicate Bank	4.17	.099	.848	.947	-4.44	-4.43	8855.4	Comparatively low persistence value
Bank of India	5.14	.136	.815	.951	-4.25	-4.24	7944.6	Very high persistence value

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<i>HDFC</i>	1.28	.089	.884	.973	-4.94	-4.93	9238.1	Very high persistence value
<i>Max Financial</i>	4.41	.123	.834	.957	-4.35	-4.34	8139.1	Very high persistence value
<i>Sundaram Finance</i>	7.47	.192	.666	.858	-4.91	-4.90	9153.9	Comparatively low persistence value
<i>Reliance Capital</i>	3.14	.101	.872	.973	-4.18	-4.17	7817.8	Very high persistence value
<i>Bajaj Fin.</i>	6.34	.148	.777	.925	-4.49	-4.48	8372.2	

(Compilation of Stock price returns data using EViews 8.0 where  $\alpha_0$ : constant in the model represents a long-run average;  $\alpha_1$ : The ARCH term which is the lag of the squared residuals from the mean equation, represents news about volatility from the previous period;  $\beta_1$ : The GARCH term is the last period's forecast variance;  $\alpha_j + \beta_i$  is close to one which means any shock to volatility is permanent.)

**Table-1.81 (T- GARCH Model)**

Company Name	Estimated Model with values					AIC	SIC	Log Likelihood	Decision (Decision Rule: If $\gamma$ is significant & positive, negative shocks have a larger effect on $\sigma_i^2$ than the positive shocks)
<b>First Period - Coefficients - GARCH (1, 1)</b>									
<b>Banking and Finance Sector</b>	$\alpha_0$	$\alpha_1$	$\gamma$	$\beta_1$	$\alpha_j + \beta_i$				
State Bank of India	2.44	.069	.054	.851	.92	-4.96	-4.94	3736.55	Positive $\gamma$ & negative shocks is larger effect on volatility
Kotak Mah. Bank	.001	.158	.135	.637	.795	-4.14	-4.12	3122.82	Positive $\gamma$ & negative shocks is larger effect on volatility
Federal Bank	.001	.099	.157	.722	.821	-4.25	-4.23	3072.66	Positive $\gamma$ & negative shocks is

									larger effect on volatility
Oriental Bank	2.23	.163	.002	.819	.982	-4.58	-4.56	3451.79	Positive (lower) $\gamma$ & negative shocks is lower effect on volatility
HDFC Bank	4.13	.109	.058	.767	.876	-5.02	-5.00	3781.90	Positive $\gamma$ & negative shocks is larger effect on volatility
ICICI Bank	.0001	.117	.103	.630	.747	-4.64	-4.62	3498.75	Positive $\gamma$ & negative shocks is larger effect on volatility
IDBI Bank	.0001	.140	.085	.665	.805	-4.05	-4.03	3052.78	Positive $\gamma$ & negative shocks is larger effect on volatility
Corporation Bank	6.17	.122	.083	.776	.898	-4.42	-4.40	3330.68	Positive $\gamma$ & negative shocks is larger effect on volatility
Bank of Baroda	4.82	.108	.056	.817	.925	-4.29	-4.27	3231.19	Positive $\gamma$ & negative shocks is larger effect on volatility
Axis Bank	.0001	.130	.027	.687	.817	-4.26	-4.24	3214.75	Positive $\gamma$ & negative shocks is larger effect on volatility
Syndicate Bank	6.65	.201	-.032	.749	.95	-4.43	-4.41	3336.23	Negative $\gamma$ & volatility is not affected
Bank of India	.0001	.133	.106	.635	.768	-4.18	-4.16	3150.86	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Bajaj Holdings</i>	7.34	.079	.082	.701	.78	-5.01	-4.99	3778.34	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>HDFC</i>	4.13	.109	.058	.767	.876	-5.02	-5.00	3781.90	Positive $\gamma$ & negative shocks is larger effect on volatility

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<i>Max Financial</i>	7.01	.096	.153	.791	.887	-4.15	-4.12	3125.09	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Sundaram Finance</i>	.0001	.237	-.052	.612	.849	-4.62	-4.60	3464.41	Negative $\gamma$ & volatility is not affected
<i>Reliance Capital</i>	.0001	.113	.178	.631	.744	-4.30	-4.28	3242.41	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Bajaj Fin.</i>	.0001	.231	.012	.550	.781	-4.39	-4.37	3291.83	Positive $\gamma$ & negative shocks is larger effect on volatility
<b>Second Period - Coefficients - GARCH (1, 1)</b>									
<b>Banking and Finance Sector</b>	$\alpha_0$	$\alpha_1$	$\gamma$	$\beta_1$	$\alpha_j + \beta_j$				
Kotak Mah. Bank	6.79	.038	.063	.920	.958	-4.71	-4.70	5268.73	Positive $\gamma$ & negative shocks is larger effect on volatility
Federal Bank	7.95	.026	.045	.938	.964	-4.74	-4.72	5294.96	Positive $\gamma$ & negative shocks is larger effect on volatility
Oriental Bank	.0001	.099	.071	.693	.792	-4.21	-4.19	4705.38	Positive $\gamma$ & negative shocks is larger effect on volatility
HDFC Bank	1.50	.025	.043	.950	.975	-5.29	-5.28	5913.97	Positive $\gamma$ & negative shocks is larger effect on volatility
ICICI Bank	7.82	.017	.100	.924	.941	-4.64	-4.62	5180.35	Positive $\gamma$ & negative shocks is larger effect on volatility
IDBI Bank	1.54	.079	.022	.895	.974	-4.38	-4.37	4896.37	Positive (lower) $\gamma$ & negative shocks is lower effect on volatility

Corporation Bank	9.26	.083	-.008	.904	.987	-4.95	-4.94	5532.28	Negative $\gamma$ & volatility is not affected
Bank of Baroda	2.39	.069	.080	.864	.933	-4.55	-4.53	5079.90	Positive $\gamma$ & negative shocks is larger effect on volatility
Axis Bank	1.19	.047	.078	.898	.945	-4.59	-4.57	5129.72	Positive $\gamma$ & negative shocks is larger effect on volatility
Syndicate Bank	3.49	.037	.060	.885	.922	-4.46	-4.45	5538.45	Positive $\gamma$ & negative shocks is larger effect on volatility
Bank of India	3.18	.090	.065	.847	.937	-4.31	-4.29	4812.66	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>H D F C</i>	4.53	.027	.064	.934	.961	-4.91	-4.89	5486.41	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Max Financial</i>	3.37	.098	.024	.850	.948	-4.51	-4.49	5039.67	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Sundaram Finance</i>	6.64	.197	-.016	.646	.843	-5.12	-5.10	5715.28	Negative $\gamma$ & volatility is not affected
<i>Reliance Capital</i>	1.93	.066	.062	.890	.956	-4.12	-4.11	4605.86	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Bajaj Fin.</i>	1.59	.064	.058	.892	.956	-4.58	-4.56	5112.01	Positive $\gamma$ & negative shocks is larger effect on volatility
<b>Overall Period - Coefficients - GARCH (1, 1)</b>									
<b>Banking and Finance Sector</b>	$\alpha_0$	$\alpha_1$	$\gamma$	$\beta_1$	$\alpha_j + \beta_j$				

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Kotak Mah. Bank	6.73	.045	.030	.933	.978	-4.46	-4.45	8350.34	Positive $\gamma$ & negative shocks is larger effect on volatility
Federal Bank	5.34	.083	.080	.807	.89	-4.53	-4.52	8332.85	Positive $\gamma$ & negative shocks is larger effect on volatility
Oriental Bank	2.78	.093	.038	.861	.954	-4.34	-4.33	8125.22	Positive $\gamma$ & negative shocks is larger effect on volatility
HDFC Bank	1.54	.079	.093	.842	.921	-5.20	-5.19	9717.59	Positive $\gamma$ & negative shocks is larger effect on volatility
ICICI Bank	1.48	.034	.094	.899	.933	-4.63	-4.62	8659.02	Positive $\gamma$ & negative shocks is larger effect on volatility
IDBI Bank	5.95	.100	.033	.825	.925	-4.23	-4.22	7913.38	Positive $\gamma$ & negative shocks is larger effect on volatility
Corporation Bank	1.43	.096	.010	.882	.978	-4.72	-4.71	8835.55	Positive $\gamma$ & negative shocks is larger effect on volatility
Bank of Baroda	3.31	.092	.071	.838	.93	-4.44	-4.43	8305.64	Positive $\gamma$ & negative shocks is larger effect on volatility
Axis Bank	2.52	.069	.052	.875	.944	-4.44	-4.43	8306.62	Positive $\gamma$ & negative shocks is larger effect on volatility
Syndicate Bank	4.53	.085	.031	.843	.928	-4.44	-4.43	8857.57	Positive $\gamma$ & negative shocks is larger effect on volatility
Bank of India	5.65	.112	.053	.808	.92	-4.25	-4.24	7948.27	Positive $\gamma$ & negative shocks is larger effect on volatility



<i>H D F C</i>	1.20	.049	.070	.893	.942	-4.95	4.94	9251.39	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Max Financial</i>	4.64	.096	.075	.826	.922	-4.36	-4.35	8147.66	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Sundaram Finance</i>	7.59	.201	-.017	.663	.864	-4.91	-4.90	9154.07	Negative $\gamma$ & volatility is not affected
<i>Reliance Capital</i>	3.35	.075	.054	.869	.944	-4.18	-4.17	7825.15	Positive $\gamma$ & negative shocks is larger effect on volatility
<i>Bajaj Fin.</i>	5.67	.120	.042	.794	.914	-4.49	-4.48	8374.38	Positive $\gamma$ & negative shocks is larger effect on volatility