Chapter-4

Relationship between Stock Market Volatility and Returns

It is well known that any emerging stock markets are characterized by high volatility. It is important to measure stock market volatility and check the pattern of volatility so that future direction of the stock market can be predicted and investment decision can be taken accordingly. A rise in stock market volatility can be interpreted as a rise in risk of equity investment. The issues of volatility and risk have become increasingly important in recent times to investors, financial practitioners, market participants, regulators and also to researchers. As a concept, volatility measures variability or dispersion about a central tendency. To be more meaningful, volatility is a measure of how far the current price of an asset deviates from its average past prices. Greater this deviation, greater is the volatility. At a more fundamental level, volatility can indicate the strength or conviction behind a price move. To measure stock market volatility, one can focus upon individual stocks and / or the market indices. These indices give a bird's eye view of the complex and vast stock market. Historical volatility simply involves calculating the variance (or standard deviation) of returns in the usual way over some historical period and this then becomes the volatility forecast for all future periods. Modeling and forecasting financial markets volatility has received considerable attention from academic researchers, policy makers and practitioners. The main reason for this enormous interest is because volatility is used as a measure of risk and different participants of the financial markets need this measure for various purposes. For instance, volatility is needed as an input in portfolio management by portfolio managers and investors. It is also needed in the pricing of derivatives securities (pricing of options in

particular). The well-known option pricing formula of Black- Scholes (1973) requires a measure of stock price volatility. Financial regulators and financial institutions require quantifying the financial risk. The principal difficulty is that volatility is not constant over time and that financial market volatility exhibits certain characteristics-asymmetry effect and relationship between time varying volatility and return etc. that are specific to financial time series (Bollerslev 1986). Therefore, practitioners and financial econometricians have developed a variety of time-varying volatility models that takes into account these characteristics. This chapter focuses on the measurement and the pattern of volatility in the Indian stock market. The chapter also deals with the relationship between stock market volatility and stock market returns in the Indian stock market. This chapter is divided into the following two sections viz; 4.1and 4.2. Section 4.1 shows the measurement of stock market volatility and its pattern; and section 4.2 shows a comparative analysis among six different sectoral indices viz; Automobile, Banking, Energy, Financial, FMCG, IT sector in the Indian stock market.

4.1 Measurement of Volatility and its Pattern:

This section measures stock market volatility and its pattern of six different industries or sectors, viz. Automobile, Banking, Energy, Financial, FMCG and IT sector in the Indian stock market. This analysis starts with the analysis of stock market returns. The return from the investment in stock market is calculated by using the following formula.

$$r_t = \ln(c_t) - ln(c_{t-1}) \qquad (1)$$

Where; r_t denotes the returns from the investment in the stock market, $\ln(c_t)$ is the natural logarithmic value of closing price at time period t and $\ln(c_{t-1})$ is the natural logarithmic

value of closing price at time period (t-1). The details are mentioned already in the methodology section (section 3.2) in Chapter 3.

To check the stationarity most popular unit root tests are ADF (Augmented Dickey - Fuller, 1979) test and Phillips-Perron (1983) test. The test simply includes AR (1) process:

$$r_t = \alpha r_{t-1} + \varepsilon_t \qquad (2.1)$$

Where r_t is a return series, α is a parameter and ε_t is a white noise error term, which follows normal distribution with zero mean and constant variance.

To examine the nature of volatility and the relationship between returns and volatility GARCH-M (Generalized Auto Regressive Conditional Heteroscadasticity) model is used. Engle (1982) introduced the ARCH model in his study as the first formal model, which seemed to capture the phenomena of changing variance in time series data. Bollerslev (1986) extends Engle's (1982) ARCH process by allowing the conditional variance to follow an ARMA process. This model is known as a generalized ARCH model, or GARCH model. Engle, Lilien and Robins (1987) extend the basic ARCH framework to allow the mean of a sequence to depend on its own conditional variance. This class of model, called the ARCH in mean (ARCH –M) model, is particularly suited to the study of asset markets. The basic insight is that risk-averse agents will require compensation for holding a risky asset. The GARCH–M model form as follows:

$$r_t = \omega + \theta h_t + \sum_{i=1}^{p} \emptyset_i \, r_{t-i} + \varepsilon_t + \sum_{i=1}^{q} \delta_i \, \varepsilon_{t-i} \qquad \ldots\ldots\ldots \quad (3)$$

Where r_t is the daily returns on equity and r_{t-i} represents lag returns and h_t represents conditional variance which are considered as regressors and ε_t represent random shocks.

The conditional variance equation (mentioned in the methodological section in Chapter 3) is formed as:

$$\varepsilon_t = v_t\sqrt{h_t} \qquad v_t \sim iid(0,\ 1)$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i\, \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j\, h_{t-i} \qquad \text{GARCH (p, q)} \qquad \ldots.(3.1)$$

Where, $\alpha_0 > 0,\ \alpha_i \geq 0,\ \beta_j \geq 0$ and $\alpha_i + \beta_j < 1$.

ARCH coefficient (α_i) indicates the impact of previous period shocks on current period volatility. The ARCH coefficient (α_i) is also treated as recent "news" component which explains that recent news has a impact on price changes which implies the impact of yesterday's news on today's volatility.

The GARCH coefficient (β_i) measures the impact of last period variance on current period volatility. GARCH coefficient (β_i) indicates the presence of volatility clustering. A positive β_i indicates that positive stock price changes are associated with further positive changes and vice versa. A relatively higher values of $\beta_1$implies a larger memory for shocks. The GARCH coefficient (β_1) also treated as old "news" component, which implies that the news, which is old by more than one day, plays a significant role in volatility. The sum of the ARCH and GARCH coefficients i.e. (α_i+β_i) indicates the extent to which a volatility shock is persistent over time. A persistent volatility shock raises the asset price volatility.

A positive value of the coefficient θ in equation (3) represents greater the impact of conditional variance on returns. This is already discussed in detail in the methodology section of Chapter 3. Before apply any ARCH or GARCH model it is important to check

whether there is ARCH effect or not. To check ARCH effect the ARCH-LM test of Engle (1982) is used. The ARCH-LM test regress the squared residual of the mean model (ε_t^2) on lagged squared residual (ε_{t-1}^2) and a constant.

To examine the leverage effect E-GARCH (Exponential Generalized Auto Regressive Conditional Heteroscadasticity) model is used. Though ARCH and GARCH models responds to good and bad news and quite useful in forecasting and modeling volatility but these models are not able to the capture leverage effect and information asymmetry. The rational and underlying logic of asymmetric or leverage effect is that the distribution of stock returns is highly asymmetric. Bad news (negative shocks) is followed by larger increase in price volatility than that of good news (positive shocks). Because when stock prices falls the value of the associated company's equity declines. As a result the debt equity ratio of the company rises, thereby signaling that the company has become riskier. Increased risk is considered an indicator of higher volatility (Black 1976). So it is important to use E-GARCH model to test asymmetric shocks to volatility.

$$\ln(h_t) = \alpha_0 + \alpha_1 \frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} + \lambda_1 \left(\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}\right) + \beta_1 \ln(h_{t-1}) \qquad (4)$$

Where, h_t is an asymmetric function of past $\mathcal{E}_t$ and α_0, α_1 λ_1 and β_1 are constant parameters. In this model specification, β_1 is the GARCH term that measures the impact of last period's forecast variance. A positive β_1 indicates volatility clustering implying that positive stock price changes are associated with further positive changes and vice versa. If $\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}$ is positive the effect of the shock on the log of the conditional variance is (α_1+λ_1). If $\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}$ is negative, the effect of the shock on the log of conditional variance is (-α_1+λ_1). λ_1 measures the leverage or asymmetric effect. λ_1 is expected to be negative

implying that bad news has a bigger impact on volatility than that of good news of the same magnitude. The details are already discussed in methodology section in Chapter 3.

As already mentioned that there are six different industries for the study viz; Automobile, Banking, Energy, Financial, FMCG and IT sector in the Indian stock market. Now, industry-wise company level analysis is explained in the following sub-sections.

4.1.1 Volatility and its Pattern in Automobile Sector:

This analysis is started with descriptive statistics of daily returns of selected Automobile companies and Automobile sector index are reported in Table 4.1.1.

Table 4.1.1: Descriptive Statistics of Return Series of Automobile Industry

Company	Mean	Std. Dev.	Max.	Min.	Skew.	Kurtosis	JB Statistics	P- Value
AL	0.00002	0.031	0.15	-0.69	-4.83	112.2	1122145	0.00
EL	0.00016	0.035	0.18	-0.23	0.05	6.17	940	0.00
HM	0.00029	0.017	0.07	-0.08	-0.12	4.73	84	0.00
HNM	-0.00117	0.031	0.18	-0.08	1.65	10.36	2105	0.00
HMT	-0.00012	0.037	0.27	-0.2	1.18	8.82	3681	0.00
M&M	0.0003	0.032	0.21	-0.69	-8.19	179.79	2943598	0.00
MSL	0.00041	0.03	0.18	-0.22	0.04	10.06	4596	0.00
MSI	0.00067	0.023	0.12	-0.13	-0.06	5.68	671	0.00
SIL	-0.00026	0.024	0.18	-0.1	0.93	8.29	1040	0.00
TM	-0.00009	0.055	0.16	-1.66	-21.56	649.99	22353939	0.00
TVS	0.00014	0.035	0.25	-0.66	-2.71	64.35	354243	0.00
VST	0.00092	0.019	0.12	-0.07	1.05	8.58	1030	0.00
CNX AUTO	0.00074	0.015	0.14	-0.10	-0.13	8.54	2875	0.00

Source: Computed on the basis of secondary time series data collected from www.nseindia.com[1]

From Table 4.1.1, it is observed that the daily mean return of V.S.T. Tiller Tractors is relatively higher than that of other Automobile firms. The daily mean return

[1] Ashok Leyland (AL), Escorts Ltd (EL), Hero Motors (HM), Hindustan Motors (HNM), Hindustan machine tools (HMT), Mahindra & Mahindra (M&M), Maharashtra Scooters Limited(MSL), Maruti Suzuki India (MSI), SML Isuzu Limited (SIL), Tata Motors Ltd (TM), TVS Motor Company (TVS), V.S.T Tillers Tractors (VST). Max= Maximum, Min= Minimum, Skew= Skewness, Std. Dev.= Standard Deviation

of CNX Auto, ie; Auto sector index is 0.00074 (0.074%). The mean returns of all other selected companies are lower than the CNX Auto except V.S.T. Tiller Tractors. The lowest even negative mean return is shown in SML Isuzu Ltd (SIL). However, AL, EL, HM, M&M, MSL, MSI and TVS shows positive returns where as HNM, HMT, SML and TM shows negative mean returns. In the Automobile sectors (within selected companies) the return is fluctuated between 0.27 to -1.66. The highest standard deviation or volatility is shown in Tata Motors (TM) where as the lowest is shown in CNX Auto. It is also observed that the highest mean return is associated with the lower risk while the lowest mean return is associated with the highest risk, which is controversial to the Capital Asset Pricing Model (CAPM). The volatility of sectoral index return is lower than that of all other companies. From this, it can be said that the investor can invest in those companies which provides good returns with lower risk. The EL, HM, HMT, MS, SML and VST are positively skewed where as the AL, HM, M&M, MSI, TM, TVS and CNX Auto are negatively skewed. A positively skewed return series indicates that it has higher possibility to generate positive returns while negatively skewed implies higher probability to generate negative returns. The kurtosis of all the return series are greater than three (excess kurtosis) thus, they are leptokurtic, i.e. the frequency distribution assigns a higher probability to return around zero as well as very high positive and negative returns. It is also observed that the JB Statistic for all the return series are highly significant even at less than one percent level which indicates that the return series are not normally distributed implying the presence of heteroscedasticity. Hence GARCH model is suitable for testing the hypothesis.

From the above Table 4.1.2, it is observed that the Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic for all the return series of Automobile sector is greater than the critical values even at less than one percent level of significance. Both ADF and PP test statistic confirms that there is no unit root. Therefore, the null hypothesis that the return series has unit root is rejected for all the return series and thus data for all return series are found to be stationary.

Table 4.1.2: Unit Root Test for Return Series in Automobile Industry

Company Name	ADF-Statistic	P Value	PP-Statistic	P Value
Ashok Leyland	-19.42	0.00	-26.21	0.00
Escort Ltd	-32.15	0.00	-38.07	0.00
Hero Motor Corp. Ltd.	-14.31	0.00	-6.79	0.00
Hindustan Machine Tools	-19.75	0.00	-29.81	0.00
Hindustan Motors	-10.59	0.00	-35.34	0.00
Mahindra & Mahindra	-24.41	0.00	-78.58	0.00
Maharastra Scooters ltd	-19.8	0.00	-67.47	0.00
Maruti Suzuki India	-21.47	0.00	-40.31	0.00
SML Isuzu Limited	-10.5	0.00	-32.79	0.00
Tata Motors Ltd	-16.72	0.00	-45.03	0.00
TVS Motor Company	-30.48	0.00	-330.61	0.00
V.S.T Tillers Tractors	-8.26	0.00	-13.62	0.00
CNX_AUTO	-33.17	0.00	-38.93	0.00
Test critical values:				
1% level		5% level		10% level
-3.43308		-2.86263		-2.5674

Source: Estimated based on secondary time series data collected from www.nseindia.com

To check ARCH effect the ARCH LM test of Engle (1982) is used. The ARCH LM test regress the squared residual of the mean model (ε_t^2) on lagged squared residual (ε_{t-1}^2) and a constant.

The ARCH-LM test provides two statistics, that is, F-statistic value and Observed R square value. From Table 4.3.1, it is observed that the F-statistic and the observed R square value is greater than their critical values for all the return series of Automobile sector, as indicating by their corresponding probability value which is less than one

percent level. Therefore, the null hypothesis that is no ARCH effect is rejected for all the return series indicating that there is ARCH effect for all the return series of Automobile sector. Thus, ARCH or GARCH model can be used for the automobile industry.

Table 4.1.3: ARCH-LM Test for Automobile Sector

Company Name	F- Statistic	P Value	Observed R^2	Prob. Value
Ashok Leyland	91.05	0.00	87.56	0.00
Escort Ltd.	171.92	0.00	159.79	0.00
Hero Motor Corp. Ltd.	25.97	0.00	25.05	0.00
Hindustan Machine Tools	142.29	0.00	133.90	0.00
Hindustan Motors	35.49	0.00	34.01	0.00
Mahindra & Mahindra	26.40	0.00	26.12	0.00
Maharastra Scooters Ltd.	89.06	0.00	85.68	0.00
Maruti Suzuki India	19.87	0.00	19.71	0.00
SML Isuzu Ltd.	8.13	0.00	8.07	0.00
Tata Motors Ltd.	12.34	0.00	12.24	0.00
TVS Motor Company	206.64	0.00	189.32	0.00
V.S.T Tillers Tractors	13.85	0.00	13.62	0.00
CNX_AUTO	52.53	0.00	51.37	0.00

Source: Estimated based on secondary time series data collected from www.nseindia.com

The most popular member of the ARCH class of model, i.e. GARCH-M (p, q) model is used to model volatility of Automobile sector return series. The Maximum Likelihood Estimation technique is used for the estimation of GARCH-M model. When using this technique the model selection is based on AIC and SIC. The model with lower value of AIC and SIC fits the data best.

As far the stationarity of the variance process is concerned, it is observed that the summation of α_i and β_j for all return series are less than one and hence the stationary condition is satisfied for all the return series of Automobile sectors. However, the sum is rather close to one which indicates a long persistence of shock on volatility (Akigray1989) (Magnus & Fosu, 2006).

From Table 4.1.4, it is observed that the return series for all companies of Automobile sector the ARCH coefficient is statistically significant at less than one percent level of significance which indicates that previous period shocks influence the current period volatility. Some companies return series such as AL, EL, HMT, MS, TM, TVS, VST and CNX Auto fit the GARCH-M (2,1) or GARCH-M (2,2) model. For these return series the second period lag shocks (ε^2_{t-2}) has some impact on current period volatility as the ARCH coefficient (α_2) is also statistically significant. The GARCH coefficient (β_1) measures the impact of last period variance (h_{t-1}) on current period volatility (h_t). A significant GARCH coefficient (β_1) indicates the presence of volatility clustering which is also treated as 'old or historical news' component which implies that the news that is old by more than one day plays a significant role on volatility.

From Table 4.1.4, it is observed that the GARCH coefficient β_1 and β_2 are statistically significant indicating that h_{t-1} and h_{t-2} has influenced the current period volatility (h_t). A relatively large value of GARCH coefficient indicates that shocks to conditional variance take a long time to die out. However, low value of ARCH coefficient suggests that market surprises induce relatively small revision in future volatility. A large sum of these coefficients implies that a large positive and negative return will lead future forecasts of the variance to be high for a particular period. So investor can take advantage for the same and by analyzing recent and historical news can forecast the future market movement and can take their investment strategies accordingly.

In the GARCH-M model in the mean equation the most important variable is h_t i.e. conditional variance. A significant positive risk parameter θ indicates that there is positive relationship between predicted return and volatility. If volatility increases then

expected return will also increases and vice versa. From Table 4.1.4, it is observed that θ is statistically significant for the return series of EL, HMT, HNM, M&M, MS, SI and TM. But the coefficient θ is positive only for EL, M&M, MS and TM while it is negative for HMT, HNM, and SI. For the rest of the companies such as HM, MSI, TVS, VST and CNX Auto the coefficient θ is statistically insignificant. Therefore, it can be argued that when volatility rises expected return is also rises for EL, M&M, MS, and TM companies. On the other hand, when volatility rises, predicted return falls for HMT, HNM, and SI. The result of Automobile sector is partially inconsistent with the theory of asset pricing. In the mean equation, the autoregressive (AR) and moving average (MA) coefficients are statistically significant for all companies of Automobile sector which indicates that one, two, or three period lag return and one or two period lag residual has some impact on current period return.

Table 4.1.4: Result of GARCH-M Model for Automobile Sector

Coefficients														Diagnostic Test			
Company	θ	ω	ϕ_1	ϕ_2	ϕ_3	δ_1	δ_2	α_0	α_1	α_2	β_1	β_2	$\alpha_i + \beta_i$	Adj R^2	Log like	F-statistic	AIC
AL	-1.93 (0.41)	0.00003** (0.052)	1.40* (0.00)	-0.96* (0.00)		-1.21* (0.00)	0.41* (0.00)	0.00000* (0.003)	0.05* (0.00)	0.49* (0.00)	0.44* (0.00)		0.98	0.85	11946	1288* (0.00)	-10.66
EL	0.00*** (0.09)	0.00225*** (0.072)	-0.38* (0.00)			0.60* (0.00)		0.00000* (0.00)	0.20* (0.00)	-0.09** (0.03)	0.86* (0.00)		0.97	0.55	10337	17* (0.00)	-9.22
HM	0.29*** (0.60)	0.00030* (0.00)	1.48* (0.00)	-0.98* (0.00)		-0.93* (0.00)	-0.06*** (0.10)	0.00000 (0.13)	0.04** (0.02)		0.95* (0.00)		0.98	0.97	4405	2691* (0.00)	-13.34
HMT	-21.15* (0.01)	-0.00074* (0.00)	0.86* (0.00)			-0.49* (0.00)		0.00000 (0.11)	0.19* (0.00)	-0.17* (0.00)	1.44* (0.00)	-0.47* (0.00)	.99	0.20	9063	61* (0.00)	-8.08
HNM	-19.80** (0.04)	-0.00130* (0.00)	0.04* (0.00)	-0.96* (0.00)		0.49* (0.00)	0.77* (0.00)	0.00000* (0.00)	0.21* (0.01)		0.51* (0.00)		0.72	0.74	3812	239* (0.00)	-9.81
M&M	47.90* (0.00)	0.00009** (0.02)	2.03* (0.00)	-1.47* (0.00)	0.38* (0.00)	-1.58* (0.00)	0.63* (0.00)	0.00000* (0.00)	0.15* (0.00)		0.82* (0.00)		0.97	0.39	11288	141* (0.00)	-10.08
MS	14.92* (0.01)	0.00026* (0.00)	0.24* (0.00)	0.43* (0.00)		-0.72* (0.00)		0.00000 (0.13)	0.37* (0.00)	-0.30* (0.00)	1.29* (0.00)	-0.38* (0.00)	0.99	0.19	9708	54* (0.00)	-8.78
MSI	5.04 (0.82)	0.00066* (0.00)	1.18* (0.00)	-0.52* (0.00)		-0.85* (0.00)		0.00000* (0.00)	0.09* (0.00)		0.88* (0.00)		0.96	0.28	12042	110* (0.00)	-10.75
SI	-23.99*** (0.07)	0.00044** (0.03)	-0.58* (0.00)			0.38* (0.00)		0.00000* (0.00)	0.26* (0.00)		0.56* (0.00)		0.82	0.55	3290	6* (0.00)	-8.28
TM	32.04* (0.00)	-0.00041* (0.00)	1.11* (0.00)	-0.66* (0.00)		-0.73* (0.00)		0.00000* (0.01)	0.31* (0.00)	-0.30* (0.00)	1.22* (0.00)	-0.25*** (0.07)	0.99	0.46	6320	110* (0.00)	-9.90
TVS	3.44 (0.11)	0.00013* (0.00)	-1.59* (0.00)	-0.93* (0.00)		0.34* (0.00)		0.00000* (0.01)	0.38* (0.00)	-0.38* (0.00)	1.37* (0.00)	-0.39* (0.00)	.99	0.91	14224	2386* (0.00)	-12.70
VST	27.07 (0.47)	0.00077* (0.00)	1.39* (0.00)	-0.99* (0.00)		-1.38* (0.00)	0.84* (0.00)	0.00000 (0.48)	0.25* (0.01)	-0.24* (0.01)	0.98* (0.00)		0.99	0.46	6320	110* (0.00)	-9.90
INDEX	9.55 (0.54)	0.00076* (0.00)	0.66* (0.00)	-0.31* (0.00)		-0.50* (0.00)		0.00000* (0.00)	0.08* (0.00)		0.90* (0.00)		0.98	0.09	10822	29* (0.00)	-9.66

Source: Estimated based on secondary time series data collected from www.nseindia.com

Note:* denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

A high value of R^2 depicts a very high degree of explained variation. Apart from this AIC and SIC is used in the study indicating lower for the regression which is quite reasonable and fit for our models. A high value of F-statistic states that the statistical models that are used are fit and appropriate.

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the ARCH-LM test is used. To check the adequacy of the mean models the Ljung-Box Q statistics of standardized residual is used and that of square standardized residual is used to check for the adequacy of variance models.

Table 4.1.5: ARCH-LM Test for Automobile Industry after Estimation

ARCH LM TEST					Standardized Residuals		Square Standardized Residual	
Company	F-Statistic	P-Value	Obs. R^2	P-Value	Q-Stat (36)	P-Value	Q-Stat (36)	P-Value
AL	0.25	0.62	0.25	0.62	7227.7	0	1.42	1
EL	0.42	0.52	0.42	0.52	32.65	0.53	31.2	0.61
HM	0.12	0.73	0.12	0.73	32.83	0.43	17.93	0.98
HMT	0	0.98	0	0.98	213.36	0	30.89	0.62
HNM	0.01	0.92	0.01	0.92	32.5	0.21	13.09	0.99
MM	0.01	0.92	0.01	0.92	35.57	0.3	0.36	1
MS	0.41	0.52	0.41	0.52	34.68	0.39	37.93	0.26
MSI	0.84	0.36	0.84	0.36	22.25	0.92	20.57	0.96
SI	0.25	0.62	0.25	0.62	118.63	0	13.84	1
TM	0	0.99	0	0.99	18.07	0.98	0.08	1
TVS	10.86	0	10.82	0	31.01	0.44	23.63	0.89
VST	0.3	0.59	0.3	0.58	32.83	0.43	24.7	0.82
INDEX	0.47	0.49	0.47	0.49	39.96	0.16	14.95	1

Source: Estimated based on secondary time series data collected from www.nseindia.com

Table 4.1.5 suggests that the Ljung Box Q-statistic of standardized residuals is insignificant for all the return series of Automobile sector except AL, HMT and SI indicating that the estimated mean models of each company fits the data well except AL, HMT and SI. For these three companies different models are used but still there remains

serial correlation. Finally those mean models are selected for these companies which have lowered AIC and SIC. However, the Ljung-Box Q-statistic of square standardized residual is highly insignificant for all the return series of Automobile sector indicating that the estimated variance models fits the data very well. That is the GARCH-M models are suitable for the return series of Automobile sector.

From Table 4.1.5, it is observed that the ARCH-LM test statistic i.e. observed R^2 for all the return series of Automobile sector is less than their critical values imply that there is no further ARCH effect. That means the estimated models are appropriate.

To examine the leverage effect E-GARCH model is estimated. Table 4.1.6 presents the result of EGARCH model for the return series of Automobile sector. The E-GARCH model takes the leverage effect into account. It is observed that the asymmetric term (λ_1) is negative and statistically significant for AL, EL, MS and CNX Auto companies indicating that the volatility is high when there is bad news or negative shocks in the market than that of good news or positive shocks for these companies (Nelson, 1991) (Jinho, Chang Jin and Nelson, 2007) (Song et al, 2013). But the asymmetric term (λ_1) is positive and statistically significant for HM, HNM, TM and VST companies indicating that the volatility is high when there is good news or positive shocks in the market than that of bad news or negative shocks for these companies (Tripathy, 2010). However, the asymmetric term (λ_1) is statistically insignificant for HMT, M&M, MSI, IS and TVS companies indicating that these companies have not significant asymmetric or leverage effect (Bekaert and Wu, 2000). In the variance equation, the ARCH and GARCH coefficients are statistically significant for all the return series of Automobile sector implying that a greater shocks on volatility (Bollerslave 1986).To check whether

the estimated models capture the ARCH effect or there remains further ARCH effect, the study here employs the ARCH-LM test.

Table 4.1.6: Result of E-GARCH Model for Automobile Industry

Company	α_0	α_1	α_2	λ_1	β_1	β_2	Adj. R^2	Log like	F-statistic	AIC	SIC	ARCH LM $T*R^2$
AL	-0.627* (0.00)	-0.36* (0.00)	0.62* (0.00)	-0.09* (0.00)	0.97* (0.00)		0.46	10736	240* (0.00)	-9	-9	0.74 (0.38)
EL	-0.69* (0.00)	0.34* (0.00)		-0.11* (0.03)	-0.02 (0.33)	0.96* (0.00)	0.05	10333	17* (0.00)	-9	-9	0 (0.95)
HM	-0.53* (0.00)	0.23* (0.00)		0.09* (0.04)	0.98* (0.00)		0.77	3755	324* (0.00)	-13	-13	0.38 (0.53)
HMT	-0.142*** (0.06)	0.46* (0.00)	-0.4* (0.00)	-0.01 (0.36)	1.53* (0.00)	-0.54* (0.00)	0.19	9059	59* (0.00)	-8	-8	1.13 (0.28)
HNM	-1.038* (0.00)	0.17* (0.01)		0.06*** (0.07)	1.45* (0.00)	-0.52* (0.01)	0.26	3327	35* (0.00)	-11	-11	0.83 (0.36)
M&M	-0.717* (0.00)	0.19* (0.00)		-0.03 (0.16)	0.95* (0.00)		0.32	11279	135* (0.00)	-10	-10	0 (0.93)
MS	-1.746* (0.00)	0.52* (0.00)		-0.07** (0.02)	0.88* (0.00)		0.2	9706	71* (0.00)	-8	-8	0 (0.98)
MSI	-0.462* (0.00)	0.26* (0.00)	-0.1*** (0.07)	-0.01 (0.71)	0.97* (0.00)		0.28	12044	98* (0.00)	-10	-10	0.18 (0.66)
SI	-3.167* (0.00)	0.45* (0.00)		0.01 (0.82)	0.74* (0.00)		0.01	3273	3* (0.00)	-8	-8	0.41 (0.52)
TM	-0.742* (0.00)	0.16* (0.00)		0.04 (0.26)	0.95* (0.00)		0.46	6318	134* (0.00)	-9	-9	1.38 (0.99)
TVS	-3.443* (0.00)	0.52* (0.00)		0 (0.98)	0.8* (0.00)		0.91	14226	2982* (0.00)	-12	-12	2.64*** (0.10)
VST	-7.165* (0.00)	0.4* (0.00)		0.15** (0.05)	0.48* (0.00)		0.84	3637	461* (0.00)	-10	-10	0.09 (0.75)
CNX Auto	-0.361* (0.00)	0.16* (0.01)		-0.07* (0.00)	0.97* (0.00)		0.02	6406	5* (0.00)	-9	-9	0.16 (0.68)

Source: Estimated based on secondary time series data collected from www.nseindia.com

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten per cent.

From Table 4.1.6, it is observed that the ARCH-LM test statistic i.e. observed R^2 for all the return series of Automobile sector is less than their critical values imply that there is no further ARCH effect. That means the selected models are appropriate.

4.1.2 Volatility and its Pattern in Banking Sector:

The analysis is started with descriptive statistics of daily returns of selected Banks and Banking sectoral index which are reported in Table 4.1.7.

Table 4.1.7: Descriptive Statistics of Return Series in Banking Sector:

Company	Mean	Std. Dev.	Max.	Min.	Skewness	Kurtosis	JB Statistic	P-Value
BOB	0.00054	0.002	0.012	-0.009	0.101	5	300	0.000
BOI	0.00035	0.004	0.014	-0.012	0.013	3	11	0.003
CBL	0.00011	0.003	0.014	-0.016	-0.219	4	188.	0.000
HDFC	0.00013	**0.000**	0.001	-0.013	-27.019	959	6291	0.000
ICICI	0.00052	0.004	0.031	-0.018	0.333	8	1989	0.000
IDBI	**-0.00016**	0.003	0.013	**-0.018**	-0.078	5	432	0.000
ILB	**0.001**	0.004	0.019	-0.016	0.007	7	1155	0.000
INGV	0.00061	0.002	0.009	-0.007	0.044	4	250	0.000
KMB	0.00038	0.003	0.013	-0.012	0.015	4	165	0.000
PNB	0.00028	0.002	0.010	-0.010	0.152	4	261	0.000
SBI	0.00047	0.003	0.019	-0.012	0.247	5	587	0.000
JK	0.00062	0.002	0.015	-0.010	0.553	8	1937	0.000
YSB	0.00084	**0.006**	**0.036**	-0.027	0.232	6	952	0.000
ABL	0.00059	0.002	0.012	-0.010	0.064	5	350	0.000
CNX Bank	0.00055	0.003	0.023	-0.016	0.297	7	1197	0.000

Source: Computed based on secondary time series data collected from www.nseindia.com

From Table 4.1.7, it is observed that the daily mean return of Induslnd bank is relatively higher than that of other banks. The daily mean return of CNX Bank, i e; banking sector index is 0.00055 (0.055%). The mean returns ILB, YSB, INGV, J&K, and ABL are relatively higher than banking sector index. But the mean returns of BOB, BOI,

CBL, HDFC, ICICI, IDBI, KMB, [2]PNB and SBI are relatively lower than banking sector index. The lowest even negative mean return is shown in IDBI bank. Except IDBI bank all other banks including CNX Bank Shows positive returns. In the Banking sector (within selected banks) the return is fluctuated between 0.036 to -0.018. The highest standard deviation or volatility is shown in Yes bank where as the lowest is shown in HDFC bank. The risk of YSB, ILB, ICICI and BOI are relatively higher than that of banking sector index. From this, it can be said that the investor can invest in those companies which provides good returns with lower risk. Except CBL, HDFC and IDBI banks all other selected banks are positively skewed. A positively skewed return series indicates that it has higher possibility to generate positive returns while negatively skewed implies higher probability to generate negative returns. The kurtosis of all the return series are greater than three (excess kurtosis) thus, they are leptokurtic; i. e. the frequency distribution assigns a higher probability of either very high positive or negative returns. From Table 4.1.7, it is also observed that the JB Statistic for all the return series are highly significant even at less than one percent level which indicates that the return series are not normally distributed implying the presence of heteroscedasticity. Hence, GARCH model is suitable for testing the hypothesis.

From Table 4.1.8, it is observed that the Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic for all the return series of banking sector is greater than their critical values even at less than one percent level of significance. Both ADF and PP

[2] Axis Bank Ltd. (ABL), Bank of Baroda (BOB), Bank of India (BOI), Canada Bank Ltd. (CBL), HDFC Bank Ltd. (HDFC), ICICI Bank Ltd. (ICICI), IDBI Bank Ltd. (IDBI), IndusInd Bank Ltd. (IBL), ING Vysya Bank Ltd. (INGV), The Jammu & Kashmir Bank Ltd. (JK), Kotak Mahindra Bank Ltd. (KMB), Punjab National Bank (PNB), State Bank of India (SBI), Standard Chartered Bank (SCB), Yes Bank Ltd. (YBL).

test statistic confirms that there is no unit root. Therefore, the null hypothesis that the return series has unit root is rejected for all the return series and thus data for all return series are found to be stationary.

Table 4.1.8: Unit Root Test for Return Series in Banking Sector

Company Name	ADF- Statistic	P Value	PP Statistic	P Value
Axis Bank Limited	-18.32	0.00	-146.88	0.0001
Bank of Baroda	-28.07	0.00	-36.28	0.00
Bank of India	-42.10	0.00	-18.06	0.00
Canada Bank ltd	-26.28	0.00	-47.08	0.0001
HDFC Bank Limited	-21.48	0.00	-46.91	0.0001
ICICI Bank Limited	-27.34	0.00	-69.12	0.0001
IDBI Bank Limited	-21.03	0.00	-71.13	0.0001
IndusInd Bank LTD	-38.88	0.00	-18.88	0.00
ING Vysya Bank Limited	-30.25	0.00	-21.98	0.00
The Jammu & Kashmir Bank Limited	-21.00	0.00	-62.73	0.0001
Kotak Mahindra Bank Limited	-49.48	0.0001	-13.82	0.00
Punjab National Bank	-22.77	0.00	-63.68	0.0001
State Bank of India	-30.19	0.00	-180.84	0.0001
Standard Chartered Bank	-21.03	0.00	-71.13	0.0001
Yes Bank Limited	-76.78	0.0001	-77.89	0.0001
Banking Sector Index	-41.43	0.00	-41.23	0.00

Source: Computed based on secondary time series data collected from www.nseindia.com

To check ARCH effect the study here employs the ARCH LM test of Engle (1982). The ARCH LM test regress the squared residual of the mean model (ε_t^2) on lagged squared residual (ε_{t-1}^2) and a constant.

The ARCH LM test provides two statistics, that is, F-statistic value and Observed R square value. From Table 4.1.9, it is observed that the F-statistic and the observed R square value is greater than their critical values for all the return series of Banking sector except HDFC bank, as indicating by their corresponding P-value which is less than one percent level. Therefore, the null hypothesis that is no ARCH effect is rejected for all the return series except HDFC bank indicating that there is ARCH effect for all the return

series of banking sector except HDFC bank. Thus, it is confirmed that the study can apply ARCH or GARCH model.

Table 4.1.9: ARCH-LM Test for Banking Sector

Company Name	F- Statistic	P Value	LM Statistics	P Value
Axis Bank Limited	109.59	0.00	102.85	0.00
Bank of Baroda	26.96	0.00	103.08	0.00
Bank of India	19.94	0.00	77.19	0.00
Canada Bank ltd	24.91	0.00	95.59	0.00
HDFC Bank Limited	0.00095	0.97	0.00095	0.97
ICICI Bank Limited	56.76	0.00	206.51	0.00
IDBI Bank Limited	111.17	0.00	371.49	0.00
IndusInd Bank LTD	14.12	0.00	55.23	0.00
ING Vysya Bank Limited	77.75	0.00	273.50	0.00
The Jammu & Kashmir Bank Limited	20.17	0.00	78.03	0.00
Kotak Mahindra Bank Limited	185.42	0.00	557.63	0.00
Punjab National Bank	29.56	0.00	112.54	0.00
State Bank of India	30.24	0.00	115.00	0.00
Yes Bank Limited	59.79	0.00	216.46	0.00
Banking Sector Index	33.42	0.00	126.39	0.00

Source: Computed based on secondary time series data collected from www.nseindia.com

The most popular member of the ARCH class of model, i.e. GARCH-M (p,q) model is used to model volatility of banking sector return series. The Maximum Likelihood Estimation technique is used for the estimation of GARCH-M model. When using this technique the model selection is based on AIC and SIC. The model with lower value of AIC and SIC fits the data best. The return series of BOI, CBL, KMB and PNB fits the GARCH-M (2,1) model and IDBI fits GARCH-M (2,2) model whereas ABL, BOB, ICICI, ILB, INGV, J&K, SBI, YSB and CNX Bank fits the GARCH-M (1,1) model. As far the stationarity of the variance process is concerned, it is observed that the summation of α_i and β_i for all return series are less than one and hence the stationary condition is satisfied for all the return series of banking sectors except INGV bank.

However, the sum is rather close to one which indicates a long persistence of shock on volatility. The summation of α_1 and β_1 is greater than one for INGV bank which implies that the persistence of shocks on volatility is unstable.

Table 4.1.10: Result of GARCH-M Model for Banking Sector

	Coefficients of Mean Equation						Coefficients of Variance Equation						Diagnostic Test			
Company	θ	ω	ϕ_1	ϕ_2	δ_1	δ_2	α_0	α_1	α_2	β_1	β_2	$\alpha_i + \beta_i$	Adj. R^2	Log like	F-statistic	AIC
ABL	-5.32 (0.61)	0.00060* (0.00)	-1.59* (0.00)	-0.91* (0.00)	1.05* (0.00)	0.07* (0.01)	0.00000** (0.02)	0.09* (0.00)		0.91* (0.00)		0.99	0.81	9418.04	793.24* (0.00)	-11.45
BOB	2.79 (0.81)	0.00051* (0.00)	1.31* (0.00)	-0.54* (0.00)	-0.88* (0.00)		0.00000* (0.00)	0.06* (0.00)		0.93* (0.00)		0.99	0.30	10944.83	121.55* (0.00)	-9.78
BOI	1.65 (0.58)	0.00034* (0.00)	1.36* (0.00)	-0.97* (0.00)	-0.70* (0.00)		0.00000* (0.00)	0.23* (0.00)	-0.16* (0.00)	0.91* (0.00)		0.99	0.95	12933.74	4380.39* (0.00)	-11.55
CBL	16.21*** (0.07)	-0.61564* (0.00)	-0.95* (0.00)	0.82* (0.00)	0.89* (0.00)		0.00000* (0.01)	0.14* (0.00)	-0.10* (0.00)	0.96* (0.00)		0.99	0.35	10460.98	1.98	-9.34
ICICI	0.00 (0.11)	0.00184 (0.03)	0.81* (0.00)	-0.12* (0.00)	-0.88* (0.00)		0.00000* (0.00)	0.08* (0.00)		0.91* (0.00)		0.99				
IDBI	25.76*** (0.06)	-0.00025* (0.00)	-1.68* (0.00)	-0.79* (0.00)	1.42* (0.00)	0.68* (0.00)	0.0000*** (0.07)	0.16* (0.00)	-0.12* (0.00)	1.37* (0.00)	-0.41** (0.03)	0.99	0.31	10611.29	91.75* (0.00)	-9.48
ILB	0.58 (0.83)	0.00100* (0.00)	1.38* (0.00)	-0.95* (0.00)	-0.58* (0.00)	-0.05** (0.03)	0.00000* (0.00)	0.08* (0.00)		0.92* (0.00)		0.99	0.93	12771.70	3250.22* (0.00)	
INGV	-15.17** (0.03)	0.00055* (0.00)	0.27* (0.00)	0.43* (0.00)	0.25* (0.00)	0.42* (0.00)	0.00000* (0.00)	0.40* (0.00)		0.79* (0.00)		1.19	0.66	12978.15	490.68* (0.00)	-11.59
J&K	0.00*** (0.05)	-0.00101 (0.22)	-0.82* (0.00)		0.56* (0.00)		0.00000	0.16		0.70		0.86	0.13	11180.81	48.99* (0.00)	-9.99
KMB	-0.11** (0.02)	-0.00024 (0.41)	-0.10* (0.00)	0.83* (0.00)	0.75* (0.00)		0.00000** (0.03)	0.19* (0.00)	-0.10** (0.03)	0.92* (0.00)		1.00	0.72	12121.44	631.40* (0.00)	-10.83
PNB	0.03 (0.59)	0.00026* (0.00)	-0.97* (0.00)	-0.42* (0.00)	0.67* (0.00)		0.00000** (0.002)	0.15* (0.00)	-0.10* (0.00)	0.95* (0.00)		1.00	0.18	11441.99	56.31* (0.00)	-10.22
SBI	-1.13 (0.83)	0.00048* (0.00)	0.75* (0.00)	-0.07* (0.00)	-0.96* (0.00)		0.00000* (0.00)	0.06* (0.00)	0.93* (0.00)			0.99	0.12	10445.33	39.68* (0.00)	-9.33
YSB	0.00 (0.28)	-0.00069 (0.63)	-0.51* (0.00)				0.00000* (0.00)	0.10* (0.00)		0.87* (0.00)		0.98	0.20	8854.26	89.52* (0.00)	-8.17
Bank	0.55 (0.73)	0.00085 (0.14)	-0.71* (0.00)	0.10* (0.01)	0.85* (0.00)		0.00000	0.07		0.92		0.99	0.01	5779.88	5.01* (0.00)	-5.15

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

From Table 4.1.10, it is observed that for all the return series of banking sector the ARCH coefficient is statistically significant at less than one percent level of significance which indicates that previous period shocks influence the current period volatility. For some return series the second period lag shocks (ε^2_{t-2}) has some impact on current period volatility as the ARCH coefficient (α_2) is also statistically significant.

From Table 4.1.10, it is observed that the GARCH coefficient β_1 is statistically significant for all the return series of banking sector indicating that h_{t-1} has influenced the current period volatility (h_t). However, for IDBI return series the GARCH coefficient β_2 is also significant indicating that h_{t-2} is also influenced the current period volatility. A relatively large value of GARCH coefficient indicates that shocks to conditional variance take a long time to die out. However, low value of ARCH coefficient suggests that market surprises induce relatively small revision in future volatility. A large sum of these coefficients implies that a large positive and negative return will lead future forecasts of the variance to be high for a particular period. So investor can take advantage for the same and by analyzing recent and historical news can forecast the future market movement and can take their investment strategies accordingly.

In the GARCH-M model in the mean equation the most important variable is h_t i.e. conditional variance. Here, the coefficient of h_t i.e. θ is the risk parameter. A significant positive coefficient of volatility (θ) indicates that there is positive relationship between predicted return and volatility. If volatility increases then expected return will also increases and vice versa. From Table 4.1.10, it is observed that θ is statistically significant for the return series of CBL, ICICI, INGV, J&K and KMB. But the coefficient θ is positive only for CBL, ICICI, and J&K while it is negative for INGV and KMB. For

the rest of the companies such as ABL, BOB, IDBI, ILB, PNB, SBI, YSB, and CNX Bank the coefficient θ is statistically insignificant. From this, it can be said that when volatility rises expected return is also rises for CBL, ICICI, and J&K banks. On the other hand, when volatility rises, predicted return falls for INGV and KMB. The result of banking sector is partially inconsistent with the theory of asset pricing. In the mean equation, the autoregressive (AR) and moving average (MA) coefficients are statistically significant for all banks which indicate that one, two, or three period lag return and one or two period lag residual has some impact on current period return.

A high value of R^2 depicts a very high degree of explained variation. Apart from this AIC and SIC is used in the study indicating lower for the regression which is quite reasonable and fit for our models. A high value of F-statistic states that the statistical models that are used are fit and appropriate

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the study here employs the ARCH-LM test. To check the adequacy of the mean models the Ljung-Box Q-statistics of standardized residual is used and that of square standardized residual is used to check for the adequacy of variance models.

From Table 4.1.11 it is observed that the Ljung Box Q-statistic of standardized residuals is insignificant for all the return series of banking sector except INGV, KMB and PNB indicating that the estimated mean models of each company fits the data well except INGV, KMB and PNB. For these three companies different models are used but still there remains serial correlation. Finally we have selected those mean models for these companies which have lowered AIC and SIC. However, the Ljung-Box Q statistic of square standardized residual is highly insignificant for all the return series of banking

sector except ICICI, INGV and J&K indicating that the estimated variance models fits the data very well. That is the GARCH-M models are suitable for the return series of banking sector.

Table 4.1.11: ARCH LM Test for Banking Sector

ARCH LM TEST After Estimation					Standardized Residuals		Squared Standardized Residuals	
Company	F-Statistics	P-Value	LM statistic	P-Value	Q-Statistic (36)	P-Value	Q-Statistic (36)	P-Value
ABL	0.65	0.63	2.59	0.63	26.53	0.74	23.70	0.86
BOB	0.33	0.57	0.33	0.57	27.82	0.72	24.66	0.85
BOI	0.04	0.85	0.04	0.85	35.46	0.35	25.77	0.81
CBL	0.00	0.97	0.00	0.97	29.67	0.59	34.08	0.37
ICICI	1.36	0.24	1.36	0.24	39.15	0.21	48.93	0.04
IDBI	1.05	0.30	1.06	0.30	40.63	0.12	37.39	0.20
ILB	0.60	0.44	0.60	0.44	24.74	0.82	24.26	0.84
INGV	1.58	0.21	1.58	0.21	3265.40	0.00	3265.40	0.00
J&K	0.64	0.43	0.64	0.42	32.72	0.53	47.50	0.06
KMB	0.00	1.00	0.00	1.00	13426	0.00	8.084	1.00
PNB	0.02	0.89	0.02	0.89	13269.00	0.00	5.85	1.00
SBI	0.00	0.95	0.00	0.95	30.25	0.61	41.54	0.15
YSB	0.04	0.84	0.04	0.84	33.20	0.56	29.26	0.74
CNX Bank	0.02	0.88	0.02	0.88	24.30	0.86	40.63	0.17

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.11, it is also observed that the ARCH- LM test statistic i.e. F-statistic and observed R^2 value for all the return series of banking sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the estimated models are appropriate.

To examine the leverage effect E-GARCH model is estimated. Table 4.1.12 presents the result of EGARCH model for the return series of banking sector. The E-GARCH model takes the leverage effect into account.

Table 4.1.12: Result of EGARCH Model for Banking Sector

	Variance Equation					Diagnostic Test						ARCH- LM
Company	α_0	α_1	α_2	λ_1	β_1	R^2	Adj. R^2	Log like	F-statistic	AIC	SIC	Obs.R^2
ABL	-0.32137* (0.00)	0.16* (0.00)		-0.05* (0.00)	0.99* (0.00)	0.81	0.81	9422	793* (0.00)	-11	-11	0.04 (0.84)
BOB	-0.34467* (0.00)	0.15* (0.00)		-0.02 (0.23)	0.98* (0.00)	0.30	0.30	10946	122* (0.00)	-10	-10	0.32 (0.57)
BOI	-0.63431* (0.00)	0.37* (0.00)	-0.18* (0.00)	-0.05* (0.00)	0.97* (0.00)	0.95	0.95	12940	4380* (0.00)	-12	-12	0.06 (0.80)
CBL	-0.30024* (0.00)	0.26* (0.00)	-0.16* (0.00)	-0.03* (0.01)	0.98* (0.00)	0.35	0.35	10457	2* (0.00)	-9	-9	1.04 (0.31)
ICICI	-0.23283* (0.00)	0.24* (0.00)	-0.08*** (0.10)	-0.01 (0.34)	0.99* (0.00)	0.06	0.06	9891	16* (0.00)	-9	-9	0.10 (0.75)
IDBI	-0.66663* (0.00)	0.22* (0.00)		-0.04* (0.01)	0.96* (0.00)	0.31	0.31	10601	112* (0.00)	-9	-9	13.25* (0.00)
ILB	-0.30372* (0.00)	0.16* (0.00)		0.02*** (0.08)	0.99* (0.00)	0.93	0.93	12775	3251* (0.00)	-11	-11	0.85 (0.36)
INGV	-0.6117* (0.00)	0.26* (0.00)		0.01 (0.50)	0.97* (0.00)	0.80	0.80	13845	972* (0.00)	-12	-12	2.23 (0.14)
J&K	-1.82756* (0.00)	0.29* (0.00)		-0.03 (0.20)	0.87* (0.00)	0.13	0.13	11183	50* (0.00)	-10	-10	0.12 (0.73)
KMB	-0.343* (0.00)	0.35* (0.00)	-0.14* (0.00)	0.01 (0.47)	0.99* (0.00)	0.72	0.72	12128	633* (0.00)	-11	-11	0.31 (0.58)
PNB	-0.1439* (0.00)	0.21* (0.00)	-0.13* (0.01)	-0.05* (0.00)	0.99* (0.00)	0.19	0.18	11455	56* (0.00)	-10	-10	0.85 (0.36)
SCP	-6.67E01* (0.00)	0.22* (0.00)		-0.04* (0.01)	0.96* (0.00)	0.31	0.31	10601	112* (0.00)	-9	-9	0.67 (0.41)
SBI	-0.34124* (0.00)	0.14* (0.00)		-0.03** (0.02)	0.98* (0.00)	0.12	0.12	10448	40* (0.00)			1.89 (0.17)
YSB	-0.48773* (0.00)	0.20* (0.00)		-0.07* (0.00)	0.97* (0.00)	0.20	0.20	8866	89* (0.00)	-8	-8	1.32 (0.25)
CNX Bank	-0.21214* (0.00)	0.14* (0.00)		-0.06* (0.00)	0.99* (0.00)	0.02	0.02	5796	6* (0.00)	-5	-5	0.46 (0.50)

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014. Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

From Table 4.1.12, it is observed that the asymmetric term (λ_1) is negative and statistically significant for ABL, BOI, CBL, IDBI, ILB, PNB, SBI, YSB and CNX Bank indicating that the volatility is high when there is bad news or negative shocks in the market than that of good news or positive shocks for these banks. But the asymmetric term (λ_1) is positive and statistically significant for ILB indicating that the volatility is high when there is good news or positive shocks in the market than that of bad news or negative shocks for this bank. However, the asymmetric term or leverage effect (λ_1) is statistically insignificant for BOB, ICICI, INGV,J&K and KMB indicating that these companies have not significant asymmetric or leverage effect. In the variance equation, the ARCH and GARCH coefficients are statistically significant for all the return series of Automobile sector implying that a greater shocks on volatility.

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the study here employs the ARCH-LM test. From Table 4.1.12, it is observed that the ARCH- LM test statistic i.e. obs. R^2 for all the return series of Banking sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the selected models are appropriate.

4.1.3 Volatility and its Pattern in Energy Sector:

4.3.1: Descriptive Statistics:

The descriptive statistics of daily mean returns of selected energy sector firms and energy sector index are reported in Table 4.1.13. It is observed that the daily mean return of CESC is relatively higher than that of other energy sector firms. The daily mean

return of CNX energy, i. e. energy sector index is 0.00038 (0.038%). The mean return of CNX energy is relatively higher than all the return series of energy sector except CESC.

Table 4.1.13: Descriptive Statistics for Return Series in Energy Sector

Company	Mean	Std. Dev.	Max.	Min.	Skew	Kurtosis	JB Statistic	P-Value
CESC	**0.00042**	0.027	0.16	-0.19	-0.07	7.44	1840	0.00
APL	-0.00064	0.025	0.16	-0.13	0.25	7.28	890	0.00
BFU	-0.00059	0.039	0.18	-0.16	0.52	4.77	302	0.00
JPV	**-0.00166**	0.030	0.18	-0.17	-0.13	9.38	1801	0.00
JSW	-0.00049	0.026	0.11	-0.12	-0.02	4.88	156	0.00
KSK	-0.00072	0.031	0.18	-0.22	0.71	10.57	3509	0.00
NHPC	-0.00055	0.018	0.08	-0.28	-2.92	55.51	133060	0.00
NTPC	0.00015	0.020	0.12	-0.15	-0.18	8.14	2477	0.00
NLC	-0.00003	0.031	0.20	-0.36	-0.49	18.16	21551	0.00
PGC	0.00004	0.022	0.15	-0.19	-0.41	12.90	6624	0.00
RIL	-0.00083	0.035	0.21	-0.22	-0.26	7.87	1458	0.00
RPL	-0.00110	0.031	0.18	-0.56	-3.49	68.57	275963	0.00
SJVN	-0.00016	**0.012**	0.04	-0.06	-0.03	6.32	446	0.00
TPC	-0.00065	**0.055**	0.21	**-2.32**	-33.32	1404.02	184000000	0.00
TPL	0.00015	0.031	**0.22**	-0.20	1.06	11.37	5667	0.00
CNX Energy	0.00038	0.017	0.15	-0.15	-0.25	11.47	6721	0.00

Source: Estimated by Author, data collected from NSE website www.nseindia.com[3]

The lowest even negative mean return is shown in JPV. However, in the energy sector a few firms' shows positive returns such as, CESC, NTPC, PGC, TPL and CNX Energy and all other selected firms shows negative returns. Therefore, investment in this sector is not favorable for those investors who want to invest for a long time as the mean returns for a long time is negative for most of the firms. In the energy sector (within selected firms) the return is fluctuated between 0.22 to -2.32. The highest standard

[3] Adani Power Limited (APL), BF Utilities ltd (BFU), CESC LTD (CESC), JSW Energy Limited (JSW), Jaiprakash Power Ventures Limited (JPV), KSK Energy Ventures Limited (KSK) National Thermal Power Corporation LTD (NTPC), National Hydroelectric Power Corporation (NHPC), Neyveli Lignite Corporation Limited (NLC), Power Grid Corporation of India Limited(PGC), Reliance Power Limited (RPL), Reliance Infrastructure Limited (RIL), SJVN Limited (SJVN), Torrent Power Limited (TPL), and Tata Power Company Limited (TPC).

deviation or volatility is shown in TPC where as the lowest is shown in SJVN. The volatility of energy sector index return is lower than that of all other firms except SJVN. From this, it can be said that the investor can invest in those companies which provides good returns with lower risk. The APL, BFU, KSK, and TPL are positively skewed where as the CESC, JPV, JSW, NHPC, NTPC, NLC, PGC, RIL, RPL, SJVN, TPC, and CNX Energy are negatively skewed. A positively skewed return series indicates that it has higher possibility to generate positive returns while negatively skewed implies higher probability to generate negative returns. The kurtosis of all the return series are greater than three ie; they are leptokurtic ie; the frequency distribution assigns a higher probability of very high positive and negative returns. From Table 4.1.13, it is also observed that the JB Statistic for all the return series are highly significant even at less than one per cent level of significance which indicates that the return series are not normally distributed implying the presence of heteroscedasticity. Hence, the GARCH model is justifiable for testing the hypothesis.

From Table 4.1.14, it is observed that the Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic for all the return series of energy sector is greater than their critical values even at less than one percent level of significance. Both ADF and PP test statistic confirms that there is no unit root. Therefore, the null hypothesis that the return series has unit root is rejected for all the return series and thus data for all return series are found to be stationary.

Table 4.1.14: Unit Root Test for Return Series in Energy Sector

Company Name	ADF Statistic	P-Value	PP Statistic	P-Value
Adani Power Ltd.	-19.72	0.00	-54.32	0.00
Bharat Forge Utilities Ltd.	-20.92	0.00	-28.27	0.00
Calcutta Electric Supply Corp. Ltd.	-12.40	0.00	-61.63	0.00
Jaiprakash Power Ventures Ltd.	-18.67	0.00	-92.55	0.00
JSW Energy Ltd.	-21.18	0.00	-31.89	0.00
KSK Energy Ventures Ltd.	-17.59	0.00	-26.02	0.00
Neyveli Lignite Corporation Ltd.	-14.91	0.00	-116.01	0.00
National Hydroelectric Power Corporation	-34.72	0.00	-34.64	0.00
National Thermal Power Corporation Ltd.	-13.80	0.00	-12.51	0.00
Power Grid Corporation of India Ltd	-21.19	0.00	-17.65	0.00
Reliance Infrastructure Ltd.	-34.47	0.00	-154.19	0.00
Reliance Power Ltd.	-14.13	0.00	-17.46	0.00
SJVN Limited	-9.98	0.00	-7.72	0.00
Tata Power Company Ltd.	-47.95	0.00	-47.96	0.00
Torrent Power Ltd.	-4.39	0.00	-66.07	0.00
CNX Energy	-44.89	0.00	-44.82	0.00

Source: Estimated based on secondary time series data collected from www.nseindia.com

To check ARCH effect the study here employs the ARCH-LM test of Engle (1982). The ARCH LM test regress the squared residual of the mean model (ε_t^2) on lagged squared residual (ε_{t-1}^2) and a constant.

From Table 4.1.15, it is observed that the F-statistic and the obs. R square value is greater than their critical values for all the return series as indicating by their corresponding P-value which is less than one percent level except TPC. Therefore, the null hypothesis that is no ARCH effect is rejected for these return series indicating that there is ARCH effect for these return series of energy sector. Thus, it is confirmed that the study can apply ARCH or GARCH model. However, for TPC, ARCH or GARCH model can not apply because for these return series the null hypothesis that is no ARCH effect is accepted.

Table 4.1.15: ARCH LM Test for Energy Sector

Company Name	F- Statistic	P Value	LM Statistic	P Value
Adani Power Ltd.	40.14	0.00	38.85	0.00
Bharat Forge Utilities Ltd.	40.09	0.00	39.22	0.00
Calcutta Electric Supply Corp. Ltd.	86.22	0.00	83.09	0.00
Jaiprakash Power Ventures Ltd.	78.34	0.00	73.06	0.00
JSW Energy Ltd.	4.35	0.04	4.34	0.04
KSK Energy Ventures Ltd.	41.79	0.00	40.65	0.00
Neyveli Lignite Corporation Ltd.	663.43	0.00	512.09	0.00
National Hydroelectric Power Corporation	2.74	0.10	2.74	0.10
National Thermal Power Corporation Ltd.	281.77	0.00	250.46	0.00
Power Grid Corporation of India Ltd	51.09	0.00	49.58	0.00
Reliance Infrastructure Ltd.	21.77	0.00	21.48	0.00
Reliance Power Ltd.	296.99	0.00	248.72	0.00
SJVN Limited	34.93	0.00	33.78	0.00
Tata Power Company Ltd.	0.00	0.98	0.00	0.98
Torrent Power Ltd.	51.12	0.00	49.77	0.00
CNX Energy	93.91	0.00	90.21	0.00

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

The most popular member of the ARCH class of model, i.e. GARCH-M (p,q) model is used to model volatility of energy sector return series. The Maximum Likelihood Estimation technique is used for the estimation of GARCH-M model. When using this technique the model selection is based on AIC and SIC. The model with lower value of AIC and SIC fits the data best. The return series of BFU, JSW, KSK, NPHC, RPL, SJVN, TPL and CNX Energy fits the GARCH-M (1,1) model and JPV, NLC and RIL fits GARCH-M (2,1) model whereas APL, CESC, NTPC, and PGC fits the GARCH-M (2,2) model.

As far the stationarity of the variance process is concerned, it is observed that the summation of α_i and β_i for all return series are less than one and hence the stationary

condition is satisfied for all the return series of energy sectors except NTPC. However, the sum is rather close to one which indicates a long persistence of shock on volatility. The summation of α_1 and β_1 is equal to one for NTPC which implies that the persistence of shocks on volatility is perfect as per integrated GARCH model.

Table 4.1.16: Result of GARCH-M Model for Energy Sector

	Mean Equation						Variance Equation						Diagnostic Test			
Company	**ω**	θ	ϕ_1	ϕ_2	δ_1	δ_2	α_0	α_1	α_2	β_1	β_2	$\alpha_i + \beta_i$	R^2	Log like	F-stat	AIC
APL	-0.00061* (0.00)	-1.44 (0.93)	-1.33* (0.00)	-0.40* (0.00)	1.08* (0.00)	0.42* (0.00)	0.00000 (0.35)	0.22* (0.00)	-0.21* (0.00)	1.66* (0.00)	-0.69* (0.00)	0.98	0.39	5589	68* (0.00)	-10
BFU	-0.00090 (0.26)	0.76 (0.93)	0.86* (0.00)	-0.54* (0.00)	-0.55* (0.00)	0.54* (0.00)	0.00001* (0.00)	0.12* (0.00)		0.78* (0.00)		0.89	0.16	5482	39* (0.00)	-6
CESC	0.00030* (0.00)	34.37*** (0.08)	0.54* (0.00)	0.36* (0.00)	-0.84* (0.00)		0.00000	0.14	-0.13	1.66	-0.70	0.97	0.11	10849	29	-10
JPV	-0.00167* (0.00)	7.93 (0.23)	-0.92* (0.00)	-0.92* (0.00)	0.61* (0.00)	0.23* (0.00)	0.00000*** (0.09)	0.27* (0.00)	-0.18* (0.00)	0.91* (0.00)		0.99	0.83	5586	505* (0. 00)	-11
JSW	-0.00049* (0.00)	42.70 (0.70)					0.00000** (0.02)	0.09* (0.00)		0.88* (0.00)		0.97	0.00	6572	0.75 (0.95)	-12
KSK	-0.00076* (0.00)	-2.12 (0.62)	0.50* (0.00)	-0.77* (0.00)	0.59* (0.00)		0.00000* (0.00)	0.38* (0.00)		0.60* (0.00)		0.98	0.79	7591	664* (0.00)	-11
NLC	-0.00004* (0.00)	-0.55 (0.90)	-0.78* (0.00)	-0.92* (0.00)	0.75* (0.00)		0.00000* (0.00)	0.17* (0.00)	-0.06*** (0.09)	0.88* (0.00)		0.98	0.84	12640	1279* (0.00)	-11
NPHC	-0.00053* (0.00)	103.02* (0.00)	0.14* (0.00)				0.00000* (0.00)	0.14* (0.00)		0.86* (0.00)		0.99	-0.10	8444	95* (0.00)	-12
NTPC	0.00034* (0.00)	24.70* (0.00)	0.73* (0.00)	0.03 (0.55)	0.44* (0.00)		0.00000*** (0.06)	0.20* (0.00)	-0.19* (0.00)	1.52* (0.00)	-0.53* (0.00)	1.00	0.77	13415	754* (0.00)	-12
PGC	0.00005* (0.00)	-2.43 (0.51)	1.33* (0.00)	-0.89* (0.00)	-0.71* (0.00)		0.00000* (0.00)	0.22* (0.00)	-0.20* (0.00)	1.56* (0.00)	-0.68* (0.00)	0.90	0.83	9088	811* (0.00)	-11
RIL	-0.00080* (0.00)	-14.36** (0.02)	-0.65* (0.00)		-0.42* (0.00)		0.00000** (0.02)	0.20* (0.00)	-0.12* (0.00)	0.91* (0.00)		0.99	0.63	8098	318* (0.00)	-11
RPL	-0.00106* (0.00)	2.37 (0.34)	1.10* (0.00)	-0.93* (0.00)	0.74* (0.00)		0.00000* (0.00)	0.08* (0.00)		0.90* (0.00)		0.98	0.96	9317	4288* (0.00)	-12
P-Value	0.00000	0.34	0.00	0.00	0.00		0.00600	0.00		0.00					0	
SJVN	-0.00010 (0.27)	4.41 (0.70)	0.75* (0.00)		0.42* (0.00)		0.00000* (0.00)	0.48* (0.00)		0.29* (0.00)		0.77	0.76	5955	451* (0.00)	-12
TPL	-0.00035* (0.01)	3.35* (0.01)	1.02* (0.00)	-0.05** (0.02)	-1.86	0.97	0.00000* (0.00)	0.12* (0.00)		0.85* (0.00)		0.97	0.47	8447	181* (0.00)	-9
CNX Energy	-0.00122 (0.15)	0.15** (0.03)					0.00000* (0.00)	0.10* (0.00)		0.89* (0.00)		0.99	-0.01	6357	21* (0.00)	-6

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014. Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

From Table 4.1.16, it is observed that for all the return series of energy sector the ARCH coefficient is statistically significant at less than one percent level of significance which indicates that previous period shocks influence the current period volatility. For some return series the second period lag shocks (ε^2_{t-2}) has some impact on current period volatility as the ARCH coefficient (α_2) is also statistically significant.

The GARCH coefficient (β_1) measures the impact of last period variance (h_{t-1}) on current period volatility (h_t). From Table 4.16, it is observed that the GARCH coefficient β_1 is statistically significant for all the return series of energy sector indicating that h_{t-1} has influenced the current period volatility (h_t). However, for some return series the GARCH coefficient β_2 is also significant indicating that h_{t-2} is also influenced the current period volatility. A relatively large value of GARCH coefficient indicates that shocks to conditional variance take a long time to die out. However, low value of ARCH coefficient suggests that market surprises induce relatively small revision in future volatility. A large sum of these coefficients implies that a large positive and negative return will lead future forecasts of the variance to be high for a particular period. So investor can take advantage for the same and by analyzing recent and historical news can forecast the future market movement and can take their investment strategies accordingly.

In the GARCH-M model in the mean equation the most important variable is h_t i.e. conditional variance. Here the coefficient of h_t (volatility) i.e. θ is the risk parameter. A significant positive θ indicates that there is positive relationship between predicted return and volatility. If volatility increases then expected return will also increases and vice versa. From Table 4.16, it is observed that coefficient of volatility (θ) is statistically significant for the return series of CESC, NPHC, NTPC, RIL and TPL. But the

coefficient θ is positive only for CESC, NPHC and NTPC while it is negative for RIL and TPL. For the rest of the firms such as APL, BFU, JPV, JSW, KSK, NLC, PGC, RPL, SJVN and CNX Energy the coefficient θ is statistically insignificant. From this, it can be said that when volatility rises expected return is also rises for CESC, NPHC and NTPC. On the other hand, when volatility rises, predicted return falls for RIL and TPL. The result of energy sector is partially inconsistent with the theory of asset pricing. In the mean equation, the autoregressive (AR) and moving average (MA) coefficients are statistically significant for all firm of energy sector which indicates that one, two, or three period lag return and one or two period lag residual has some impact on current period return.

A high value of R^2 depicts a very high degree of explained variation. Apart from this AIC is used in the study indicating lower for the regression which is quite reasonable and fit for our models. A high value of F-statistic states that the statistical models that are used are fit and appropriate.

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the study here employs the ARCH-LM test. To check the adequacy of the mean models the Ljung-Box Q-statistics of standardized residual is used and that of square standardized residual is used to check for the adequacy of variance models.

From Table 4.1.17 it is observed that the Ljung Box Q-statistic of standardized residuals is insignificant for all the return series of energy sector except NPHC, NTPC, PGC, RIL, RPL and CNX Energy indicating that the estimated mean models of each firm fits the data well except NPHC, NTPC, PGC, RIL, RPL and CNX Energy. For these companies different models are tried but still there remains serial correlation. Finally we

have selected those mean models for these companies which have lowered AIC and SIC. However, the Ljung-Box Q-statistic of square standardized residual is highly insignificant for all the return series of energy sector indicating that the estimated variance models fits the data very well. That is the GARCH-M models are suitable for the return series of energy sector.

Table 4.1.17: ARCH LM Test for Energy Sector

ARCH LM Test After Estimation					Standardised Residual		Square Standardised Residual	
Return Series	F-Statistics	P-Value	LM Statistic	P-Value	Q-Stat	P-Value	Q-Stat	P-Value
APL	1.42	0.23	1.42	0.23	23.78	0.85	38.38	0.20
BFU	0.33	0.57	0.33	0.57	37.03	0.25	58.24	0.00
CESC	0.46	0.50	0.46	0.50	30.29	0.60	17.98	0.98
JPV	0.01	0.93	0.01	0.93	27.11	0.71	29.61	0.59
JSW	0.21	0.64	0.21	0.64	41.30	0.25	19.94	0.99
KSK	0.20	0.65	0.20	0.65	41.08	0.16	23.11	0.90
NLC	0.23	0.63	0.23	0.63	40.69	0.14	12.81	1.00
NPHC	0.00	0.98	0.00	0.98	66.81	0.00	5.75	1.00
NTPC	1.56	0.21	1.56	0.21	52.59	0.02	27.90	0.72
PGC	0.18	0.67	0.18	0.67	49.98	0.03	33.18	0.46
RIL	0.45	0.50	0.45	0.50	39.39	0.24	30.36	0.65
RPL	0.25	0.61	0.25	0.61	45.64	0.07	1.42	1.00
SJVN	0.05	0.82	0.05	0.82	66.31	0.00	21.53	0.95
TPL	0.27	0.60	0.27	0.60	42.68	0.11	26.97	0.72
CNX Energy	0.04	0.83	0.04	0.83	56.72	0.02	26.59	0.87

Source: Estimated based on secondary time series data collected from www.nseindia.com , 2014.

From Table 4.17, it is also observed that the ARCH- LM test statistic i.e. observed R^2 and F-statistic value for all the return series of energy sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the estimated models are appropriate.

To examine the leverage effect E-GARCH model is estimated. Table 4.1.18 presents the result of EGARCH model for the return series of Energy sector.

Table 4.1.18: Result of EGARCH Model for Energy Sector

	Variance Equation						Diagnostic Test						ARCH LM Test	
Company	α_0	α_1	α_2	λ_1	β_1	β_2	R^2	Adj. R^2	Log like	F-statistic	AIC	SIC	F-Statistics	$T*R^2$
APL	-0.55* (0.00)	0.44* (0.00)	-0.17* (0.01)	0.01 (0.82)	0.97* (0.00)		0.40	0.39	5583	75* (0.00)	-10	-10	1.60 (0.21)	1.60 (0.21)
BFU	-1.08* (0.00)	0.21* (0.00)		-0.02 (0.48)	0.90* (0.00)		0.17	0.16	5485	35* (0.00)	-6	-6	0.24 (0.62)	0.24 (0.62)
CESC	-0.57* (0.00)	0.29* (0.00)	-0.09 (0.11)	-0.04** (0.02)	0.97* (0.00)		0.11	0.11	10846	32* (0.00)	-10	-10	0.95 (0.33)	0.95 (0.33)
JPV	-0.29** (0.02)	0.41* (0.00)	-0.26* (0.00)	-0.05* (0.00)	0.99* (0.00)		0.83	0.83	5589	503* (0.00)	-11	-11	0.01 (0.92)	0.01 (0.92)
JSW	-0.78* (0.00)	0.20* (0.00)		-0.01 (0.80)	0.96* (0.00)		0.00	0.00	6574		-12	-12	0.38 (0.54)	0.38 (0.54)
KSK	-2.12* (0.00)	0.57* (0.00)		-0.09** (0.02)	0.87* (0.00)		0.79	0.79	7603	664* (0.00)	-11	-11	0.21 (0.65)	0.21 (0.65)
NLC	-0.44* (0.00)	0.31* (0.00)	-0.10*** (0.06)	-0.03** (0.05)	0.98* (0.00)		0.84	0.84	12642	1277* (0.00)	-11	-11	0.68 (0.41)	0.68 (0.41)
NPHC	-9.56* (0.00)	0.21* (0.00)		0.45* (0.00)	0.31* (0.00)		-0.02	-0.02	7996		-11	-11	0.35 (0.55)	0.35 (0.55)
NTPC	-0.08* (0.00)	0.39* (0.00)	-0.35* (0.00)	0.00 (0.81)	1.63* (0.00)	-0.64* (0.00)	0.77	0.77	13416	755* (0.00)	-12	-12	3.43*** (0.06)	3.43*** (0.06)
PGC	-0.08* (0.00)	0.42* (0.00)	-0.38* (0.00)	0.01** (0.05)	1.64* (0.00)	-0.64* (0.00)	0.84	0.83	9090	814* (0.00)	-11	-11	0.04 (0.85)	0.04 (0.85)
RIL	-0.28* (0.00)	0.36* (0.00)	-0.19* (0.00)	0.03** (0.04)	0.99* (0.00)		0.64	0.64	8094	318* (0.00)	-11	-11	0.50 (0.48)	0.50 (0.48)
RPL	-0.69* (0.00)	0.20* (0.00)		-0.03 (0.13)	0.96* (0.00)		0.96	0.96	9321	4277* (0.00)	-12	-12	0.05 (0.82)	0.05 (0.82)
SJVN	-6.43* (0.00)	0.78* (0.00)		-0.07 (0.27)	0.61* (0.00)		0.77	0.76	5961	449* (0.00)	-12	-12	0.11 (0.74)	0.11 (0.74)
TPL	-0.67* (0.00)	0.27* (0.00)		-0.02 (0.25)	0.96* (0.00)		0.47	0.47	8447	179* (0.00)	-9	-9	1.35 (0.24)	1.35 (0.24)
CNX Energy	-0.34* (0.00)		0.20* (0.00)	-0.05* (0.00)	0.98* (0.00)		0.00	0.00	6361	2	-6	-6	0.02 (0.89)	0.02 (0.89)

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

From Table 4.1.18, it is observed that the asymmetric term (λ_1) is negative and statistically significant for CESC, JPV, KSK, NLC, and CNX Energy indicating that the volatility is high when there is bad news or negative shocks in the market than that of good news or positive shocks for these firms. But the asymmetric term (λ_1) is positive and statistically significant for NPHC, PGC and RIL indicating that the volatility is high when or positive shocks in the market than that of bad news or negative shocks for these firms. However, the asymmetric term (λ_1) is statistically insignificant for APL, BFU, JSW, NTPC, RPL, SJVN and TPL indicating that these companies have not significant asymmetric or leverage effect. In the variance equation, the ARCH and GARCH coefficients are statistically significant for all the return series of energy sector implying that a greater shocks on volatility.

From Table 4.1.18, it is also observed that the ARCH- LM test statistic i.e. F-statistic and LM statistic ($T*R^2$) value for all the return series of energy sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the selected models are appropriate.

4.1.4 Volatility and its Pattern in Financial Sector:

This analysis is started with descriptive statistics of daily returns of selected financial sector firms and financial sectoral index are reported in Table 4.1.19.

Table 4.1.19 Descriptive Statistics of Return Series in Financial Sector

Company	Mean	Std. Dev.	Maximum	Minimum	Skewness	Kurtosis	J B Statistic	P-Value
BFL	0.000957	**0.020**	0.097	-0.073	0.339	5	141	0.00
BFSL	0.000301	0.028	0.182	-0.223	-0.161	10	3156	0.00
BHI	0.000184	0.024	0.172	-0.182	-0.187	12	4963	0.00
CIFC	0.00073	0.021	0.131	-0.092	0.482	6	382	0.00
GFL	0.000816	0.042	0.165	-1.570	-22.947	862	68910180	0.00
IDFC	0.000263	0.032	0.221	-0.181	0.199	7	1647	0.00
IFCI	0.000309	0.040	0.249	-0.283	-0.029	9	2925	0.00
LTH	0.000587	0.022	0.150	-0.101	0.984	9	1145	0.00
LICH	0.000005	**0.045**	**0.270**	**-1.591**	-20.054	721	48205721	0.00
MMF	0.00004	0.044	0.160	-1.610	-24.439	899	67096329	0.00
MFL	**-0.00003**	0.030	0.182	-0.145	0.725	10	1473	0.00
RCL	0.000255	0.036	0.235	-0.217	-0.049	8	2111	0.00
SCU	0.001538	0.024	0.173	-0.218	0.521	15	13898	0.00
SRT	**0.001161**	0.026	0.163	-0.172	0.364	8	2133	0.00
SFL	0.000374	0.029	0.115	-0.730	-13.207	331	10099304	0.00
CNX Finance	0.000636	0.021	0.178	-0.126	0.082	8	2411	0.00

Source: Computed based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.19, it is observed that the daily mean return of SRT is relatively higher than that of [4]other financial sector firms. The daily mean return of CNX Finance, i.e; financial sector index is 0.00063 (0.063%). The mean returns of SRT, BFL, GFL and CIFC are relatively higher than that of financial sector index which implies that the contribution of these firms to the financial sector index is more than other firms. So the investor can invest in these firms with expectation of higher returns. But the mean returns of BFSL, BHI, IDFC, IFCI, LTH, LICH, MMF, MFL, RCL and SFL lower than the financial sector index returns. The lowest even negative mean return is shown in MFL. However, except MFL all other firms have shown positive returns. In the financial

[4] Bajaj Finance Ltd (BFL), Bajaj Finanserv Ltd (BFSL), Bajaj Holdings & Investment Ltd. (BHI), Cholamandalam Investment and Finance Company Limited (CIFC), Gruh Finance Limited (GFL), IDFC Ltd (IDFC), IFCI, L &T Holdings (LTH), LIC Housing (LICH), Mahindra & Mahindra Financial (MMF), Muthoot Finance Limited (MFL), Reliance Capital Ltd (RCL), Shri City Union (SCU), Sriram Trans (SRT), Sundaram Finance Limited (SFL), Finacial Sector Index (CNX Finance).

sectors (within selected firms) the return is fluctuated between 0.27 to -1.60. The highest standard deviation or volatility is shown in LICH where as the lowest is shown in BFL. Here, it is observed that the highest mean return is associated with the lower risk while the lowest mean return is associated with the higher risk, which is controversial to the Capital Asset Pricing Model (CAPM). The volatility of financial sector index return is lower than that of all other firms except BFL. From this, it can be said that the investor can invest in those companies which provides good returns with lower risk. The BFL, CIFC, IDFC, LTH, MFL, SCU, SRT and CNX Finance are positively skewed where as the GFL, BFSL, BHI, IFCI, LICH, MMF, RCL and SFL are negatively skewed. A positively skewed return series indicates that it has higher possibility to generate positive returns while negatively skewed implies higher probability to generate negative returns. The kurtosis of all the return series are greater than three thus, they are leptokurtic; i e; the frequency distribution assigns a higher probability of very high positive and negative returns. From Table 4.1.19, it is also observed that the JB Statistic for all the return series are highly significant even at less than one percent level which indicates that the return series are not normally distributed implying the presence of heteroscedasticity. Hence, the GARCH model is suitable for testing the hypothesis.

From Table 4.1.20, it is observed that the Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic for all the return series of financial sector is greater than their critical values even at less than one percent level of significance. Both ADF and PP test statistic confirms that there is no unit root. Therefore, the null hypothesis that the return series has unit root is rejected for all the return series and thus data for all return series are found to be stationary.

Table 4.1.20: Unit Root Test for Return Series in Financial Sector

Return Series	ADF		PP	
	Statistic	P-Value	Statistic	P-Value
BFL	-21.61	0.00	-21.70	0.00
BFSL	-11.08	0.00	-23.62	0.00
BHI	-15.27	0.00	-95.55	0.00
CIFC	-18.37	0.00	-36.38	0.00
GFL	-31.83	0.00	-53.36	0.00
IDFC	-33.70	0.00	-43.44	0.00
IFCI	-25.70	0.00	-33.82	0.00
LICH	-45.60	0.00	-45.60	0.00
LTH	-16.99	0.00	-24.11	0.00
MFL	-23.37	0.00	-23.37	0.00
MMF	-45.08	0.00	-45.08	0.00
RCL	-27.70	0.00	-55.81	0.00
SCU	-36.71	0.00	-84.45	0.00
SFL	-45.94	0.00	-45.96	0.00
SRT	-32.19	0.00	-34.77	0.00
Finance	-41.60	0.00	-41.39	0.00
Test critical values:				
1% level		5% level		10% level
-3.43308		-2.86263		-2.5674

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

To check ARCH effect the study here employs the ARCH-LM test of Engle (1982). The ARCH LM test regress the squared residual of the mean model (ε_t^2) on lagged squared residual (ε_{t-1}^2) and a constant.

From Table 4.1.21, it is observed that the F-statistic and the LM statistic ($T*R^2$) value is greater than their critical values for BFL, BSFL, BHI, CIFC, IDFC, IFCI, LTH, MFL, SCU, SRT, RCL,SFL and CNX Finance return series as indicating by their corresponding P-value which is less than one percent level. Therefore, the null hypothesis that is no ARCH effect is rejected for these the return series indicating that there is ARCH effect for these the return series of financial sector. Thus, it is confirmed that the study can apply ARCH or GARCH model. However, for GFL, LICH, MMF and SFL

ARCH or GARCH model can not apply because for these return series the null hypothesis that is no ARCH effect is accepted.

Table 4.1.21: ARCH-LM Test for Financial Sector

Company Name	F-Statistics	P Value	LM statistics	P Value
Bajaj Finance Ltd.	19.77	0.00	19.38	0.00
Bajaj Finance Service Ltd.	82.16	0.00	77.87	0.00
Bajaj Holdings & Investment Ltd.	236.63	0.00	204.64	0.00
Cholamandalam Investment and Finance Company Ltd.	74.43	0.00	71.00	0.00
Gruh Finance Ltd.	0.00	0.98	0.00	0.98
Industrial Development. Finance Corp.	104.49	0.00	99.74	0.00
Industrial Finance Corp. of India	103.05	0.00	98.60	0.00
Life Insurance Corporation Housing	0.00	0.96	0.00	0.96
Larsen &Toubro Holdings	34.12	0.00	32.53	0.00
Muthoot Finance Ltd.	17.82	0.00	17.44	0.00
Mahindra & Mahindra Financial Ltd.	0.00	0.99	0.00	0.99
Relience Capital Ltd.	101.79	0.00	97.45	0.00
Shri. City Union	167.94	0.00	156.32	0.00
Sundaram Finance Ltd.	0.00	0.99	0.00	0.99
Sriram Trans	129.45	0.00	122.47	0.00
CNX Finance	46.11	0.00	45.22	0.00

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

The most popular member of the ARCH class of model, i.e. GARCH-M (p,q) model is used to model volatility of financial sector return series. The Maximum Likelihood Estimation technique is used for the estimation of GARCH-M model. When using this technique the model selection is based on AIC and SIC. The model with lower value of AIC and SIC fits the data best. The return series of IDFC, LTH, MFL and CNX Finance fits the GARCH-M (1,1) model and BFL, CIFC, RCL and SRT fits GARCH-M (2,1) model whereas BFSL, BHI, IFCI, and SCU fits the GARCH-M (2,2) model.

As far the stationarity of the variance process is concerned, it is observed that the summation of α_i and β_i for all return series are less than one and hence the stationary

condition is satisfied for all the return series of financial sectors except CIFC and SCU. However, the sum is rather close to one which indicates a long persistence of shock on volatility. The summation of α_1 and β_1 is greater than one for CIFC and SCU which implies that the persistence of shocks on volatility is unstable.

Table 4.1.22: Result of GARCH-M Model for Financial Sector:

	Mean Equation							Variance Equation						Diagnostic Test			
Company	**ω**	θ	ϕ_1	ϕ_2	ϕ_3	δ_1	δ_2	α_0	α_1	α_2	β_1	β_2	$\alpha_i + \beta_i$	Adj. R^2	Log like	F-statistic	AIC
BFL	0.00102* (0.00)	-0.05 (0.43)	0.87* (0.00)	-0.82* (0.00)		-0.48* (0.00)		0.00000 (0.13)	0.22* (0.00)	-0.15** (0.05)	0.88* (0.00)		0.95	0.71	4627	237* (0.00)	-10
BFSL	-0.00006 (0.77)	-7.45** (0.04)	-0.36* (0.00)	-0.29* (0.00)	0.60* (0.00)	0.77* (0.00)	0.91* (0.00)	0.00000 (0.17)	0.20* (0.00)	-0.19* (0.00)	1.45* (0.00)	-0.47* (0.00)	0.99	0.50	5849	123* (0.00)	-8
BHI	0.00017* (0.00)	-24.26 (0.12)	-0.77* (0.00)	-0.50* (0.00)	0.25* (0.00)	0.95* (0.00)	0.88* (0.00)	0.00000** (0.02)	0.29* (0.00)	-0.29* (0.00)	1.57* (0.00)	-0.58* (0.00)	0.99	0.25	7985	40* (0.00)	-11
CIFC	0.00073* (0.00)	-6.12 (0.67)						0.00000* (0.00)	0.14* (0.00)	0.45* (0.00)	0.43* (0.00)		1.02	0.00	9732	2* (0.00)	-13
IDFC	0.00032* (0.00)	-16.51 (0.23)	-0.55* (0.00)			0.62* (0.00)		0.00000* (0.00)	0.07* (0.00)		0.91* (0.00)		0.98	0.01	10004	3* (0.00)	-9
IFCI	-0.00014** (0.04)	60.78* (0.00)	0.94* (0.00)	-0.44* (0.00)		-0.66* (0.00)		0.00000** (0.02)	0.20* (0.00)	-0.19* (0.00)	1.38* (0.00)	-0.41* (0.00)	0.98	0.21	10334	60* (0.00)	-9
LTH	0.00049** (0.02)	-3.64 (0.79)	0.79* (0.00)	-0.15* (0.00)		-0.78* (0.00)		0.00000* (0.01)	0.27* (0.00)		0.49* (0.00)		0.75	0.01	2749	2* (0.00)	-8
MFL	-0.00024 (0.23)	0.56 (0.96)	0.03 (0.41)					0.00001* (0.00)	0.29* (0.00)		0.33** (0.03)		0.62	0.00	3069	1* (0.00)	-8
RCL	0.00016* (0.01)	27.20* (0.00)	-0.80* (0.00)			0.60* (0.00)		0.00000* (0.00)	0.17* (0.00)	-0.08** (0.03)	0.90* (0.00)		0.99	0.05	10270	16* (0.00)	-9
SCU	0.00157* (0.00)	1.24 (0.45)	0.25* (0.00)	-0.96* (0.00)		0.16* (0.00)		0.00000* (0.02)	0.48* (0.00)	-0.41* (0.00)	1.17* (0.00)	-0.24* (0.00)	1.01	0.93	14080	3119* (0.00)	-13
SRT	0.00116* (0.00)	-10.81 (0.20)	1.04* (0.00)	-0.85* (0.00)		-0.65* (0.00)		0.00000* (0.00)	0.33* (0.00)	-0.14** (0.04)	0.70* (0.00)		0.89	0.72	13199	643* (0.00)	-12
CNX Finance	0.00267 (0.61)	0.00 (0.77)	0.13* (0.00)					0.00000* (0.00)	0.08* (0.00)		0.91* (0.00)		0.99	0.01	5904	6* (0.00)	-5

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five percent and *** denotes the ten percent.

From Table 4.1.22, it is observed that for all the return series of financial sector the ARCH coefficient is statistically significant at less than one percent level of significance which indicates that previous period shocks influence the current period volatility. For some return series the second period lag shocks (ε^2_{t-2}) has some impact on current period volatility as the ARCH coefficient (α_2) is also statistically significant.

From Table 4.1.22, it is observed that the GARCH coefficient β_1 is statistically significant for all the return series of financial sector indicating that h_{t-1} has influenced the current period volatility (h_t). However, for some return series the GARCH coefficient β_2 is also significant indicating that h_{t-2} is also influenced the current period volatility. A relatively large value of GARCH coefficient indicates that shocks to conditional variance take a long time to die out. However, low value of ARCH coefficient suggests that market surprises induce relatively small revision in future volatility. A large sum of these coefficients implies that a large positive and negative return will lead future forecasts of the variance to be high for a particular period. So investor can take advantage for the same and by analyzing recent and historical news can forecast the future market movement and can take their investment strategies accordingly.

From Table 4.1.22, it is observed that θ is statistically significant for the return series of BFSL, IFCI and RCL. But the coefficient θ is positive only for IFCI and RCL while it is negative for BFSL. For the rest of the firms such as BFL, BHI, CIFC, IDFC, IFCI, LTH, MFL, SCU, SRT and CNX Finance the coefficient θ is statistically insignificant. From this, it can be said that when volatility rises expected return is also rises for IFCI and RCL. On the other hand, when volatility rises, predicted return falls for BFSL. The result of financial sector is partially inconsistent with the theory of asset

pricing. In the mean equation, the autoregressive (AR) and moving average (MA) coefficients are statistically significant for all firms of financial sector which indicates that one, two, or three period lag return and one or two period lag residual has some impact on current period return.

A high value of R^2 depicts a very high degree of explained variation. Apart from this AIC is used in the study indicating lower for the regression which is quite reasonable and fit for our models. A high value of F-statistic states that the statistical models that are used are fit and appropriate.

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the study here employs the ARCH-LM test. To check the adequacy of the mean models the Ljung-Box Q-statistics of standardized residual is used and that of square standardized residual is used to check for the adequacy of variance models.

Table 4.1.23: ARCH -LM Test for Financial Sector

ARCH LM Test					Standardized Residual		Squared Standardized Residual	
Company	F-Statistics	P-Value	LM statistic	P-Value	Q-Statistic	P-Value	Q-Statistic	P-Value
BFL	0.54	0.46	0.54	0.46	24.14	0.87	19.61	0.97
BFSL	0.24	0.62	0.24	0.62	25.11	0.76	16.28	0.99
BHI	1.93	0.17	1.93	0.17	97.50	0.00	29.50	0.49
CIFC	0.00	0.99	0.00	0.99	815.13	0.00	0.05	1.00
IDFC	0.03	0.87	0.03	0.87	31.31	0.12	24.31	0.39
IFCI	0.54	0.46	0.54	0.46	30.75	0.58	17.11	0.99
LTH	0.43	0.51	0.43	0.51	37.06	0.29	37.08	0.29
MFL	0.07	0.79	0.07	0.79	34.36	0.50	33.79	0.53
RCL	0.07	0.80	0.07	0.80	56.54	0.01	28.91	0.72
SCU	0.17	0.68	0.17	0.68	35.89	0.34	22.08	0.93
SRT	0.75	0.39	0.75	0.39	38.31	0.24	30.20	0.61
Finance	0.00	0.96	0.00	0.96	27.88	0.80	33.48	0.54

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.23, it is observed that the Ljung Box Q-statistic of standardized residuals is insignificant for all the return series of financial sector except BHI, CIFC and RCL indicating that the estimated mean models of each firm fits the data well except BHI, CIFC and RCL. For these three companies different models are used but still there remains serial correlation. Finally we have selected those mean models for these companies which have lowered AIC and SIC. However, the Ljung-Box Q-statistic of square standardized residual is highly insignificant for all the return series of financial sector indicating that the estimated variance models fits the data very well. That is the GARCH-M models are suitable for the return series of financial sector.

From Table 4.1.23, it is observed that the ARCH- LM test statistic i.e. LM statistic and F-statistic value for all the return series of financial sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the estimated models are appropriate.

To examine the leverage effect E-GARCH model is estimated. Table 4.1.24 presents the results of EGARCH model for the return series of financial sector.

Table 4.1.24: Result of EGARCH Model for Financial Sector

	Variance Equation				Diagnostic Test					ARCH- LM Test	
Company	α_0	α_1	λ_1	β_1	Adj. R^2	Log like	F-statistic	AIC	SIC	F-Statistics	LM statistic
BFL	-0.733** (0.03)	0.15* (0.00)	-0.04*** (0.08)	0.95* (0.00)	0.71	4627	267* (0.00)	-10	-10	1.59 (0.21)	1.60 (0.21)
BFSL	-0.389* (0.00)	0.18* (0.00)	0.00 (0.82)	0.98* (0.00)	0.51	5848	150* (0.00)	-8	-8	1.75 (0.19)	1.75 (0.19)
BHI	-0.574* (0.00)	0.28* (0.00)	0.06** (0.04)	0.97* (0.00)	0.26	7968	48* (0.00)	-11	-11	2.14 (0.14)	2.14 (0.14)
CIFC	-11.363* (0.00)	0.60* (0.00)	0.07 (0.30)	0.18*** (0.06)	0.00	8250	2* (0.00)	-11	-11	11.18* (0.00)	11.11* (0.00)
IDFC	-0.297* (0.00)	0.14* (0.00)	0.05* (0.00)	0.98* (0.00)	0.00	10009	2* (0.00)	-9	-9	0.44 (0.51)	0.44 (0.51)
IFCI	-0.608* (0.00)	0.25* (0.00)	-0.05** (0.03)	0.58* (0.00)	0.21	10336	68* (0.00)	-9	-9	1.45 (0.23)	1.45 (0.23)
LTH	-2.438* (0.00)	0.40* (0.00)	0.03 (0.62)	0.81* (0.00)	0.02	2750	2* (0.00)	-8	-8	0.06 (0.81)	0.06 (0.81)
MFL	-5.092* (0.00)	0.48* (0.00)	-0.09 (0.23)	0.57* (0.00)	0.00	3070	0* (0.00)	-8	-8	0.04 (0.84)	0.04 (0.84)
RCL	-0.470* (0.00)	0.22* (0.00)	-0.05* (0.00)	0.97* (0.00)	0.06	10272	20* (0.00)	-9	-9	2.70*** (0.10)	2.70*** (0.10)
SCU	-1.910* (0.00)	0.59* (0.00)	0.03 (0.43)	0.90* (0.00)	0.93	14078	3911* (0.00)	-13	-13	0.01 (0.93)	0.01 (0.93)
SRT	-3.797* (0.00)	0.49* (0.00)	-0.09* (0.01)	0.76* (0.00)	0.72	13208	726* (0.00)	-12	-12	0.28 (0.59)	0.28 (0.59)
Finance	-0.247* (0.00)	0.15* (0.00)	-0.07* (0.00)	0.98* (0.00)	0.01	5915	6* (0.00)	-5	-5	0.06 (0.81)	0.06 (0.81)

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.
Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

From Table 4.1.24, it is observed that the asymmetric term (λ_1) is negative and statistically significant for BFL, IFCI, RCL, SRT and CNX Finance indicating that the volatility is high when there is bad news or negative shocks in the market than that of good news or positive shocks for these firms. But the asymmetric term (λ_1) is positive and statistically significant for BHI and IDFC indicating that the volatility is high when there is good news or positive shocks in the market than that of bad news or negative shocks for these firms. However, the asymmetric term (λ_1) is statistically insignificant for BFSL, CIFC, LTH, MFL, and SCU indicating that these companies have not significant asymmetric or leverage effect. In the variance equation, the ARCH and GARCH coefficients are statistically significant for all the return series of financial sector implying that a greater shocks on volatility.

From Table 4.1.24, it is further observed that the ARCH- LM test statistic i.e. F-statistic and observed R^2 value for all the return series of financial sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the selected models are appropriate.

4.1.5 Volatility and its Pattern in FMCG Sector:

This analysis is started with descriptive statistics of daily returns of selected FMCG companies and FMCG sector index are reported in Table 4.1.25. From Table 4.25, it is observed that the daily mean return of GSCH is relatively higher [5]than that of other FMCG sector firms. The daily mean return of CNX FMCG, i. e. FMCG sector

[5] Britannia Inds. Ltd (BIL), Bajaj Corp Limited (BCL), Colgate Palmolive (India) Ltd (CPI), Dabur India Ltd. (DIL), Emami Limited (EL), Gillette India Limited (GIL), GlaxoSmithkline Consumer Healthcare Ltd. (GSCH), Godrej Consumer Products Ltd. (GCP), Hindustan Unilever Ltd. (HUL), Jyothy Laboratories Limited (JLL), KRBL Limited (KRBL), Marico Ltd. (ML), Nestle India Limited (NIL), P & G Hygiene (PGHC), Zydus Wellness Limited (ZWL), Fast Moving Consumer Goods (FMCG) Sector index (CNX FMCG).

index is 0.00083 (0.083 per cent). The mean return of CNX FMCG is relatively higher than all the return series of FMCG sector except GSCH. The lowest even negative mean return is shown in PGHC. However, in the FMCG sector a few firms' shows positive returns such as, CPI, DIL, EL, GIL, GSCH, GCP, HUL, NIL, ZWL and CNX FMCG and all other selected firms shows negative returns.

Table 4.1.25: Descriptive Statistic of Return Series in FMCG Sector

Company	Mean	Std. Dev.	Maximum	Minimum	Skewness	Kurtosis	J B Statistic	P-Value
BIL	-0.00001	0.04	0.15	-1.48	-32.17	1344	168000000	0.00
BCL	-0.00138	0.06	0.15	-1.60	-24.43	688	17783360	0.00
CPI	0.00080	0.02	0.07	-0.09	0.31	6	543	0.00
DIL	0.00023	0.03	**0.18**	-0.72	-11.58	254	5926828	0.00
EL	0.00025	0.03	0.18	-0.71	-6.96	153	1794115	0.00
GIL	0.00040	0.02	0.18	-0.09	1.33	13	8377	0.00
GSCH	**0.00112**	0.02	0.18	-0.15	0.67	12	8181	0.00
GCP	0.00047	0.04	0.14	-1.39	-24.88	955	84732510	0.00
HUL	0.00067	0.02	0.16	-0.08	0.45	8	2090	0.00
JLL	-0.00087	0.05	0.15	-1.49	-18.38	524	17719726	0.00
KRBL	-0.00217	0.10	0.18	-3.89	-30.47	1109	115000000	0.00
ML	-0.00010	0.05	0.15	-2.28	-36.22	1557	221000000	0.00
NIL	0.00063	0.01	0.07	-0.06	0.04	5	147	0.00
PGHC	**-0.00284**	**0.17**	0.14	**-8.07**	-46.56	2192	448000000	0.00
ZWL	0.00082	0.02	0.18	-0.12	1.48	13	4876	0.00
CNX_ FMCG	0.00083	**0.014**	0.08	-0.09	-0.24	6.33	1057	0.00

Source: Computed based on secondary time series data collected from www.nseindia.com, 2014.

In the FMCG sector (within selected firms) the return is fluctuated between 0.18 to -8.07. The highest standard deviation or volatility is shown in PGHC where as the lowest is shown in CNX FMCG. The volatility of FMCG sector index return is lower than that of all other selected firms. From this, it can be said that the investor can invest in those companies which provides good returns with lower risk. Here, it is also find that

investment in portfolio is associated with lower risk and higher returns than that of investment of individual stock. The CPI, GIL, GSCH and HUL are positively skewed where as the BIL, BCL, DIL, EL, GCP, JLL, KRBL, ML, NIL, PGHC, ZWL and CNX FMCG are negatively skewed. A positively skewed return series indicates that it has higher possibility to generate positive returns while negatively skewed implies higher probability to generate negative returns. The kurtosis of all the return series are greater than three thus, they are leptokurtic; ie; the frequency distribution assigns a higher probability of very high positive and negative returns. From Table 4.1.25, it is also observed that the JB Statistic for all the return series are highly significant even at less than one percent level of significance which indicates that the return series are not normally distributed implying the presence of heteroscedasticity. Hence, the GARCH model is justifiable for testing the hypothesis.

Table 4.1.26: Unit Root Test for FMCG Sector

Company Name	ADF Statistic	P-Value	PP Statistic	P-Value
Bajaj Corporation Ltd	-4.23	0.00	-10.38	0.00
Britannia Inds. Ltd	-36.03	0.00	-31.11	0.00
Colgate Palmolive India Ltd.	-124.26	0.00	-131.22	0.00
Dabur India Ltd.	-13.16	0.00	-13.14	0.00
Emami Ltd	-16.79	0.00	-16.84	0.00
Godrej Consumer Products Ltd	-8.72	0.00	-22.21	0.00
Gillette India Ltd	-15.78	0.00	-15.79	0.00
Glaxo Smithkline Consumer Healthcare Ltd.	-9.38	0.00	-74.61	0.00
Hindustan Unilever Ltd.	-5.90	0.00	-28.69	0.00
Jyothy Laboratories Ltd.	-10.17	0.00	-103.70	0.00
Khushi Ram Behari Lal Ltd.	-26.26	0.00	-26.30	0.00
Marico Ltd.	-51.10	0.00	-9.54	0.00
Nestle India Ltd.	-5.94	0.00	-18.91	0.00
Procter & Gamble Hygiene	-5.03	0.00	-5.02	0.00
Zydus Wellness Ltd.	-10.41	0.00	-92.51	0.00
CNX FMCG	-46.24	0.00	-46.23	0.00

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.26, it is observed that the Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic for all the return series of FMCG sector is greater than their critical values even at less than one percent level of significance. Both ADF and PP test statistic confirms that there is no unit root. Therefore, the null hypothesis that the return series has unit root is rejected for all the return series and thus data for all return series are found to be stationary.

To check ARCH effect the study here employs the ARCH-LM test of Engle (1982). The ARCH LM test regress the squared residual of the mean model (ε_t^2) on lagged squared residual (ε_{t-1}^2) and a constant.

Table 4.1.27: ARCH LM TEST for FMCG Sector

Company Name	F-Statistic	P-Value	LM Statistic ($T*R^2$)	P-Value
Bajaj Corporation Ltd	225.70	0.00	180.93	0.00
Britannia Inds. Ltd	1796.32	0.00	996.98	0.00
Colgate Palmolive India Ltd.	39.01	0.00	38.10	0.00
Dabur India Ltd.	0.00	1.00	0.00	1.00
Emami Ltd	0.08	0.78	0.08	0.78
Godrej Consumer Products Ltd	118.10	0.00	112.28	0.00
Gillette India Ltd	73.30	0.00	70.77	0.00
Glaxo Smithkline Consumer Healthcare Ltd.	64.15	0.00	62.42	0.00
Hindustan Unilever Ltd.	67.71	0.00	65.14	0.00
Jyothy Laboratories Ltd.	0.00	1.00	0.00	1.00
Khushi Ram Behari Lal Ltd.	0.00	0.99	0.00	0.99
Marico Ltd.	6.36	0.01	6.34	0.01
Nestle India Ltd.	26.28	0.00	25.69	0.00
Procter & Gamble Hygiene	0.09	0.76	0.09	0.76
Zydus Wellness Ltd.	8.10	0.00	8.06	0.00
CNX FMCG	388.34	0.00	331.17	0.00

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.27, it is observed that the F-statistic and the observed R square value is greater than their critical values for BCL, BIL,CPI, GCP, GIL, GSCH, HUL,

ML, NIL, ZWL and CNX FMCG return series as indicating by their corresponding P-value which is less than one percent level. Therefore, the null hypothesis that is no ARCH effect is rejected for these return series indicating that there is ARCH effect for these return series of FMCG sector. Thus, it is confirmed that the study can apply ARCH or GARCH model. However, for DIL, EL, JIL, KRBL and PGHC the ARCH or GARCH model can not apply because for these return series the null hypothesis that is no ARCH effect is accepted.

The most popular member of the ARCH class of model, i.e. GARCH-M (p,q) model is used to model volatility of FMCG sector return series. The Maximum Likelihood Estimation technique is used for the estimation of GARCH-M model. When using this technique the model selection is based on AIC and SIC. The model with lower value of AIC and SIC fits the data best. The return series of BCL, BIL, CPI, GCP, GIL, HUL, ML, ZWL, and CNX FMCG fits the GARCH-M (1,1) model and GSCH and NIL fits GARCH-M (2,1) model.

As far the stationarity of the variance process is concerned, it is observed that the summation of α_i and β_i for all return series are less than one and hence the stationary condition is satisfied for all the return series of FMCG sectors except BCL and ML. However, the sum is rather close to one which indicates a long persistence of shock on volatility The summation of α_1 and β_1 is greater than one for BCL and ML which implies that the persistence of shocks on volatility is unstable.

From Table 4.1.28, it is observed that for all the return series of FMCG sector the ARCH coefficient is statistically significant at less than one percent level of significance which indicates that previous period shocks influence the current period volatility. For

some return series the second period lag shocks (ε^2_{t-2}) has some impact on current period volatility as the ARCH coefficient (α_2) is also statistically significant.

From Table 4.1.28, it is observed that the GARCH coefficient β_1 is statistically significant for all the return series of FMCG sector indicating that h_{t-1} has influenced the current period volatility (h_t). A relatively large value of GARCH coefficient indicates that shocks to conditional variance take a long time to die out. However, low value of ARCH coefficient suggests that market surprises induce relatively small revision in future volatility. A large sum of these coefficients implies that a large positive and negative return will lead future forecasts of the variance to be high for a particular period. So investor can take advantage for the same and by analyzing recent and historical news can forecast the future market movement and can take their investment strategies accordingly.

In the GARCH-M model in the mean equation the most important variable is h_t i.e. conditional variance. Here the coefficient of h_t i.e. θ is the risk parameter. A significant positive θ indicates that there is positive relationship between predicted return and volatility. If volatility increases then expected return will also increases and vice versa. From Table 4.1.28, it is observed that θ is statistically significant for the return series of BIL, ML, NIL and ZWL. But the coefficient θ is positive only for ZWL while it is negative for BIL, ML and NIL. For the rest of the firms such as BCL, CPI, GCP, GIL, GSCH, HUL and CNX FMCG the coefficient θ is statistically insignificant. From this, it can be said that when volatility rises expected return is also rises for ZWL. On the other hand, when volatility rises, predicted return falls for BIL, ML, and NIL. The result of FMCG sector is almost inconsistent with the theory of asset pricing. In the mean equation, the autoregressive (AR) and moving average (MA) coefficients are statistically

significant for all firm of FMCG sector which indicates that one or two period lag return and one or two period lag residual has some impact on current period return.

A high value of adjusted R^2 depicts a very high degree of explained variation. Apart from this AIC is used in the study indicating lower for the regression which is quite reasonable and fit for our models. A high value of F-statistic states that the statistical models that are used are fit and appropriate.

Table 4.1.28: Result of GARCH Model for FMCG Sector

Company	Mean Equation						Variance Equation					Diagnostic Test				
	ω	θ	ϕ_1	ϕ_2	δ_1	δ_2	α_0	α_1	α_2	β_1	$\alpha_i + \beta_i$	Adj R^2	Log like	F-statistic	AIC	SIC
BCL	-0.00144* (0.00)	0.94 (0.70)	1.35* (0.00)	-0.97* (0.00)	0.10* (0.01)		0.00000** (0.03)	0.47* (0.00)		0.64* (0.00)	1.11	0.88	5773	805* (0.00)	-13	-13
BIL	0.00000 (0.13)	-1.18*** (0.08)	1.08* (0.00)	-0.89* (0.00)	-0.53* (0.00)		0.00000* (0.00)	0.34* (0.00)		0.31* (0.00)	0.65	0.76	14677	875* (0.00)	-13	-13
CPI	0.00080* (0.00)	-11.56 (0.24)	0.12* (0.00)	0.77* (0.00)	-0.96* (0.00)		0.00000* (0.00)	0.29* (0.00)		0.52* (0.00)	0.81	0.67	9510	391* (0.00)	-12	-12
GCP	0.00046* (0.00)	3.94 (0.76)	1.21* (0.00)	-0.88* (0.00)	-0.49* (0.00)	0.30* (0.00)	0.00000* (0.00)	0.32* (0.00)		0.62* (0.00)	0.94	0.55	13383	302* (0.00)	-12	-12
GIL	0.00029* (0.00)	-11.08 (0.47)	0.72* (0.00)				0.00000* (0.00)	0.28* (0.00)		0.38* (0.00)	0.66	0.60	12584	496* (0.00)	-13	-13
GSCH	0.00129* (0.00)	11.55 (0.23)	-0.94* (0.00)	0.67* (0.00)	0.79* (0.00)	-0.12* (0.00)	0.00000* (0.00)	0.21* (0.00)	-0.16* (0.00)	0.92* (0.00)	0.98	0.62	12262	333* (0.00)	-11	-11
HUL	0.00081* (0.00)	1.66 (0.91)	0.30* (0.00)	0.56* (0.00)	-0.14* (0.00)		0.00000* (0.00)	0.25* (0.00)		0.65* (0.00)	0.89	0.58	9240	292* (0.00)	-11	-11
ML	-0.00023* (0.00)	-17.88** (0.02)	0.70* (0.00)		0.67* (0.00)		0.00000* (0.00)	0.40* (0.00)		0.65* (0.00)	1.06	0.79	14483	1197* (0.00)	-13	-13
NIL	0.00050** (0.02)	-37.60** (0.05)	0.94* (0.00)		-0.55* (0.00)		0.00000* (0.00)	0.27* (0.00)	0.17* (0.00)	0.29*** (0.08)	0.72	0.52	5843	143* (0.00)	-11	-11
ZWL	0.00083* (0.00)	18.72*** (0.07)	-1.42* (0.00)	-0.81* (0.00)	0.88* (0.00)		0.00000* (0.00)	0.14* (0.00)		0.80* (0.00)	0.94	0.72	6125	351* (0.00)	-11	-11
CNX FMCG	0.00010 (0.90)	0.09 (0.24)	-1.59* (0.00)	-0.98* (0.00)	1.60* (0.00)	0.99* (0.00)	0.00001* (0.00)	0.14* (0.00)		0.82* (0.00)	0.96	0.43	6674	1* (0.00)	-6	-6

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the ARCH-LM test is used. To check the adequacy of the mean models the Ljung-Box Q-statistics of standardized residual is used and that of square standardized residual is used to check for the adequacy of variance models.

Table 4.1.29: ARCH LM Test for FMCG Sector

ARCH LM Test after Estimation					Standardized Residual		Square Standardized Residual	
Company	F-Statistics	P-Value	LM	P-Value	Q Statistic (36)	P-Value	Q-Statistic (36)	P-Value
BCL	0.10	0.75	0.11	0.75	502.11	0.00	0.36	1.00
BIL	0.00	0.99	0.00	0.99	28.46	0.69	0.05	1.00
CPI	0.35	0.55	0.35	0.55	38.83	0.22	37.74	0.26
GCP	0.00	0.99	0.00	0.99	145.75	0.00	0.07	1.00
GIL	1.72	0.19	1.72	0.19	47.06	0.08	30.55	0.68
GSCH	0.11	0.74	0.11	0.74	21.80	0.89	4.75	1.00
HUL	0.26	0.61	0.26	0.61	287.96	0.00	16.50	0.99
ML	0.00	0.96	0.00	0.96	511.10	0.00	0.06	1.00
NIL	0.19	0.66	0.19	0.66	35.63	0.39	23.58	0.91
ZWL	0.03	0.87	0.03	0.87	38.56	0.23	29.83	0.63
CNX FMCG	0.69	0.41	0.69	0.41	37.00	0.25	27.38	0.62

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.29, it is revealed that the Ljung Box Q-statistic of standardized residuals is insignificant for all the return series of FMCG sector except BCL, GCP, GIL, HUL and ML indicating that the estimated mean models of each firm fits the data well except BCL, GCP, GIL, HUL and ML. For these companies different models are tried but still there remains serial correlation. Finally we have selected those mean models for these companies which have lowered AIC and SIC. However, the Ljung-Box Q-statistic of square standardized residual is highly insignificant for all the return series of FMCG

sector indicating that the estimated variance models fits the data very well. That is the GARCH-M models are suitable for the return series of FMCG sector.

From Table 4.1.29, it is observed that the ARCH- LM test statistic i.e. LM statistic and F-statistic value for all the return series of FMCG sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the estimated models are appropriate.

To examine the leverage effect E-GARCH model is estimated. Table 4.1.30 presents the result of EGARCH model for the return series of FMCG sector.

From Table 4.1.30, it is observed that the asymmetric term (λ_1) is negative and statistically significant for BCL, BIL, CPI, GCP, ML and CNX FMCG indicating that the volatility is high when there is bad news or negative shocks in the market than that of good news or positive shocks for these firms. But the asymmetric term (λ_1) is positive and statistically significant for GSCH indicating that the volatility is high when there is good news or positive shocks in the market than that of bad news or negative shocks for this firm. However, the asymmetric term (λ_1) is statistically insignificant for GIL, HUL, NIL and ZWL indicating that these companies have not significant asymmetric or leverage effect. In the variance equation, the ARCH and GARCH coefficients are statistically significant for all the return series of FMCG sector implying that a greater shocks on volatility.

Table 4.1.30: Result of EGARCH Model for FMCG Sector

	Variance Equation					Diagnostic Test					ARCH LM Test	
Company	CONST	ARCH1	ARCH 2	EGARCH	GARCH(-1)	Adj. R^2	Log like	F-statistic	AIC	SIC	F-Statistics	T*R
BCL	-1.15* (0.00)	0.47* (0.00)		-0.09* (0.01)	0.95* (0.00)	0.88	5775	805	-13	-13	0.00 (0.98)	0.00 (0.98)
BIL	-4.82* (0.00)	0.35* (0.00)		-0.11* (0.01)	0.71* (0.00)	0.76	14675	863	-13	-13	0.00 (0.97)	0.00 (0.97)
CPI	-3.78* (0.00)	0.47* (0.00)		-0.09** (0.02)	0.77* (0.00)	0.67	9513	390	-12	-12	0.04 (0.84)	0.04 (0.84)
GCP	-2.16* (0.00)	0.39* (0.00)		-0.07* (0.00)	0.87* (0.00)	0.54	13380	299	-12	-12	0.00 (0.97)	0.00 (0.97)
GIL	-3.80* (0.00)	0.38* (0.00)		-0.01 (0.75)	0.77* (0.00)	0.60	12585	493	-13	-13	0.52 (0.47)	0.52 (0.47)
GSCH	-0.44* (0.00)	0.35* (0.00)	-0.21* (0.00)	0.07* (0.00)	0.97* (0.00)	0.62	12281	331	-11	-11	0.01 (0.93)	0.01 (0.93)
HUL	-1.96* (0.00)	0.42* (0.00)		0.00 (0.92)	0.88* (0.00)	0.58	9240	291	-11	-11	0.01 (0.92)	0.01 (0.92)
ML	-1.33* (0.00)	0.35* (0.00)		-0.13* (0.00)	0.93* (0.00)	0.81	14446	1298	-13	-13	0.00 (1.00)	0.00 (1.00)
NIL	-8.12* (0.00)	0.47* (0.00)		0.03 (0.63)	0.44* (0.00)	0.52	5844	164	-11	-11	0.14 (0.71)	0.14 (0.70)
ZWL	-1.33* (0.00)	0.28* (0.00)		-0.02 (0.56)	0.92* (0.00)	0.72	6124	350	-11	-11	0.03 (0.87)	0.03 (0.87)
CNX FMCG	-0.68* (0.00)	0.26* (0.00)		-0.07* (0.00)	0.95* (0.00)	0.43 (0.43)	6675	2* (0.00)	-6	-6	2.03 (0.15)	2.03 (0.15)

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the study here employs the ARCH-LM test. From Table 4.1.30, it is observed that the ARCH- LM test statistic i.e. F-statistic and LM ($T*R^2$) value for all the return series of FMCG sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the selected models are appropriate.

4.1.6 Volatility and its Pattern in IT Sector:

This analysis is started with descriptive statistics of daily returns of selected IT companies and IT sector index are reported in Table 4.1.6.

Table 4.1.31: Descriptive Statistics of Return Series in IT Sector

Company	Mean	Std. Dev.	Maximum	Minimum	Skewness	Kurtosis	J B Statistic	P-Value
HCL	0.00058	0.030	0.17	-0.71	-5.56	137	1679800	0.00
CSL	0.00057	0.030	0.17	-0.39	-1.40	26	36123	0.00
HTL	**-0.00070**	**0.050**	**0.51**	**-1.62**	-16.22	517	24757971	0.00
IL	0.00020	0.020	0.16	-0.24	-2.39	42	44683	0.00
IEL	0.00007	0.037	0.18	-1.03	-12.32	322	9567468	0.00
KTL	-0.00030	0.049	0.20	-1.58	-16.38	505	23661899	0.00
MPL	0.00045	0.027	0.28	-0.14	1.38	18	16805	0.00
MSL	0.00018	0.029	0.20	-0.33	-0.66	17	13886	0.00
NTL	0.00052	0.032	0.18	-0.42	-0.91	22	34671	0.00
OFS	0.00088	0.023	0.15	-0.12	0.66	10	2587	0.00
PSL	0.00094	0.019	0.10	-0.08	0.37	5	248	0.00
TCL	0.00058	0.030	0.17	-0.71	-5.56	137	1679800	0.00
TML	0.00063	0.029	0.23	-0.16	0.49	9	3328	0.00
VL	**0.00149**	**0.015**	0.06	-0.05	0.18	6	29	0.00
WL	-0.00008	0.029	0.11	-0.69	-8.17	179	2924206	0.00
CNX_IT	0.00052	0.018	0.12	-0.12	-0.13	7.43	1836	0.00

Source: Computed based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.31, it is observed that the daily mean return of VL is relatively higher than that of other IT sector firms. The daily mean return of CNX IT, i.e. IT sector

index is 0.00052 [6](0.052%). The mean return of VL, HCL, CSL, NTL, OFS, PSL, TCL and TML are relatively higher than CNX IT index return whereas the mean returns of HTL, IL, IEL, KTL, MPL, MSL and WL are lower than that of CNX IT. The lowest even negative mean return is shown in HTL. However, in the IT sector a few firms' shows negative returns such as, HTL, KTL and WL and all other selected firms shows positive returns. In the IT sector (within selected firms) the return is fluctuated between 0.51 to -1.62. The highest standard deviation or volatility is shown in HTL where as the lowest is shown in VL. The volatility of IT sector index return is lower than that of all other selected firms except VL. From this it can be said that the highest return is associated with the lower risk and lower return is associated with higher risk which is controversial to the capital asset pricing theory. Here, it is also find that investment on portfolio is associated with lower risk than that of investment on individual stock. The VL, TML, PSL, OFS, and MPL are positively skewed where as the HCL, CSL, HTL, IL, IEL, KTL, MSL, NTL, TCL, WL and CNX IT are negatively skewed. A positively skewed return series indicates that it has higher possibility to generate positive returns while negatively skewed implies higher probability to generate negative returns. The kurtosis of all the return series are greater than three (excess kurtosis) thus, they are leptokurtic; i. e. the frequency distribution assigns a higher probability of very high positive and negative returns. From table 4.31, it is also observed that the J. B. Statistic for all the return series are highly significant even at less than one percent level of significance which indicates

[6] HCL Technologies Ltd (HCL), eClerx Services Ltd (CSL), Hexaware Technologies Ltd (HTL), Infosys Ltd (IL), Infotech Enterprises Ltd (IEL), KPIT Technologies Ltd (KTL), MphasiS Ltd (MPL), NIIT Technologies Ltd (NTL), Oracle Financial Service Ltd. (OFS), Persistent System Ltd (PSL), Tata Consultancy service Ltd (TCL), Tech Mahindra Ltd (TML), Vakrangee Ltd (VL), Wipro Ltd (WL), IT sector Index (CNX IT).

that the return series are not normally distributed implying the presence of heteroscedasticity. Hence, the GARCH model is justifiable for testing the hypothesis.

Table 4.1.32: Unit Root Test for IT Sector

Company Name	ADF Test Statistic	P-Value	PP Test Statistic	P-Value
Clerx Services Ltd	-16.77	0.00	-87.37	0.00
Hindustan Computer Ltd	-23.07	0.00	-16.93	0.00
Hexaware Technologies Ltd	-21.54	0.00	-32.98	0.00
Infotech Enterprises Ltd	-15.66	0.00	-211.95	0.00
Infosys Ltd	-19.14	0.00	-5.97	0.00
KPIT Technologies Ltd	-42.40	0.00	-18.74	0.00
Mindtree Ltd	-36.94	0.00	-649.27	0.00
Mphasis Ltd	-46.92	0.00	-146.90	0.00
NIIT Technologies Ltd	-26.00	0.00	-106.19	0.00
Oracle Financial Service Ltd.	-9.66	0.00	-31.35	0.00
Persistent System Ltd	-14.44	0.00	-29.05	0.00
Tata Consultancy service Ltd	-23.07	0.00	-16.93	0.00
Vakrangee Ltd.	-8.00	0.00	-8.05	0.00
Wipro Ltd	-23.16	0.00	-23.06	0.00
CNX IT	-35.24	0.00	-46.234	0.00

Estimated based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.32, it is observed that the Augmented Dickey-Fuller test statistic and Phillips-Perron test statistic for all the return series of IT sector is greater than their critical values even at less than one percent level of significance. Both ADF and PP test statistic confirms that there is no unit root. Therefore, the null hypothesis that the return series has unit root is rejected for all the return series and thus data for all return series are found to be stationary.

To check ARCH effect the study here employs the ARCH-LM test of Engle (1982). The ARCH LM test regress the squared residual of the mean model (ε_t^2) on lagged squared residual (ε_{t-1}^2) and a constant. From Table 4.1.33, it is observed that the F-statistic and the observed R square value is greater than their critical values for CSL,

HCL, HTL, IEL, IL, MPL, MSL, NTL, OFS, PSL, TCL and CNX IT return series as indicating by their corresponding P-value which is less than one percent level.

Table 4.1.33: ARCH LM Test for IT Sector

Company Name	F-Statistic	P-Value	LM Statistic ($T*R^2$)	P-Value
Clerx Services Ltd	114.64	0.00	106.86	0.00
Hindustan Computer Ltd	154.42	0.00	144.58	0.00
Hexaware Technologies Ltd	396.01	0.00	336.71	0.00
Infotech Enterprises Ltd	611.35	0.00	480.47	0.00
Infosys Ltd	120.84	0.00	102.97	0.00
KPIT Technologies Ltd	**0.00**	**0.99**	**0.00**	0.99
Mindtree Ltd	80.62	0.00	77.16	0.00
Mphasis Ltd	83.86	0.00	80.22	0.00
NIIT Technologies Ltd	215.89	0.00	197.06	0.00
Oracle Financial Service Ltd.	167.31	0.00	149.30	0.00
Persistent System Ltd	25.19	0.00	24.62	0.00
Tata Consultancy service Ltd	154.42	0.00	144.58	0.00
Vakrangee Ltd	**0.01**	**0.93**	**0.01**	0.93
Wipro Ltd	**0.02**	**0.89**	**0.02**	0.89
CNX IT	137.72	0.00	129.84	0.00

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Therefore, the null hypothesis that is no ARCH effect is rejected for these return series indicating that there is ARCH effect for these return series of IT sector. Thus, it is confirmed that the study can apply ARCH or GARCH model. However, for KTL, VL and WL the ARCH or GARCH model can not apply because for these return series the null hypothesis that is no ARCH effect is accepted.

The most popular member of the ARCH class of model, i.e. GARCH-M (p,q) model is used to model volatility of IT sector return series. The Maximum Likelihood Estimation technique is used for the estimation of GARCH-M model. When using this technique the model selection is based on AIC and SIC. The model with lower value of

AIC and SIC fits the data best. The return series of Clerx Services Ltd (CSL), Hindustan Computer Ltd (HCL), Hexaware Technologies Ltd (HTL), Infotech Enterprises Ltd (IEL), Infosys Ltd (IL), KPIT Technologies Ltd (KTL), Oracle Financial Service Ltd. (OFS), Tata Consultancy service Ltd (TCL) and CNX IT fits the GARCH-M (1, 1) model and MSL fits GARCH-M (2,1) model while MPL, NTL and PSL fits the GARCH-M (2,2) model.

Table 4.1.34: Result of GARCH-M Model for IT Sector

	Mean Equation						Variance Equation						Diagnostic Test			
Company	θ	**ω**	ϕ_1	ϕ_2	δ_1	δ_2	α_0	α_1	α_2	β_1	β_2	$\alpha_i + \beta_i$	Adj R	Log like	F-statistic	AIC
CSL	1.59 (0.84)	0.00056* (0.00)	0.69* (0.00)	-0.94* (0.00)	-0.66* (0.00)	0.59* (0.00)	0.00000* (0.00)	0.13* (0.00)		0.86* (0.00)		0.99	0.18	7266	38* (0.00)	-9
HCL	1.85*** (0.10)	0.00056* (0.00)	1.41* (0.00)	-0.95* (0.00)	-0.82* (0.00)		0.00000* (0.00)	0.15* (0.00)		0.84* (0.00)		0.99	0.92	13256	3180* (0.00)	-12
HTL	-2.51** (0.03)	-0.00073** (0.05)	-0.03* (0.00)	0.95* (0.00)	0.93* (0.00)	0.42* (0.00)	0.00000* (0.00)	0.27* (0.00)		0.59* (0.00)		0.87	0.93	13482	3282* (0.00)	-12
IEL	-1.62 (0.25)	0.00008* (0.00)	-2.28* (0.00)	-2.20* (0.00)	1.27* (0.00)	0.45* (0.00)	0.00000* (0.00)	0.27* (0.00)		0.67* (0.00)		0.94	0.84	12625	1188* (0.00)	-11
IL	3.44 (0.61)	0.00028* (0.00)	0.66* (0.00)	0.64* (0.00)	0.33* (0.00)	-0.59* (0.00)	0.00000* (0.00)	0.50* (0.00)		0.29** (0.02)		0.79	0.77	3699	237* (0.00)	-11
KTL	2.88* (0.00)	-0.00032* (0.00)	1.32* (0.00)	-0.94* (0.00)	-0.40* (0.00)		0.00000* (0.00)	0.26* (0.00)		0.65* (0.00)		0.91	0.92	13244	3107* (0.00)	-12
MPL	-0.38 (0.61)	0.00044* (0.00)	-1.66* (0.00)	-0.97* (0.00)	0.11* (0.00)		0.00000*** (0.09)	0.35* (0.00)	-0.33* (0.00)	1.29* (0.00)	-0.32* (0.00)	0.99	0.98	12031	7439* (0.00)	-14
MSL	-4.98 (0.17)	0.00021* (0.00)	-0.79* (0.00)		-0.14* (0.00)		0.00000* (0.00)	0.33* (0.00)	-0.21* (0.00)	0.87* (0.00)		0.98	0.66	9088	441* (0.00)	-10
NTL	0.02 (0.82)	0.00051* (0.00)	0.20* (0.00)	-1.00* (0.00)	-0.60* (0.00)	-0.04*** (0.07)	0.00000** (0.03)	0.24* (0.00)	-0.22* (0.00)	1.43* (0.00)	-0.48* (0.00)	0.98	1.00	18736	164414* (0.00)	-17
OFS	0.00** (0.04)	0.00330** (0.02)	1.18* (0.00)	-0.20* (0.00)	-0.92* (0.00)		0.00000** (0.02)	0.24* (0.00)	-0.20* (0.00)	0.94* (0.00)		0.99	0.27	6816	56* (0.00)	-10
PSL	-199.72*** (0.06)	0.00147* (0.00)	-1.26* (0.00)	-0.36** (0.03)	1.31* (0.00)	0.47* (0.00)	0.00000 (0.53)	0.18* (0.00)	-0.14** (0.04)	0.85* (0.00)		0.89	0.04	5071	5* (0.00)	-10
TCL	1.85*** (0.10)	0.00056* (0.00)	1.41* (0.00)	-0.95* (0.00)	-0.82* (0.00)		0.00000* (0.00)	0.15* (0.00)		0.84* (0.00)		0.99	0.92	13256	3180* (0.00)	-12
CNX IT	0.00* (0.01)	-1.04250 (0.51)	0.48*** (0.07)	-0.07* (0.00)	-0.45*** (0.09)		0.00002* (0.00)	0.16* (0.00)		0.79* (0.00)		0.95	0.01	6137	2* (0.00)	-5

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

As far the stationarity of the variance process is concerend, it is observed that the summation of α_i and β_i for all return series are less than one and hence the stationary condition is satisfied for all the return series of IT sector. However, the sum is rather close to one which indicates a long persistence of shock on volatility.

From Table 4.1.34, it is observed that for all the return series of IT sector the ARCH coefficient is statistically significant at less than one percent level of significance which indicates that previous period shocks influence the current period volatility. For some return series the second period lag shocks (ε^2_{t-2}) has some impact on current period volatility as the ARCH coefficient (α_2) is also statistically significant.

From Table 4.1.34, it is observed that the GARCH coefficient β_1 is statistically significant for all the return series of IT sector indicating that h_{t-1} has influenced the current period volatility (h_t). A relatively large value of GARCH coefficient indicates that shocks to conditional variance take a long time to die out. However, low value of ARCH coefficient suggests that market surprises induce relatively small revision in future volatility. A large sum of these coefficients implies that a large positive and negative return will lead future forecasts of the variance to be high for a particular period. So investor can take advantage for the same and by analyzing recent and historical news can forecast the future market movement and can take their investment strategies accordingly.

In the GARCH-M model in the mean equation the most important variable is h_t i.e. conditional variance. Here the coefficient of h_t i.e. θ is the risk parameter. A significant positive θ indicates that there is positive relationship between predicted return and volatility. If volatility increases then expected return will also increases and vice versa. From table 4.1.34, it is observed that θ is statistically significant for HCL, HTL,

KTL, OFS, PSL, TCL and CNX IT. But the coefficient θ is positive only for HCL, KTL, OFS, TCL and CNX IT while it is negative for HTL, and PSL. For the rest of the firms such as CSL, IEL, IL, MPL, MSL and NTL the coefficient θ is statistically insignificant. From this, it can be said that when volatility rises expected return is also rises for HCL, KTL, OFS, TCL and CNX IT. On the other hand, when volatility rises, predicted return falls for HTL, and PSL. In the mean equation, the autoregressive (AR) and moving average (MA) coefficients are statistically significant for all firm of IT sector which indicates that one or two period lag return and one or two period lag residual has some impact on current period return.

A high value of adjusted R^2 depicts a very high degree of explained variation. Apart from this AIC is used in the study indicating lower for the regression which is quite reasonable and fit for our models. A high value of F-statistic states that the statistical models that are used are fit and appropriate.

To check the adequacy of the mean models the Ljung-Box Q statistics of standardized residual is used and that of square standardized residual is used to check for the adequacy of variance models. From Table 4.1.35, it is revealed that the Ljung Box Q statistic of standardized residuals is insignificant for all the return series of IT sector except CSL, IEL, IL, ML and OFS indicating that the estimated mean models of each firm fits the data well except CSL, IEL, IL, MPL and OFS. For these companies different models are tried but still there remains serial correlation. Finally we have selected those mean models for these companies which have lowered AIC and SIC. However, the Ljung-Box Q statistic of square standardized residual is highly insignificant for all the

return series of IT sector indicating that the estimated variance models fits the data very well. That is the GARCH-M models are suitable for the return series of IT sector.

Table 4.1.35: ARCH LM TEST for IT Sector

ARCH LM TEST After Estimation								
					Standardised Residual		Square Standardised Residual	
Company	F-Statistics	P-Value	$T*R^2$	P-Value	Q-Statistic	P-Value	Q-Statistic	P-Value
CSL	0.45	0.50	0.45	0.50	11873.00	0.00	8.11	96.00
HCL	0.00	0.97	0.00	0.97	40.24	0.18	3.94	1.00
HTL	10.44	0.00	10.40	0.00	17.44	0.99	3.02	1.00
IEL	0.88	0.35	0.88	0.35	48.63	0.02	5.90	1.00
IL	0.03	0.87	0.03	0.87	47.32	0.03	0.18	1.00
MPL	0.15	0.70	0.15	0.70	44.42	0.09	31.96	0.52
MSL	0.32	0.57	0.33	0.57	29.48	0.69	23.98	0.90
NTL	0.01	0.91	0.01	0.91	41.57	0.12	16.97	0.99
OFS	0.00	1.00	0.00	1.00	56.36	0.01	29.34	0.65
PSL	0.02	0.88	0.02	0.88	22.45	0.90	25.65	0.78
TCL	0.00	0.97	0.00	0.97	40.24	0.18	3.94	1.00
CNX IT	0.19	0.66	0.19	0.66	28.34	0.70	10.24	1.00

Estimated based on secondary time series data collected from www.nseindia.com, 2014.

From Table 4.1.35, it is observed that the ARCH- LM test statistic i.e. observed R^2 and F-statistic value for all the return series of IT sector except HTL is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the estimated models are appropriate. For HTL different orders of GARCH-M model are tried but still there remains ARCH effect. However, GARCH-M (1, 1) model fits the data well.

Table 4.1.36: Result of EGARCH Model for IT Sector

	Variance Model						Diagnostic Test					ARCH LM Test	
Company	Constant	ARCH1	ARCH2	EGARCH	GARCH(-1)	GARCH(-2)	Adj R	Log like	F-statistic	AIC	SIC	F statistic	T*R
CSL	-0.96* (0.00)	0.44* (0.00)		0.00 (0.87)	0.95* (0.00)		0.49	7201	165* (0.00)	-9	-9	0.47 (0.49)	0.47 (0.49)
HCL	-0.64* (0.00)	0.25* (0.00)		0.05** (0.02)	0.97* (0.00)		0.92	13257	3161* (0.00)	-12	-12	0.00 (0.95)	0.00 (0.95)
HTL	-2.61* (0.00)	0.47* (0.00)		0.00 (0.83)	0.85* (0.00)		0.93	13485	3291* (0.00)	-12	-12	0.23 (0.63)	0.23 (0.63)
IEL	-1.69* (0.00)	0.41* (0.00)		0.01 (0.56)	0.90* (0.00)		0.84	12634	1186* (0.00)	-11	-11	0.00 (0.99)	0.00 (0.99)
IL	-4.29* (0.00)	0.64* (0.00)		-0.04 (0.48)	0.72* (0.00)		0.78	3700	238* (0.00)	-11	-11	0.01 (0.91)	0.01 (0.91)
KTL	-0.57* (0.01)	0.21* (0.00)	-0.06 (0.22)	0.07* (0.00)	0.49*** (0.03)	0.48*** (0.03)	0.92	13251	2495* (0.00)	-12	-12	0.00 (0.96)	0.00 (0.96
MPL	-0.39* (0.00)	0.55* (0.00)	-0.43* (0.00)	0.00 (0.91)	1.28* (0.00)	-0.30* (0.01)	0.98	12034	7436* (0.00)	-14	-14	0.39 (0.54)	0.39 (0.53)
MSL	-0.17* (0.00)	0.50* (0.00)	-0.42* (0.00)	0.01 (0.14)	1.45* (0.00)	-0.46* (0.00)	0.66	9089	352* (0.00)	-10	-10	2.03 (0.15)	2.03 0.15)
NTL	-0.92* (0.00)	0.48* (0.00)	-0.17* (0.00)	-0.03*** (0.08)	0.97* (0.00)		1.00	18735	181070* (0.00)	-17	-17	0.02 (0.89)	0.02 0.89)
OFS	-0.16* (0.00)	0.45* (0.00)	-0.34* (0.00)	-0.02 (0.17)	0.99* (0.00)		0.26	6815	54* (0.00)	-10	-10	2.11 (0.15)	2.11 (0.15)
PSL	-6.53* (0.00)	0.36* (0.00)		-0.05 (0.35)	0.52* (0.00)		0.02	5067	4* (0.00)	-10	-10	0.02 (0.90)	0.02 (0.90)
TCL	-0.64* (0.00)	0.25* (0.00)		0.05** (0.02)	0.97* (0.00)		0.92	13257	3161* (0.00)	-12	-12	0.00 (0.95)	0.00 (0.95)
CNX IT	-0.54* (0.00)	0.23* (0.00)		-0.07* (0.00)	0.95* (0.00)		0.00	6145	1* (0.00)	-5	-5	0.36 (0.55)	0.36 (0.55)

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

From Table 4.1.36, it is observed that the asymmetric term (λ_1) is negative and statistically significant for NTL and CNX IT indicating that the volatility is high when there is bad news or negative shocks in the market than that of good news or positive shocks for these return series. But the asymmetric term (λ_1) is positive and statistically significant for HCL, KTL, MSL and TCL indicating that the volatility is high when there is good news or positive shocks in the market than that of bad news or negative shocks for this firm. However, the asymmetric term (λ_1) is statistically insignificant for CSL, HTL, IEL, IL, MPL, OFS and PSL indicating that these companies have not significant asymmetric or leverage effect. In the variance equation, the ARCH and GARCH coefficients are statistically significant for all the return series of IT sector implying that a greater shocks on volatility.

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the study here employs the ARCH-LM test. From Table 4.1.36, it is observed that the ARCH- LM test statistic i.e. F-statistic and LM value for all the return series of IT sector is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the selected models are appropriate.

4.2 Comparative Analysis among the Sectoral Indices:

The section 4.2 deals with a comparative analysis among the sectoral indices. This section is also divided into three sub sections, viz. 4.2.1 shows the descriptive statistics for return series and 4.2.2 deals with the result of GARCH-M model, 4.2.3 explain the result of EGARCH model and 4.2.4 deals with sector wise and company wise comparative analysis of risk.

4.2.1 Descriptive Statistics of Sectoral Indices

This analysis is started with descriptive statistics of daily returns of selected sectoral indices, which are reported in Table 4.2.1.

Table 4.2.1 Descriptive Statistics of Return Series for Sectoral Indices

Sector	Mean	Std. Dev.	Max.	Min.	Skew.	Kurtosis	J.B.-Statistic	P-Value
Automobile sector	0.00074	0.015	0.140	-0.10	-0.13	8.54	2875	0.00
Banking sector	0.00055	**0.003**	0.023	-0.01	0.29	7.00	1197	0.00
Energy sector	**0.00038**	0.017	0.15	**-0.15**	-0.25	11.47	6721	0.00
Financial sector	0.00063	**0.021**	**0.178**	-0.12	0.08	8.00	2411	0.00
FMCG sector	**0.00083**	0.014	0.08	-0.09	-0.24	6.33	1057	0.00
IT sector	0.00052	0.018	0.12	-0.12	-0.13	7.43	1836	0.00

Source: computed based on secondary time series data collected from www.nseindia.com, 2014

From Table 4.2.1 it is observed that the daily mean return of FMCG sector is relatively higher than that of other sectors followed by Automobile sector and financial sector respectively. The daily mean return of FMCG sector is 0.00083 (0.083%). The lowest mean return is shown in energy sector 0.00038 (0.038%). Among the selected sectors the return is fluctuated between 0.17 to -0.15. The highest standard deviation or volatility is shown in financial sector (0.021) where as the lowest is shown in banking sector (0.003). From this, it can be said that higher return is associated with relatively lower risk. A positively skewed return series indicates that it has higher possibility to generate positive returns while negatively skewed implies higher probability to generate negative returns. Except banking and financial sectors all other sectors have negative skewness. The kurtosis of all the sectors are greater than three (leptokurtic) i.e; the frequency distribution assigns a higher probability of very high positive and negative returns. It is also observed that the JB Statistic for all the sectors are highly significant

even at less than one percent level of significance, which indicates that the return series are not normally distributed implying the presence of heteroscedasticity. Hence, the GARCH model is justifiable.

4.2.2 Result of GARCH-M Model:

The study here compares the result of GARCH-M model of the selected sectors viz; automobile, banking, energy, financial, FMCG and IT sector.

Table 4.2.2: Result of GARCH-M Model of Sectoral Indices

Coefficients of Mean Equation							Coefficients of Variance Equation				Diagnostic Test		
Return Series	θ	ω	ϕ_1	ϕ_2	δ_1	δ_2	α_0	α_1	β_1	$\alpha_i + \beta_i$	Log like	F-statistic	AIC
Automobile sector	9.55 (0.54)	0.0007* (0.00)	0.66* (0.00)	-0.31* (0.00)	-0.50* (0.00)		0.00000* (0.00)	0.08* (0.00)	0.90* (0.00)	0.98	10822	29* (0.00)	-9.66
Banking sector	0.55 (0.73)	0.0008 (0.14)	-0.71* (0.00)	0.10* (0.00)	0.85* (0.00)		0.00000* (0.00)	0.07* (0.00)	0.92* (0.00)	0.99	5779	5.01* (0.00)	-5.15
Energy Sector	0.15** (0.03)	-0.0012 (0.15)					0.00000* (0.00)	0.10* (0.00)	0.89* (0.00)	0.99	6357	21* (0.00)	-6
Financial Sector	0.00 (0.77)	0.0026 (0.61)	0.13* (0.00)				0.00000* (0.00)	0.08* (0.00)	0.91* (0.00)	0.99	5904	6* (0.00)	-5
FMCG Sector	0.09 (0.24)	0.0001 (0.90)	-1.59* (0.00)	-0.98* (0.00)	1.60* (0.00)	0.99* (0.00)	0.00001* (0.00)	0.14* (0.00)	0.82* (0.00)	0.96	6674	10* (0.00)	-6
IT Sector	0.009* (0.00)	-1.0425 (0.51)	0.48*** (0.07)	-0.07* (0.00)	-0.45*** (0.09)		0.00002* (0.00)	0.16* (0.00)	0.79* (0.00)	0.95	6137	2* (0.00)	-5

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.

Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

From the above table, it is observed that the ARCH and GARCH coefficients for all the sectors viz. automobile, banking, energy, financial, FMCG and IT sector are statistically significant even at less than one percent level. In case of ARCH effect the most sensitive sector is IT sector (0.16) followed by FMCG (0.14) and Energy sector (0.10). This means that the impact of recent information on volatility is higher on IT sector in comparison with other selected sectors. However, the GARCH effect is higher in Banking sector (0.92) followed by Financial (0.91) and Automobile sector (0.90). This indicates that the impact of old information on volatility is relatively higher in banking sector than that of other selected sectors. It is also observed that the value of GARCH coefficients in all sectors is high indicating that shocks to conditional variance take a long time to die out. As far the stationarity of the variance process is concerend, it is observed that the summation of α_i and β_i for all sectors are less than one and hence the stationary condition is satisfied for all the sectors of. However, the sum is rather close to one, which indicates a long persistence of shock on volatility.

In the GARCH-M model in the mean equation the most important variable is h_t i.e. conditional variance. Here the coefficient of h_t i.e. θ is the risk parameter. A significant positive θ indicates that there is positive relationship between predicted return and volatility. If volatility increases then expected return will also increases and vice versa. From Table 4.2.2 it is observed that the coefficient θ is positive for all the sectors but it is statistically significant for Energy and IT sector. From this, it can be said that when volatility rises expected return is also rises for Energy and IT sectors.

4.2.3 Result of EGARCH Model:

The study here compares the result of EGARCH model of the selected sectors viz; automobile, banking, energy, financial, FMCG and IT sector.

Table 4.2.3 Result of EGARCH Model of Sectoral Indices

Return Series	α_0	α_1	λ_1	β_1	Log like.	F-statistic	AIC	SIC	Obs.R^2
Automobile sector	-0.361* (0.00)	0.16* (0.01)	-0.07* (0.00)	0.97* (0.00)	6406	5* (0.00)	-9	-9	0.16 (0.68)
Banking sector	-0.212* (0.00)	0.14* (0.00)	-0.06* (0.00)	0.99* (0.00)	5796	6* (0.00)	-5	-5	0.46 (0.50)
Energy Sector	-0.34* (0.00)	0.20* (0.00)	-0.05* (0.00)	0.98* (0.00)	6361	21* (0.00)	-6	-6	0.02 (0.89)
Financial Sector	-0.247* (0.00)	0.15* (0.00)	-0.07* (0.00)	0.98* (0.00)	5915	6* (0.00)	-5	-5	0.06 (0.81)
FMCG Sector	-0.68* (0.00)	0.26* (0.00)	-0.07* (0.00)	0.95* (0.00)	6675	20* (0.00)	-6	-6	2.03 (0.15)
IT Sector	-0.54* (0.00)	0.23* (0.00)	-0.07* (0.00)	0.95* (0.00)	6145	10* (0.00)	-5	-5	0.36 (0.55)

Source: Estimated based on secondary time series data collected from www.nseindia.com, 2014.
Note: * denotes the level of significance at one or less than one per cent level of significant, ** denotes at five or less than five per cent and *** denotes the ten percent.

From Table 4.2.3, it is observed that the asymmetric term (λ_1) is negative and statistically significant for all the sectors viz; automobile, banking, energy, financial, FMCG and IT sectors. This indicates that the volatility is high when there is bad news or negative shocks in the market than that of good news or positive shocks for all the sectoral indices. The asymmetric effect or leverage effect of automobile, financial, FMCG and IT sectors is same (-0.07). However, the lowest asymmetric effect is shown in the energy sector. In the variance equation, the ARCH and GARCH coefficients are statistically significant for all the sectoral indices.

To check whether the estimated models capture the ARCH effect or there remains further ARCH effect, the study here employs the ARCH-LM test. From table 4.2.3, it is observed that the ARCH- LM test statistic i.e. F-statistic and $T*R^2$ value for all the sectors is less than their critical values imply that the null hypothesis of no ARCH effect is accepted. This implies that there is no further ARCH effect. That means the selected models are appropriate.

4.2.4 Sector wise and Company wise Analysis of Risk:

The study here makes a sector wise and company wise comparative analysis of risk. In this study all the sectors are classified into three categories based on risk viz; high risk, medium risk and low risk sectors which is presented in the following Table 4.2.4.

From Table 4.2.4, it is found that the financial sector is relatively higher risky followed by IT and energy sector. Automobile and FMCG sector belongs to medium risk category. However, the banking sector bears the lowest risk. Each sector is further classified into three categories considering the risk associated with companies. In the financial sector LICH, MMF, GFL, IFCI, and RCL companies are belongs to high risk

category whereas IDFC, MFL, SFL, BFSL, SRT are included in medium risk category and SCU, BHI, LTH, CIFC, BFL are consist of low risk category. In the IT sector HTL, KTL and IEL companies are belongs to high risk category whereas NTL, HCL, TCL, CSL, TML, WL, MSL, and ML are included in medium risk category.

Table 4.2.4: Sector wise and Company wise Analysis of Risk

High Risk Sectors			**Medium Risk Sectors**			**Low Risk Sectors**		
Financial Sector			**Automobile Sector**			**Banking Sector**		
High Risk co.	Medium Risk co.	Low Risk co.	High Risk co.	Medium Risk co.	Low Risk co.	High Risk co.	Medium Risk co.	Low Risk co.
LICH	IDFC	SCU	TM	MM	SI			YSB
MMF	MFL	BHI	HMT	AL	MSI			ICICI
GFL	SFL	LTH	EL	HNM	VST			BOI
IFCI	BFSL	CIFC	TVS	MS	HM			ILB
RCL	SRT	FINANCE		EM				CBL
		BFL						KMB
IT Sector			**FMCG Sector**					IDBI
HTL	NTL	OFS	PGHC	EL	ZWL			SBI
KTL	HCL	IL	KRBL	DIL	GSCH			BOB
IEL	TCL	PSL	BCL		GIL			ABL
	CSL	VL	ML		HUL			JK
	TML		JLL		CPI			PNB
	WL		GCP		NIL			HDFC
	MSL							
	ML							
Energy Sector								
TPC	RPL	PGC						
BFU	TPL	NTPC						
RIL	NLC	NHPC						
	KSK	SJVN						
	JPV							
	CESC							
	JSW							
	APL							

Source: Arranged from estimated result, data collected from www.nseindia.com, 2014.

The low risk category consists of OFS, IL, PSL, and VL. In the energy sector TPC, BFU and RIL bear relatively higher risk than that of other companies. In this sector

most of the companies belongs to the medium risk category viz; RPL, TPL, NLC, KSK, JPB, CESC, JSW and APL whereas PGC, NTPC, NHPC, SIVN are comes under low risk category.

The Automobile and the FMCG sector belong to medium risk category. In the automobile sector TM, HMT, EL and TVS are categorized as high risk companies whereas MM, AL, HNM, MS, and EM are belongs to medium risk category and SI, MSI, VST and HM are included in low risk category. In the FMCG sector, companies like PGHC, KRBL, BCL, ML, JLL, and GCP are bearing relatively higher risk as compared to the other selected companies. The company EL and DIL belongs to the medium risk category whereas ZWL, GSCH, GIL, HNL, CPI and NIL fall under low risk category.

In the sectoral comparison, it is find that the banking sector comes under low risk category. In the banking sector all the banks belong to low risk category. From this it is observed that the banking sector is relatively more stable than that of other sector regarding risk.