A Study on the Performance in BSE Sectoral Indices of India

Sankar Thappa★

Abstract

An impact of globalization on a country's economy is that it brings in many participants from various countries to invest in the capital market. This increases the importance of the role of the financial market in that country. Financial markets help in capital formation to develop the economy in a country through industrial development and are the primary source of capital for various economic activities in a country. Capital formation is very important for the development of the business environment as well as economic growth. The economy of a country depends on its stock market for capital formation as, through the stock market, surplus funds get channelized to meet the industry's need. Capital formation through the stock market provides a platform that offers a win-win situation to both industry as well as the investor as it may provide the highest return.

The paper tries to examine the performance of sectoral indices of BSE from April 2010 to March 2018 for which S&P BSE sectoral indices like S&P BSE Consumer Durables, Realty, Health Care, Oil & Gas, AUTO, Information & Technology (IT), Telecom, Banking, FMCG Index and BSE Sensex have been used. Descriptive Statistics, Augmented Dicky-Fuller Test, and GARCH model have been used for all sectors. GARCH (1, 1) is the best one in modelling the volatility of the return series.

Keywords: *BSE, Sectoral indices, Capital formation, Investment avenues*

Introduction

An impact of globalization on a country's economy is that it brings in a large number of participants from various countries to invest in the capital market. This increases the importance of the role of the financial market in that country. Financial markets help in capital formation to develop the economy in a country through industrial development and are the primary source of capital for various economic activities in a country. Thus, the financial health of an economic system depends to a great extent on the financial market.

Capital formation is very important for the development of the business environment and economic growth in an economy and takes place through the inflow of investments from various sources. The economy of a country depends on its stock market for capital formation as, through the stock market, surplus funds get channelized to meet the industry's need. This allocation of capital is used as productive investments causing economic growth. Capital formation through the stock market provides a platform that offers a win-win situation to both industry as well as the investor. Investors find the stock market as an alternative investment avenue, which may provide the highest return. Every stock market has its own index. The index highlights the movements of stock prices, which helps to understandto understand the sentiments of a particular stock market.

Shares of various companies are listed and traded in the stock market. These companies belong to various sectors such as automobile, information technology, banking, FMCG, oil & gas. Each sector

★ Dr. Sankar Thappa, Associate Professor, Department of Management, Rajiv Gandhi University, Rono Hills, Doimukh, Arunachal Pradesh

in an economy has some distinct characteristic features that make it react in a diverse manner to various changes in the macro-economic variables and international factors.

Literature Review

Bollerslev (1986), in his study, argued that a simple GARCH model provides a marginally better fit and more plausible learning mechanism than the ARCH model with an eighth-order linear declining lag structure.

Lim and Sek (2013) found in their study on Malaysia that symmetric and asymmetric GARCH models perform differently in different time periods.

Sharma and Khanna (2013) examined the market behaviour during the quarterly announcement period using BSE sectoral indices and BSE Sensex benchmark from 2008 to 2011 and found that different indices had different types of causal relationships; therefore, the sectoral indices had not any significant impact on the market benchmark.

Mohandass and Renukadevi (2013) did a study on all BSE sectoral indices in which they found that the GARCH (1,1) model was the best fit to model the volatility of the return series.

Banumathy and Azhagaiah. (2014), using the GARCH-M (1,1) model in their study, found that there is a positive relationship between risk and return.

Dangi (2015), in her study using the GARCH-M model and EGARCH model, confirmed the presence of volatility clustering and asymmetric effect in BSE bankex and CNX bank return series.

Lama et al. (2015), in their study, found that the EGARCH model outperformed the ARIMA and GARCH models in forecasting international cotton price series primarily due to its ability to capture asymmetric volatility pattern.

Birau et al. (2015), in their study of BSE Bankex using the GARCH (1,1) model, found that the volatility impact had generated highly positive and resulted on actual stocks.

Lodha and Soral (2015) studied the existence of seasonality in the Indian stock market using the GARCH model and explored four types of seasonal effects, namely day-of-the-week effect, month-of-the-year effect, quarterly effect and monthly effect of stocks were explored.

Nageswari et al. (2015), using the GARCH model, found that the highest mean return was earned by BSE Auto, and BSE Metal had earned the lowest mean return.

Tanty and Patjoshi (2016) found that GARCH models illustrated that lower volatility clustering and ARMA (1,1) was the suitable model for modelling the average return.

Ekong and Onye (2017), in their study, found that GARCH (1,1) and A_EGARCH (1,1) in GED are adjusted the best performing GARCH family model for zanalyzing Nigerian stock return.

Dritsaki (2017) found that the ARIMA (0,1) and EGARCH (1,1) model with t-student provide more precise forecasting on volatilities and expected returns of the Stockholm stock exchange.

Mallikarjuna and Rao (2017), in their study applying GARCH, EGARCH, and TGARCH models, found that volatility is highly persistent in all indices of BSE.

Savadatti (2018), using GARCH (1,1), TGARCH (1,1) and EGARCH (1,1) in her study of five sectoral indices of BSE found that news about the volatility in previous period and lagged conditional variance significantly impact the volatility of daily return series in the current period of sectoral indices.

Objectives of the study

To examine the stationarity of BSE sectoral indices.

To zanalyze the performance of BSE sectoral indices' returns.

To assess the extent of volatility among BSE sectoral indices.

Methodology

Sample

For the purpose of the study, nine sectoral indices were selected from the BSE: S&P BSE Banking, Realty, Consumer Durable, Oil & Gas, Information & Technology (IT), FMCG, Health Care, Telecom, AUTO Index and BSE Sensex. To carry out time series analysis, the daily closing price of the nine indices were converted into daily return series using the formula

$$R_t = \log p_t / P_{(t-1)}$$

where

R_t = Daily log return on all sectoral index for time t

P_t = Closing price at time 't'

$P_{(t-1)}$ = Corresponding price in the period at time t-1

Source of the data

The data source of is secondary: the data for daily closing prices of the nine sectoral indices are collected from BSE sectoral Indices and BSE Sensex from the BSE website and related literature published in the books, journals, etc.

Study period

The study period is from 1 April 2010 to 31 March 2018.

Techniques for the analysis

Descriptive statistics

An analysis was done using descriptive statistics to specify the properties of daily return series of the sectoral indices, and the mean, standard deviation, skewness, kurtosis, and Jarque-Berra tests of the daily returns were calculated and analyzed.

H_0: Series is normally distributed (Jarque-Bera statistic = 0).

The normality was tested by the Jarque-Bera statistic. To satisfy the normality test, the histogram should be bell-shaped, and the Jarque-Bera statistic has not to be significant.

Unit root test: The stationarity properties were tested by unit root test. In order to test the stationarity of the series, augmented Dicky-Fuller Test (ADF, 1979) was carried out.

H_0: There is non-stationarity in the returns of selected sectoral indices of BSE.

Augmented Dickey-Fuller Test

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{(t-1)} + \delta 1 \Delta Y_{(t-1)} + ... + \delta \Delta Y_{(t-p)} + \varepsilon_t \text{ --------(1)}$$

where

α = constant,

β = the coefficient on a time trend,

p = the lag order of the autoregressive process.

Imposing the constraints $\alpha = 0$ and $\beta = 0$ corresponds to modelling a random walk, and using the constraint $\beta = 0$ corresponds to modelling a random walk with a drift.

Testing for heteroscedasticity

It is important to check the presence of heteroscedasticity in the daily returns of the sectoral

indices before applying the GARCH model. Autoregressive Conditional Heteroscedasticity Lagrange Multiplier (ARCH –LM) was used to test heteroscedasticity in the residual return series of the sectoral indices. For this, the residuals of the return series are obtained by the following mean equation – (2).

H_0: There is no ARCH effect.

GARCH (1, 1) Model

The third objective of this paper was to assess the extent of volatility among BSE sectoral stock indices. For this purpose, Generalized Auto Regressive Conditional Heteroscedasticity (GARCH) technique was used to zanalyze the daily return series of the nine sectoral indices.

In a GARCH model, two equations have to be estimated. One is the mean equation, and the other is the conditional variance model. The Mean equation for the GARCH model is

$$Rt = \delta + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where

Rt = daily return of an index under consideration at time 't'

δ = mean return

ε_t = residual return

The conditional variance equation is

$$\delta_t^2 = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \beta \delta^2_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where

δ_t^2 = dependent variable

α_0 = intercept

α_1 = ARCH parameter

β = GARCH parameter

ε^2_{t-1} = squared error term at 't-1' time (lagged ARCH term)

δ^2_{t-1} = lagged conditional variance

The equation for conditional variance was used to study the symmetric behaviour of volatility (irrespective of signs) in daily returns of different sectoral indices of BSE during the study period (Bollerslev, 1986).

Results and Discussion

Analysis of descriptive statistics relating to S&P BSE sectoral indices from 2010 to 2018

Summary of the Descriptive statistics related to the nine indices for the study period is shown in Table 1. It can be seen that all sample indices have positive mean returns, with the Consumer Durable Index having the highest mean return (0.082962) and the highest standard deviation of 1.417342. Whereas, Telecom Index has the lowest mean return and the standard deviation of 1.602452 during the study period. In the analysis, it is proved that Leptokurtic for sample Index returns as it has been found that the Kurtosis measures of return for all sample indices were higher than 3.

The value of Jarque–Bera statistic was greater than 3, clearly denoting that returns of all indices were not normally distributed during the study period.

Table 1: Descriptive Statistics Relating to S&P BSE Sectorial Indices from 2010 to 2018

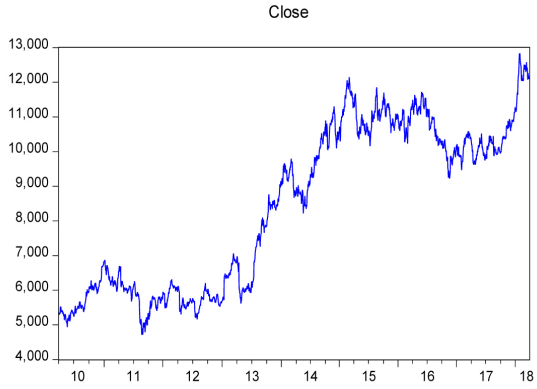
	FMCG	Health Care	I& T	OIL & Gas	Telecom	Auto	Consumer Durables	Reality	Banking	Sensex
Mean	0.065093	0.045371	0.041042	0.017819	0.003477	0.057592	0.082962	-0.019888	0.046913	0.031340
Median	0.090584	0.072710	0.031501	0.012628	-0.036446	0.085771	0.121906	0.078217	0.059690	0.049232
Maximum	5.167169	4.724255	8.928543	5.124823	7.089826	5.811138	8.245613	8.450878	8.896773	3.703417
Minimum	-6.319318	-6.993554	-11.75858	-9.655576	-6.729479	-7.462321	-8.756482	-11.57282	-7.244705	-6.119712
Std. Dev	1.022873	0.991482	1.264588	1.250225	1.602452	1.197839	1.417342	2.057613	1.427781	0.975702
Skewness	-0.237618	-0.532424	-0.604996	-0.265700	0.179327	-0.141238	-0.238328	-0.289416	0.071670	-0.166450
Kurtosis	5.683643	5.929861	11.21085	5.22910	4.401255	4.809328	6.579789	4.777631	5.084259	4.726713
Jarque-Bera	614.6496	804.1633	5700.003	432.6304	172.5150	277.4988	1079.233	289.2127	361.1773	255.8927
Prob-ability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Obser-vations	1986	1986	1986	1986	1979	1986	1986	1986	1986	1986

Figure 1: The daily closing prices of S&P BSE Sectoral Indices

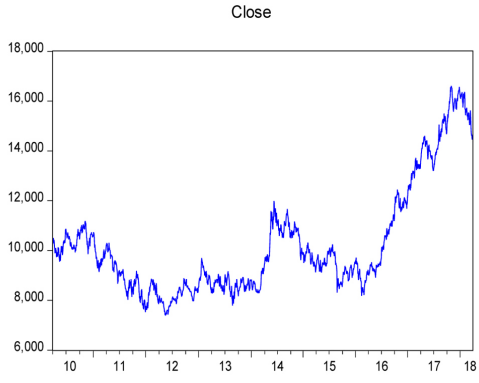
BSE FMCG-1

BSE Health Care:-1

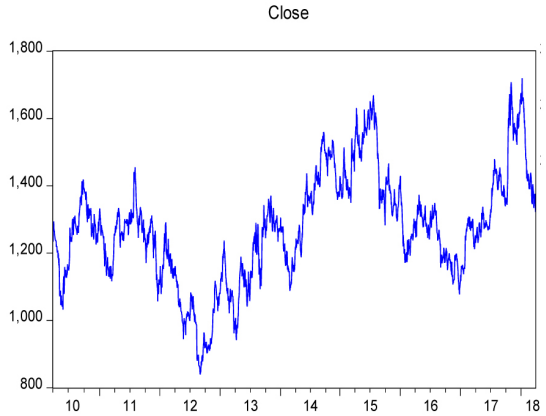
BSE Information & Technology-1



BSE OIL & GAS-1



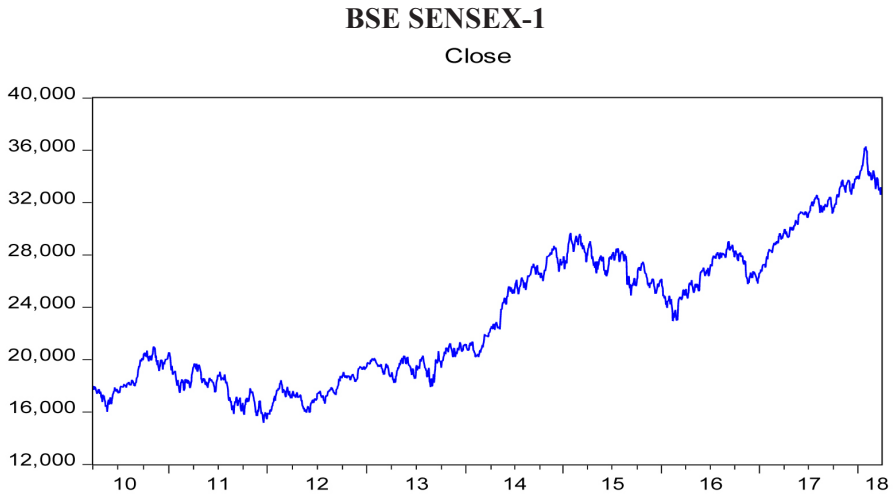
BSE TELECOM-1



BSE AUTO-1

BSE - Reality1

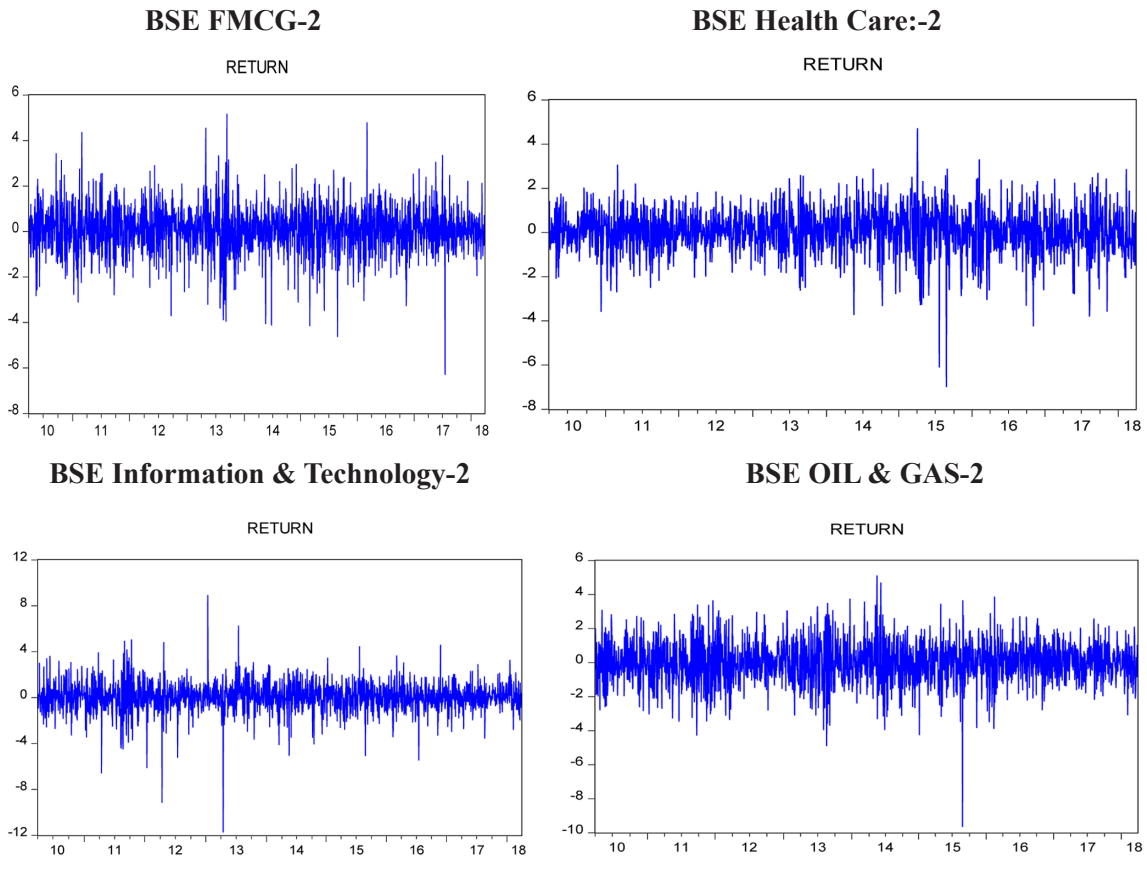
BSE - Banking 1

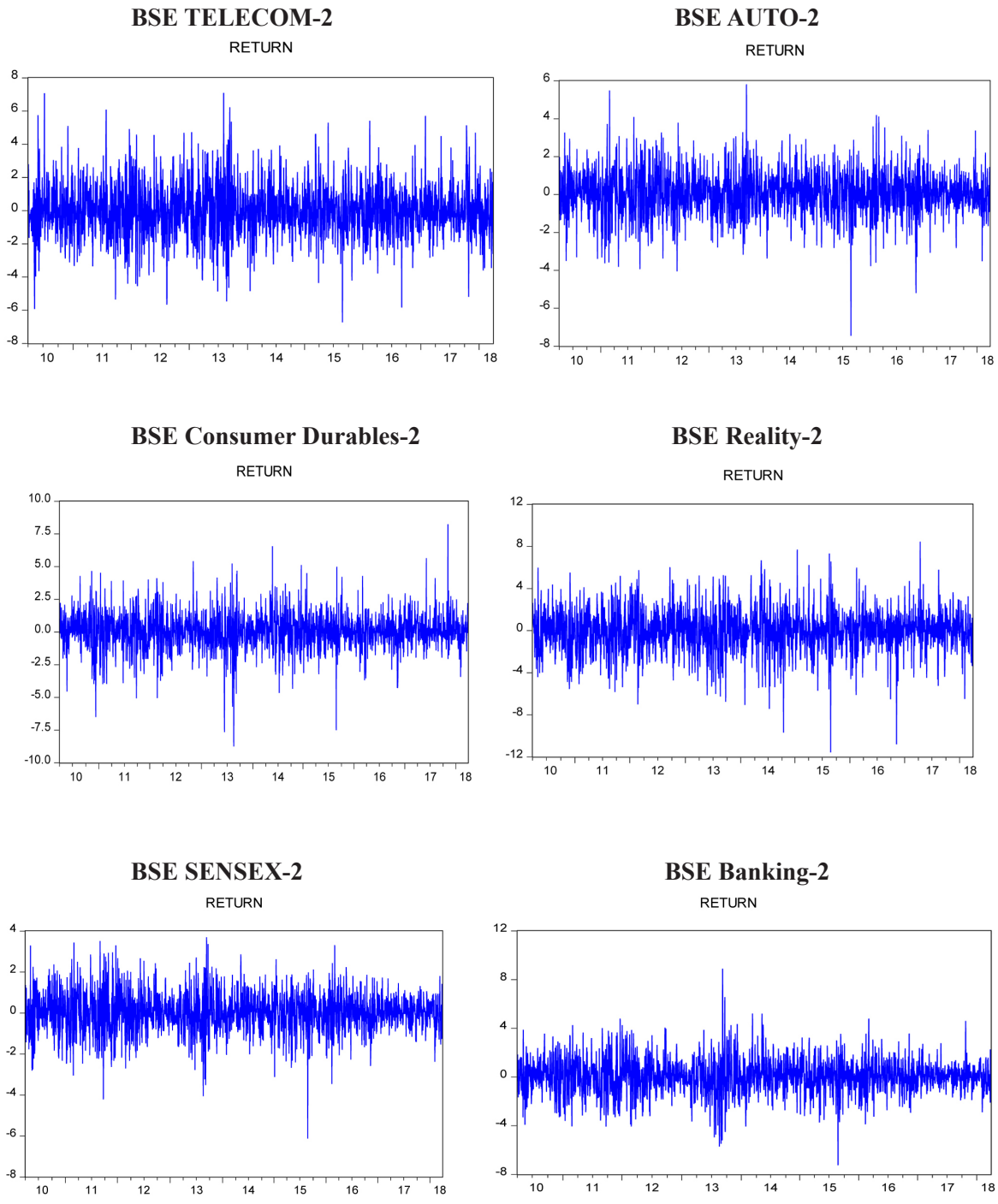


Empirical analysis

The results of the empirical analysis done on the sectoral indices started with a plot of the return series of all indices. The presence of ARCH effects can be seen in the plot of return series.

Figure 2: Return Series of S&P BSE Sectoral Indices





Analysis of Augmented Dickey-Fuller test fordaily returns of S&P BSE sectoral indices

As shown in Table2,the results of the ADF indicate that the returns of sample indices were stationary. Thus, the null hypothesis'There is non-stationary in the returns of selected Sectoral indices of BSE'is not accepted.

Table 2: Augmented Dickey-Fuller test forBSE sectoral indices from 2010 to 2018

FMCG			t-Statistic	Prob.
	Augmented Dickey-Fuller Test Statistic		-43.28019	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	
Health Care				
	Augmented Dickey-Fuller Test Statistic		-40.35469	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	
Oil & Gas				
	Augmented Dickey-Fuller Test Statistic		-44.35410	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	
InformationTech				
	Augmented Dickey-Fuller Test Statistic		-43.47280	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	
Telecom				
	Augmented Dickey-Fuller Test Statistic		-44.77802	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	
Auto				
	Augmented Dickey-Fuller Test Statistic		-41.24459	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	
Consumer Durables				
	Augmented Dickey-Fuller Test Statistic		-42.65469	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	
Reality				
	Augmented Dickey-Fuller Test Statistic		-5.059831	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	

Banking				
	Augmented Dickey-Fuller Test Statistic		-40.89201	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	
Sensex				
	Augmented Dickey-Fuller Test Statistic		-42.14728	0.01
	Test critical values	1% level	-4.949133	
		5% level	-4.443649	
		10% level	-4.193627	

Table 3: ARCH-LM Test-for BSE Sectoral Indices from 2010 to 2018

FMCG	F-Statistic	8.708622	Prob. F(1,1810)	0.0032
	Obs*R-squared	8.676499	Prob. Chi-Square(1)	0.0032
Health Care	F-Statistic	6.068952	Prob. F(3,1338)	0.0004
	Obs*R-squared	18.01613	Prob. Chi-Square(3)	0.0004
Information Tech	F-Statistic	3.975939	Prob. F(1,507)	0.0467
	Obs*R-squared	3.960564	Prob. Chi-Square(1)	0.0467
Oil & Gas	F-Statistic	8.225836	Prob. F(1,1342)	0.0042
	Ob*R-squared	8.187907	Prob. Chi-Square(1)	0.0042
Telecom	F-Statistic	21.32387	Prob. F(1,855)	0.0000
	Obs*R-squared	20.85366	Prob. Chi-Square(1)	0.0000
Auto	F-Statistic	3.818611	Prob. F(3,1338)	0.0097
	Obs*R-squared	11.39254	Prob. Chi-Square(3)	0.0098
Consumer Durables	F-Statistic	54.45588	Prob. F(1,799)	0.0000
	Obs*R-squared	51.10887	Prob. Chi-Square(1)	0.0000
Reality	F-Statistic	4.960625	Prob. F(1,1342)	0.0261
	Obs*R-squared	4.949722	Prob. Chi-Square(1)	0.0261
Banking	F-Statistic	8.472955	Prob. F(2,856)	0.0002
	Obs*R-squared	16.67519	Prob. Chi-Square(2)	0.0002
Sensex	F-Statistic	6.953089	Prob. F(3,1338)	0.0001
	Obs*R-squared	20.60047	Prob. Chi-Square(3)	0.0001

GARCH (1,1) Model

The results of GARCH (1,1) model for all sectoral indices are shown in Table 4. All coefficients of both mean equation and variance equation are significant at 5% level. The model fit can also be inferred using F and the corresponding probability value. The residuals of the GARCH (1,1) model for these sectors do not exhibit ARCH effect, hence the null hypotheses 'There is no ARCH effect' has been accepted. This has been

tested through ARCH-LM test (Table 4). It has been found that all sectoral indices have a probability value greater than 0.05. The sum of the coefficients of ARCH and GARCH is the highest for BSE Oil & Gas, which is less than one, indicating mean reverting process. Akaike criterion, Schwarz criterion and Hannan–Quinn criterion are least for this model and log likelihood is higher than the ARMA model. Durbin-Watson test value of all sectoral indices lie nearer to 2, indicating the absence of autocorrelation. These criteria had proved that GARCH (1,1) model is the best in modelling the conditional variance of BSE sectors.

Table 4: The Results of GARCH (1,1) Model for BSE Sectoral Indices from 2010 to 2018

Sectoral Index	Equation/ Test	Variable	Co-efficient	Std. Error	z-Statistic	Prob.	Inference
FMCG	**Mean variance**	δ	0.073600	0.026263	2.802391	0.0051	
		α_0	0.715042	0.082305	8.687702	0.0000	
		α_1 (ARCH)	0.150000	0.024683	6.077097	0.0000	
		B (GARCH)	0.230590	0.72928	3.161871	0.0016	
	ARCH-LM Test	F-Statistic	1.150644	Prob. F(1,1809)		0.2836	No ARCH
		Obs*R-squared	1.151184	Prob. Chi-Square(1)		0.2833	
Health Care	**Mean variance**	δ	0.089930	0.032258	2.787810	0.0053	
		α_0	0.544091	0.101181	5.377418	0.0000	
		α_1 (ARCH)	0.092408	0.024645	3.749479	0.0002	
		β (GARCH)	0.329023	0.106199	3.098178	0.0019	
	ARCH-LM Test	F-Statistic	0.015167	Prob. F(1,1341)		0.9020	No ARCH
		Obs*R-squared	0.015189	Prob. Chi-Square(1)		0.9019	
Information Technology	**Mean variance**	δ	0.039506	0.074806	0.528105	0.5974	
		α_0	1.462236	0.306827	4.765670	0.0000	
		α_1 (ARCH)	0.175989	0.058257	3.020916	0.0025	
		β(GARCH)	0.178607	0.152790	1.168967	0.2424	
	ARCH-LM Test	F-Statistic	0.009454	Prob. F(1,503)		0.9226	No ARCH
		Obs*R-squared	0.009492	Prob. Chi-Square(1)		0.9224	
Oil & Gas	**Mean variance**	δ	-0.006404	0.035772	-0.179019	0.8579	
		α_0	0.078846	0.030617	2.575200	0.0100	
		α_1 (ARCH)	0.067944	0.015289	4.444138	0.0000	
		β(GARCH)	0.890085	0.028049	31.73320	0.0000	
	ARCH-LM Test	F-Statistic	0.000184	Prob. F(1,1342)		0.9892	No ARCH
		Obs*R-squared	0.000185	Prob. Chi-Square(1)		0.9892	

Telecom	**Mean variance**	δ	0.004337	0.059702	0.072638	0.9421	
		α_0	1.281659	0.334709	3.829170	0.0001	
		α_1 (ARCH)	0.196519	0.041862	4.694477	0.0000	
		β(GARCH)	0.340362	0.155212	2.192886	0.283	
	ARCH-LM Test	F-Statistic	0.108914	Prob. F(1,855)		0.7415	No ARCH
		Obs*R-squared	0.109155	Prob. Chi-Square(1)		0.7411	
Auto	**Mean variance**	δ	0.081303	0.038781	2.096453	0.0360	
		α_0	0.118655	0.033737	3.517071	0.0004	
		α_1 (ARCH)	0.150000	0.031894	4.703103	0.0000	
		β(GARCH)	0.218630	0.130412	1.676453	0.0936	
	ARCH-LM Test	F-Statistic	2.571802	Prob. F(1,1341)		0.1090	No ARCH
		Obs*R-squared	2.570708	Prob. Chi-Square(1)		0.1089	
Consumer Durables	**Mean variance**	δ	0.076538	0.055495	1.379176	0.1678	
		α_0	1.447225	0.283112	5.111845	0.0000	
		α_1 (ARCH)	0.150000	0.033305	4.503885	0.0000	
		β(GARCH)	0.176669	0.128618	1.373596	0.1695	
	ARCH-LM Test	F-Statistic	0.936790	Prob. F(1,798)		0.3334	No ARCH
		Obs*R-squared	0.938036	Prob. Chi-Square(1)		0.3328	
Banking	**Mean variance**	δ	0.006099	0.058007	0.105135	0.9163	
		α_0	1.613498	0.389228	4.144740	0.0000	
		α_1 (ARCH)	0.150000	0.050348	2.979282	0.0029	
		β(GARCH)	0.211225	0.165881	1.273355	0.2029	
	ARCH-LM Test	F-Statistic	2.695614	Prob. F(1,857)		0.1010	No ARCH
		Obs*R-squared	2.693433	Prob. Chi-Square(1)		0.1008	
Reality	**Mean variance**	δ	-0.063759	0.065786	-0.969198	0.3324	
		α_0	3.057798	0.559108	5.469065	0.0000	
		α_1 (ARCH)	0.150000	0.036053	4.160512	0.0000	
		β(GARCH)	0.201943	0.120477	1.676195	0.0937	
	ARCH-LM Test	F-Statistic	1.686064	Prob. F(1,1341)		0.1943	No ARCH
		Obs*R-squared	1.686458	Prob. Chi-Square(2)		0.1941	

Sensex	**Mean variance**	δ	0.032523	0.031013	1.048657	0.2943	
		α_0	0.678600	0.176651	3.841469	0.0001	
		α_1 (ARCH)	0.111171	0.042588	2.610406	0.0090	
		β(GARCH)	0.302634	0.162277	1.864924	0.0622	
	ARCH-LM Test	F-Statistic	2.606232	Prob. F (2,1339)		0.0742	No ARCH
		Obs*R-squared	5.203884	Prob. Chi-Square(1)		0.0741	

Conclusion

This paper examined the volatility of stock returns of selected BSE sectoral indices (S&P BSE Banking, Realty, Consumer Durable, Oil & Gas, Information & Technology (I&T), FMCG, Health Care, Telecom, AUTO, Index and BSE Sensex). ARCH-LM test confirmed the absence of ARCH effect in the selected sectoral indices. The characteristics of return such as normality, stationarity, autocorrelation and heteroscedasticity were also tested. The GARCH (1,1) model has been found to be the best model for predicting the volatility of the return series of the indices selected in the study.

Limitations

The following are the limitations of the study:

1. The study used only 8 years' data of BSE sectoral indices (2010 to 2018).

2. Only GARCH (1, 1) model is used for the study.

Future studies

The analysis can be extended for the individual share of other BSE indices such as BSE 100, BSE 200, BSE 500, etc. The study can also be extended to other stock market indices like NSE sectoral indices. Other GARCH variants also can be used to model the volatility and forecast the same.

References

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of econometrics,* 31(3), 307-327.

Banumathy K. & Azhagaiah R. (2014). Risk-return relationship in sectoral indices: Some evidence from India. *Asia Pacific Journal of Business and Management,* 5(2), 1-13.

Birau, R., Trivedi, J., & Antonescu M. (2015). Modeling S&P Bombay Stock Exchange BANKEX index volatility patterns using GARCH model. *Procedia Economics and Finance,* 32, 520–525.

Dangi, V. (2015). Risk-return trade-off, volatility behaviour and leverage effect in Indian banking sector. *International Journal of Science Technology and Management,* 4(11), 471-482.

Dritsaki C. (2017). An empirical evaluation in GARCH volatility modeling: Evidence from the Stockholm Stock Exchange. *Journal of Mathematical Finance,* 7, 366-390.

Ekong, C. N., Onye, K. U. (2017). Application of Garch models to estimate and predict financial volatility of daily stock returns in Nigeria. MPRA Paper No. 88309.

Lama A., Jha, G. K., Paul, R. K., & Gurung, B. (2015). Modelling and forecasting of price volatility: An application of GARCH and EGARCH models. *Agricultural Economics Research Review,* 28(1), 73-82.

Lim, C. M., Sek, S. K. (2013). Comparing the performances of GARCH-type models in capturing the stock market volatility in Malaysia. *ScienceDirect Procedia Economics and Finance.* 5 478–487.

Lodha Shilpa, & Soral, G. (2015) (Seasonal Patterns in Indian Stock Markets: An Application of GARCH (1, 1) Model American International Journal of Research in Humanities, Arts and Social Sciences pp 33-43

Mallikarjuna, M., & Rao, R. P. (2017). Volatility behaviour in selected sectoral indices of Indian stock markets. *Asian Journal of Research in Banking and Finance,* 7(2), 23-34.

Mohandass, S., Renukadevi, P. (2013). Modeling volatility of BSE sectoral indices.

International Journal of Marketing, Financial Services & Management Research, 2(3), 12-24.

Nageswari, P., Jeyachitra, A., & Desh, K. (2015). A study on performance of sectoral indices in Bombay Stock Exchange. *The International Journal of Business & Management,* 3(3), 211-217

Savadatti, P. M. (2018). Sectoral analysis of Bombay Stock Exchange: Application of Garch models. *International Journal of Management Studies,* V, 2(7), 40-52.

Sharma, N., & Khanna, K. (2013). Stock market volatility dynamics and results announcements: A causal link (a study of India). *Indian Journal of Applied Research,* 3(7), 127-128.

Tanty, G., Patjoshi, P. K. (2016). Measurement of sectoral indices volatility with reference to Bombay Stock Market. *International Journal of Research and Development: A Management Review,* 5(3), 4-10.