Stock market Volatility: Comparative study between India and US.

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Abstract : The global stock market is having its influence on Indian stock market. The impact of developed country effect, particularly, that of US stock market, has been the most prominent. The study on "Stock market Volatility: Comparative study between India and US." The Objective of this study is to determine the trend in volatility in BSE Sensex Vis a NYSE Composite. Period chosen for study is 2012 to 2017 monthly data for respective stock exchange. Research design is Descriptive using Eview Software the Unit root test, GARCH & ARCH Model. The result of the Unit root test which gives an idea about whether the data follows trend or not. The output states that all the variables become non stationary at the level only, so that suggests that data does follow any trend at level. The model used for measuring the volatility was GARCH (1, 1) because it was well significant as compared to the other models, because it has highest probability and fulfils all the criteria of selection as compared to other variables. The GARCH (1, 1) model which undertakes the variables i.e. are Logbse and Lognew which are the selected stock market, the output of model states that the indices has presence of volatility in the stock market that can be stated through the ARCH and GARCH term which are significant to explain the model.

Key Words: Stock Market Volatility, Unit root, ARCH & GARCH

I. INTRODUCTION

Volatility is the most basic statistical measure. It can be used to measure the market risk of a single instrument or an entire portfolio of instruments. While volatility can be expressed in different ways, statistically, volatility of a random variable is its standard deviation. In day-to-day practice, volatility is calculated for all sorts of random financial variables such as stock return, interest rate, the market value of portfolio, etc. stock return volatility measures the random variability of the stock returns. Simply put stock return volatility in the variation of the stock return in time. More specifically, it is the standard deviation of the daily stock return around the mean value and the stock market volatility in the return volatility of the aggregate market portfolio.

With the advent of globalization, world financial markets and economies are increasingly integrated due to free flow capital and international trade. Globalization has also increased co-movement in stock prices across international markets. This comovement stimulates vulnerability to market shocks. Therefore, shocks originating in one market not only affect its own market but are also transmitted to other equity markets. Consequently, any information regarding the economic fundamentals of one country gets transmitted to other markets and thus affects other's stock markets. Before investing in an asset, investors incorporate information about price movements and volatility in the same asset and related assets listed in different countries. This issue is an important concern for portfolio investors because greater integration among world markets implies stronger co-movements between markets, thereby nullifying much of the gain out of diversification across borders

II. LITERATURE REVIEW

Zhang, Yan (Dec. 2016), Comparative Analysis on China, Japan and the US Stock-price volatilities and linkage between these three countries are analyzed. The impact that the global financial crisis had on the stock markets of China, Japan, and the United States, the stock-price volatilities and linkage between these three countries are analyzed. In addition, the relationships between macroeconomic variables (real-economy variables and monetary-policy variables) and stock price volatility in each country are investigated. The sample period is from 1 January 1991 to 31 December 2014. EGARCH model**.** The estimation results of the EGARCH model revealed that although China's stock price volatility was far greater than those of Japanese and US stock prices, China was less affected by the global financial crisis in 2007 than Japan and the United States. For China, stock price volatility was greater in the early 1990s, shortly after the stock market had been established, than in 2007 when the global financial crisis occurred. Furthermore, it has been revealed that the linkage of Chinese, Japanese, and US stock prices has increased since the global financial crisis. Moreover, Granger causality testing revealed US interest rate affects stock price volatility, while the China and Japan's monetary-policy variables (M2 and lending interest rate) do not affect China and Japan's stock price volatilities, respectively.

Dr. Anubha Srivastava, Assistant Professor (Dec. 2014) Is Indian Stock Market Highly Volatile? - A Comprehensive Study Author**.** 1. To find out the volatility in Indian stock market in terms of BSE and NSE. 2. To find out the volatility with respect to open to open, close to close and high- low. 3. To suggest the measures to improve the volatility. Data were taken from 2008- 2013 Daily Data has been used**.** Mean, Standard Deviation, Percentage Return, Volatility the two indices taken for the study confirmed

that there is relationship between the economic recession and stock market volatility. Whenever there is recession or financial crisis the stock market reacts negatively thus increasing the volatility. The reason for long term volatility during and after recession can be attributed to corporate leverage as at the time of economic recession the demand for the goods and services comes down thus increasing the fixed operation cost and putting pressure on the operating profits. The sentiment of the market remains negative with panic in minds of investors selling their shares which influence the volatility of the market to a great extent.

Aparna Bhatia. (July 2014), Analysis of stock market volatility: a comparative study of India and china. 1. To determine the trend in volatility in BSE Sensex Vis a Vis SSE Composite. 2. To identify the reasons for volatility in Indian stock market. 3. To determine the causal relation between BSE Sensex and SSE Composite. The time period chosen for study is April 2004 to March 2012. Test: Granger Causality test. The transmission of volatility between India and China is examined by applying Granger causality test. The results show that the volatility was at its highest level in the year 2008 in both the countries. However, the Indian stock market is found to be more volatile than Chinese stock market but returns in Indian stock market were comparatively more than in China.

Md. Ariful Islam, Md. Rayhan Islam, Mahmudul Hasan Siddiqui (2014). Stock market volatility: comparison between Dhaka stock exchange and Chittagong stock exchange**.** 1. To provide an overview of security markets of Bangladesh**,** to provide an overview of volatility of stock exchange, 3. To acquaint with the technique of calculation of volatility. The daily price index throughout the year 2004**.** Standard deviation, coefficient of Variation, F-test and monthly return is calculated**.** Although investors are suffering from lack of information about the quality of securities, they take investment decision considering the general price index of two markets. Some time it may mislead the investor the differences of indexes of two markets. As the base of these two indices is different they can consider the percentage change in indexes and standard deviation of the indexes.

Manex Yonis (2011), Stock Market Co-Movement and Volatility Spillover between USA and South Africa. The purpose of this study is twofold. First, they look at the co-movement of the US and South African stock markets. Second, they examine the existence of volatility spillover between them. The data used in this paper are daily stock indices of the New York and Johannesburg stock markets, April 1, 2005 to May 31, 2011. MA-GARCH, Unrestricted Bivariate BEKK-GARCH Model. They find evidence of return spillover from NYSE to JSE by analyzing VAR based on two lags. While analyzing the MA-GARCH model, empirical results exhibit that volatility spillover between US and SA is persistence. Uni-directional link regarding transmission of shocks and volatility persistence between NYSE and JSE is revealed, the direction is from NYSE to JSE, as off-diagonal parameters a12 and g12 are statistically significant. Finally, a strong influence of US market is observed in this paper regarding stock movement in the SA market.

III. RESEARCH METHODOLOGY

3.1 Problem Statement

Does Stock Market Volatility have any influencing relationship on each other?

3.2 Objective

To determine the trend in volatility in BSE Sensex Vis a NYSE Composite.

3.3 Research Design

Descriptive research is used for the study where data are gathered from respective stock exchanges.

Data Collection and Period

Data collection period for the study is from last 5 years (2012-17)

Data are collected from respective indices and stock exchanges used in the study. (INDIA & US)

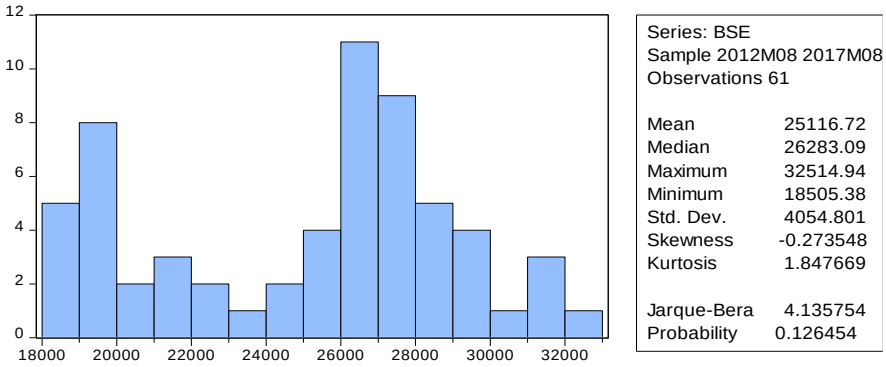
3.4 Tool Used:

Eviews .

IV. Data Analysis and Interpretation

Normality Test

BSE



From the above table, we can say that **mean** value of data is 25116.72, **median** which is a middle value 26283.09, **maximum** value is 32514.94 and **minimum** value is 18505.38. **standard deviation** is 4054.801 which means if any new variable added in data will leads to change of 4054.801**, skewness** is -0.273548 which data are not symmetric which is here negatively skewed. **Kurtosis** measures the peakness of data where it is 1.84 which is less than 3, we can say data are relative to normal.

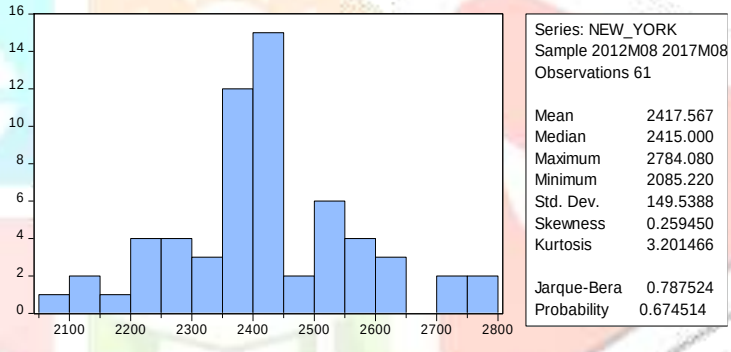
The **Jarque-Bera** probability is 0.12

H0= Data of BSE is Normal

H1 = Data of BSE is not normal

From the p value (0.12) which is greater than 0.05, so null is accepted and so data is normal.

NYSE



From the above table, we can say that **mean** value of data is 2417.567, **median** which is a middle value 2415.000, **maximum** value is 2784.080 and **minimum** value is 2085.220. **standard deviation** is 149.5388 which means if any new variable added in data will leads to change of 149.5388**, skewness** is 0.259450 which measures dispersion in the data which is here positively skewed. **Kurtosis** measures the peakness of data where it is 3.20 which is more than 3, we showcase leptokurtic.

The **Jarque-Bera** probability is 0.67

H0= Data of NYSE is Normal

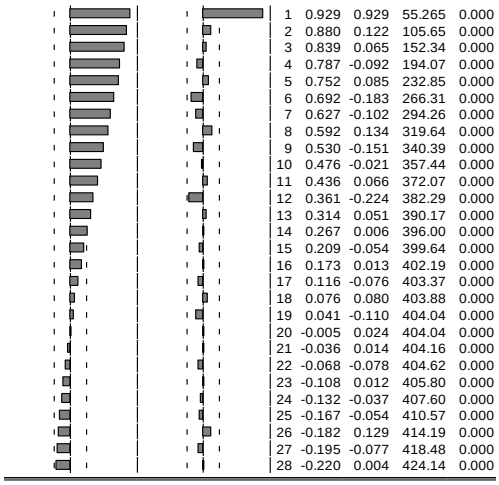
H1 = Data of NYSE is not normal

From the p value we can say that it is 0.67 which is greater than 0.05, so null is accepted so data is normal.

Residuals test for log series data

Correlogram of residuals

Date: 12/20/17 Time: 11:57
Sample: 2012M08 2017M08
Included observations: 61



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.929	0.929	55.265	0.000
		2	0.880	0.122	105.65	0.000
		3	0.839	0.065	152.34	0.000
		4	0.787	-0.092	194.07	0.000
		5	0.752	0.085	232.85	0.000
		6	0.692	-0.183	266.31	0.000
		7	0.627	-0.102	294.26	0.000
		8	0.592	0.134	319.64	0.000
		9	0.530	-0.151	340.39	0.000
		10	0.476	-0.021	357.44	0.000
		11	0.436	0.066	372.07	0.000
		12	0.361	-0.224	382.29	0.000
		13	0.314	0.051	390.17	0.000
		14	0.267	0.006	396.00	0.000
		15	0.209	-0.054	399.64	0.000
		16	0.173	0.013	402.19	0.000
		17	0.116	-0.076	403.37	0.000
		18	0.076	0.080	403.88	0.000
		19	0.041	-0.110	404.04	0.000
		20	-0.005	0.024	404.04	0.000
		21	-0.036	0.014	404.16	0.000
		22	-0.068	-0.078	404.62	0.000
		23	-0.108	0.012	405.80	0.000
		24	-0.132	-0.037	407.60	0.000
		25	-0.167	-0.054	410.57	0.000
		26	-0.182	0.129	414.19	0.000
		27	-0.195	-0.077	418.48	0.000
		28	-0.220	0.004	424.14	0.000

From the above table, which is an output of the Correlogram that states that whether data is having serial correlation or not.

H0= Data is not serially correlated

H1= Data is serially correlated

From the above table, we can say that most of the p value of most the variables is less than 0.05, so data are serially correlated.

Breusch-Godfrey Serial correlation LM Test

Breusch-Godfrey Serial correlation LM Test				
Method: Least Squares				
Total Observations: 61				
Dependent Variable: RESID				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.887946
LOGNEW	-0.000983	0.9934	**Adjusted R-squared**	0.882048
C	0.011331	0.9903	**F-statistics**	150.5604
RESID(-1)	0.785950	0.0000	**Prob.(statistics)**	0.000000
RESID(-2)	0.179511	0.1893	**DWN**	1.604431

The table shows the output of Breusch-Godfrey Serial correlation LM Test which gives ide about the serial correlation in the data.

H0= Data is not serially correlated

H1= Data is serially correlated

From the above table, we can say that most of the p value is 0.0000 which is less than 0.05, so null is reject and we can say that data are serially correlated. Durbin Watson is 1.60 which is less than 2 it means positive serial correlations. Adjusted R-Square value is 0.887946 than means the 88.7946% variations is explain by the independent variable which is included in the model.

Hetroskedasticity Test by ARCH

Hetroskedasticity Test by ARCH				
Method: Least Squares				
Dependent Variable: RESID^2				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.655312

C	0.005194	0.9934	**Adjusted R-squared**	0.649370
RESID^2(-1)	0.770610	0.9903	**F-statistics**	110.2683
			Prob.(statistics)	0.000000
			Durbin-Watson Stat.	2.668916

The above table shows the output of Hetroskedasticity generated through the ARCH method, that shows the whether the data is fluctuating or not.

H0= Residuals does not have Hetroskedasticity

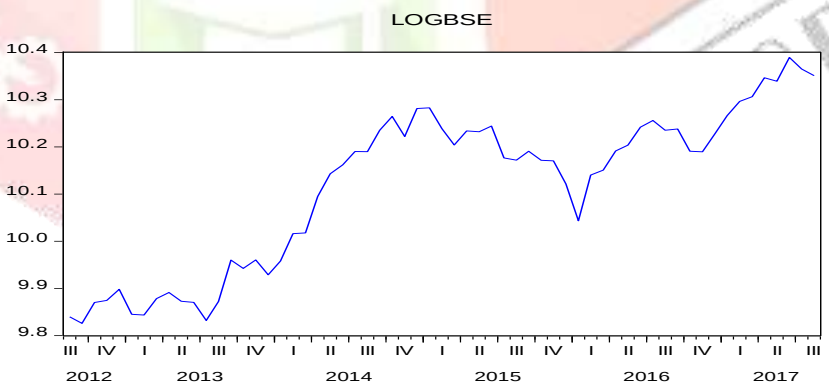
H1= Residuals have Hetroskedasticity

From the table we can say that the probability value of chi-square is 0.0000 which is less than 0.05, so we can say than null is rejected and alternative is accepted. So the data has Hetroskedasticity and GARCH model can be used for further study. Durbin Watson is 2.66 which is more than 2 there is serial correlations. Adjusted R-Square value is 0.649370 than means the 64.9370% variations is explain by the independent variable which is included in the model.

Unit Root Test

Name of the variable	**Level**		**1st Difference**		**2nd Difference**	
	Constant	**Constant & Trend**	**Constant**	**Constant & Trend**	**Constant**	**Constant & Trend**
	ADF test Value	**ADF test Value**	**ADF test Value**	**ADF test Value**	**ADF test Value**	**ADF test Value**
LogBSE	**-1.097801**	**-1.767630**	**-7.797054*** **	**-7.747101*** **	**-7.563275*** **	**-7.477221*** **
LogNYSE	**-2.287769**	**-2.248841**	**-9.180985*** **	**-9.129301*** **	**-10.46412*** **	**-100.36793*** **
***** indicate 1%, ** indicate 5%, * indicate 10% ADF test value is significance respectively**						

Intercept- Level



Unit Root Test- Logbse				
Intercept- Level				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.020356
ADF	-1.097801	0.7113	**Adjusted R-squared**	0.003465
LOGBSE(-1)	-0.031480	0.2766	**F-statistics**	1.205167
C	0.326910	0.2644	**Prob.(statistics)**	0.276828
			Durbin-Watson Stat.	2.029069

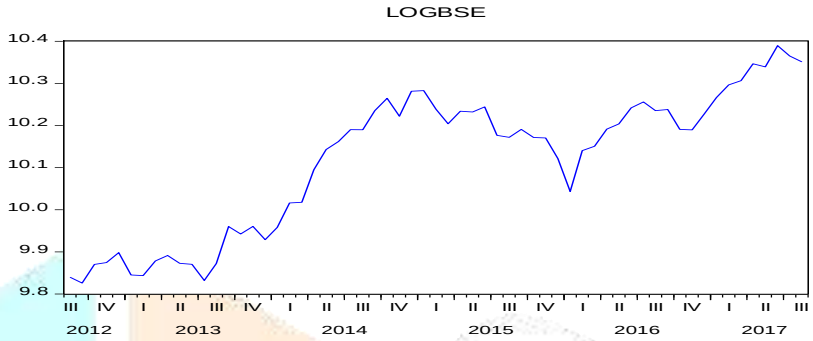
From the above table, I can say that the output is generated through unit root test using ADF test.

H0= Logbse has a unit root

H1= Logbse does not have a unit root

From the p value we can interpret that, 0.7113 is more than 0.05 so here we accept null and reject alternative that means data have unit root. The value of Durbin Watson is 2.02 which states the data is negatively serial correlation. The value of F statistics is 0.27 which is more than 0.05, so we can say that model is not statically significant. Data becomes not stationary at level, which states it does follows the trend. Adjusted R-Square value is 0.003466 than means the variations is explain by the independent variable which is included in the model.

Intercept- 1st diff.



Unit Root Test- Logbse				
Intercept- 1st diff.				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.516105
ADF	-7.797054	0.0000	**Adjusted R-squared**	0.507615
D(LOGBSE(-1))	-1.032316	0.0000	**F-statistics**	60.79406
C	0.009187	0.0712	**Prob.(statistics)**	0.000000
			Durbin-Watson Stat.	1.959216

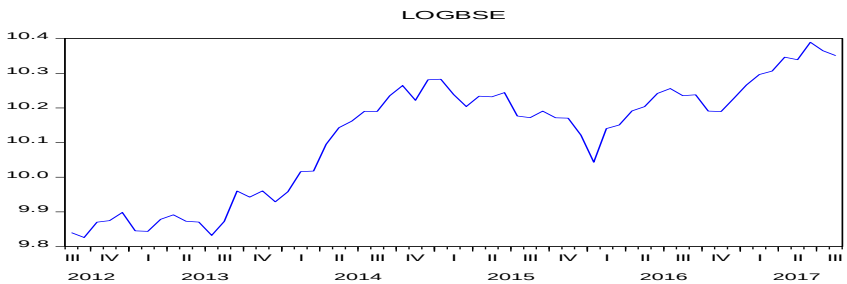
From the above table, I can say that the output is generated through unit root test using ADF test.

H0= Logbse has a unit root

H1= Logbse does not have a unit root

From the p value we can interpret that, 0.000 is less than 0.05 so here we reject null and accept alternative that means data doesn't have unit root. The value of Durbin Watson is 1.95 which states the data is not having problem of auto correlation. The value of F statistics is 0.00 which is less than 0.05, so we can say that model is significant. Adjusted R-Square value is 0.507615 than means 50.76% the variations is explain by the independent variable which is included in the model. Data becomes stationary at level, which states that it does not follow trend.

Trend & Intercept- Level



Unit Root Test- Logbse

Trend & Intercept- Level				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.053213
ADF	-1.767630	0.7080	**Adjusted R-squared**	0.019993
LOGBSE(-1)	-0.103148	0.0825	**F-statistics**	1.601814
C	1.027845	0.0794	**Prob.(statistics)**	0.210469
			Durbin-Watson Stat.	1.954307

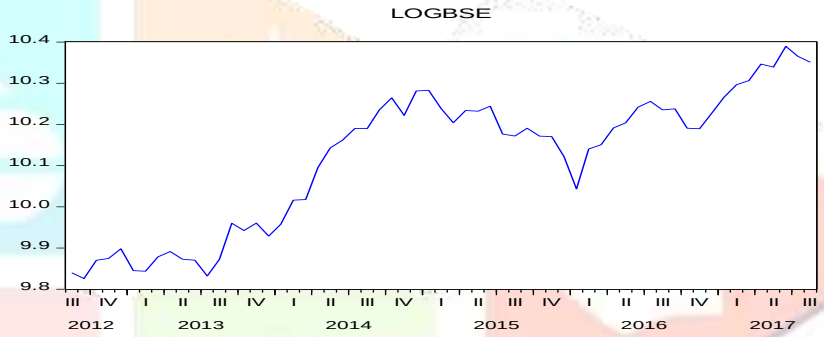
From the above table, I can say that the output is generated through unit root test using ADF test.

H0= Logbse has a unit root

H1= Logbse does not have a unit root

From the p value we can interpret that, 0.7080 is more than 0.05 so here we accept null and reject alternative that means data have unit root. The value of Durbin Watson is 1.95 which states the data is positive serial correlation. The value of F statistics is 0.21 which is more than 0.05, so we can say that model is not statically significant. Data becomes not stationary at level, which states it does follows the trend.

Trend & Intercept- 1st Diff



Unit Root Test- Logbse				
Trend & Intercept- 1st Diff				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.517629
ADF	-7.747101	0.0000	**Adjusted R-squared**	0.500401
D(LOGBSE(-1))	-1.033371	0.0000	**F-statistics**	30.04658
C	0.012942	0.2119	**Prob.(statistics)**	0.000000
			Durbin-Watson Stat.	1.963181

From the above table, I can say that the output is generated through unit root test using ADF test.

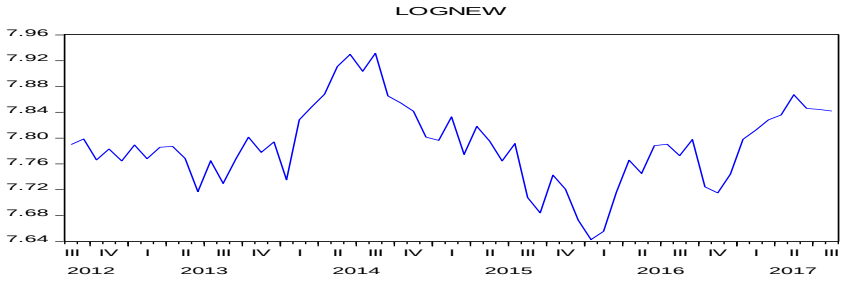
H0= Logbse has a unit root

H1= Logbse does not have a unit root

From the p value we can interpret that, 0.000 is less than 0.05 so here we reject null and accept alternative that means data doesn't have unit root. The value of Durbin Watson is 1.96 which states the data is not having problem of auto correlation. The value of F statistics is 0.00 which is less than 0.05, so we can say that model is significant.

Data becomes stationary at level, which states that it does not follow trend.

Intercept- level



Unit Root Test- Lognew				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.082770
ADF	-2.287769	0.1792	**Adjusted R-squared**	0.066966
LOGNEW(-1)	-0.171725	0.0258	**F-statistics**	5.233889
C	1.338215	0.0257	**Prob.(statistics)**	0.025815
			Durbin-Watson Stat.	2.185469

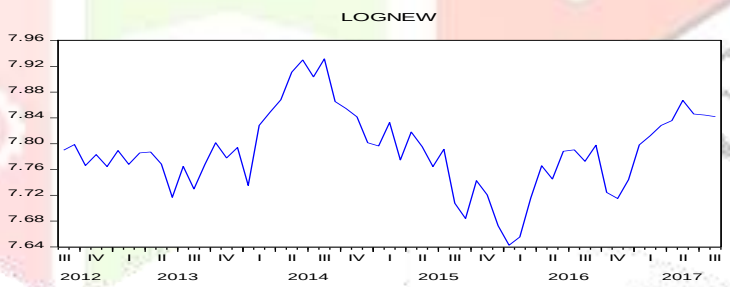
From the above table, I can say that the output is generated through unit root test using ADF test.

H0= Lognew has a unit root

H1= Lognew does not have a unit root

From the p value we can interpret that, 0.1792 is more than 0.05 so here we accept null and reject alternative that means data have unit root. The value of Durbin Watson is 2.18 which states the data is negatively serial correlation. The value of F statistics is 0.27 which is more than 0.05, so we can say that model is not statically significant. Data becomes not stationary at level, which states it does follows the trend.

Intercept- 1st diff



Unit Root Test- Lognew				
Intercept- 1st diff				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.596576
ADF	-9.180985	0.0000	**Adjusted R-squared**	0.589498
D(LOGNEW(-1))	-1.192839	0.0000	**F-statistics**	84.29049
C	0.000911	0.8500	**Prob.(statistics)**	0.000000
			Durbin-Watson Stat.	1.978309

From the above table, I can say that the output is generated through unit root test using ADF test.

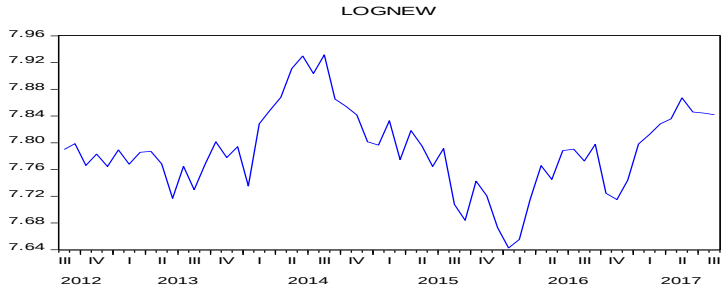
H0= Lognew has a unit root

H1= Lognew does not have a unit root

From the p value we can interpret that, 0.000 is less than 0.05 so here we reject null and accept alternative that means data doesn't have unit root. The value of Durbin Watson is 1.97 which states the data is not having problem of auto correlation. The value of F statistics is 0.00 which is less than 0.05, so we can say that model is significant.

Data becomes stationary at level, which states that it does not follow trend.

Trend & Intercept- level



Unit Root Test- Lognew				
Trend & Intercept- level				
Variable	**Coefficient**	**Prob.***	**R-squared**	0.083269
ADF	-2.248841	0.4545	**Adjusted R-squared**	0.051103
LOGNEW(-1)	-0.170717	0.0284	**F-statistics**	2.588728
C	1.328923	0.0286	**Prob.(statistics)**	0.083926
			Durbin-Watson Stat.	2.188909

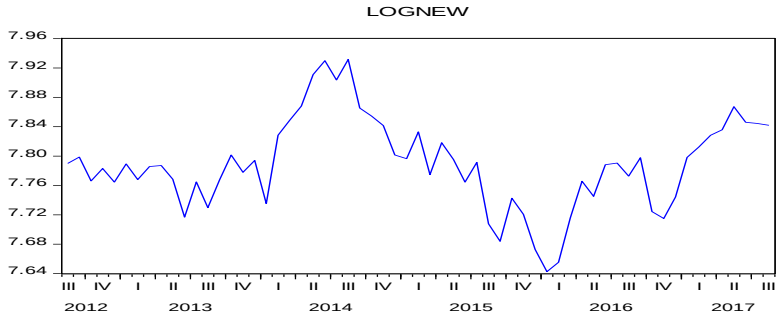
From the above table, I can say that the output is generated through unit root test using ADF test.

H0= Lognew has a unit root

H1= Lognew does not have a unit root

From the p value we can interpret that, 0.4545 is more than 0.05 so here we accept null and reject alternative that means data have unit root. The value of Durbin Watson is 2.18 which states the data is negatively serial correlation. The value of F statistics is 0.08 which is more than 0.05, so we can say that model is not statically significant. Data becomes not stationary at level, which states it does follows the trend.

Trend & Intercept- 1st diff



Unit Root Test- Lognew
Trend & Intercept- 1st diff

Variable	Coefficient	Prob.*	R-squared	0.598119
ADF	-9.129301	0.0000	**Adjusted R-squared**	0.583767
D(LOGNEW(-1))	-1.196742	0.0000	**F-statistics**	41.67244
C	-0.000132	0.7534	**Prob.(statistics)**	0.000000
			Durbin-Watson Stat.	1.980007

From the above table, I can say that the output is generated through unit root test using ADF test.

H0= Lognew has a unit root

H1= Lognew does not have a unit root

From the p value we can interpret that, 0.000 is less than 0.05 so here we reject null and accept alternative that means data doesn't have unit root. The value of Durbin Watson is 1.98 which states the data is not having problem of auto correlation. The value of F statistics is 0.00 which is less than 0.05, so we can say that model is significant.

Data becomes stationary at level, which states that it does not follow trend.

GARCH MODEL ESTIMATION

BSE			**NYSE**		
Particular	**Value**	**Probability**	**Particular**	**Value**	**Probability**
Model	**(1,1)**		**Model**	**(1,1)**	
GARCH(-1)	-0.01	0.98	GARCH(-1)	0.05	0.87
GARCH(-2)	-	-	GARCH(-2)	-	-
Resid(-1)	0.88	0.07	Resid(-1)	0.81	0.10
Resid(-2)	-	-	Resid(-2)	-	-
AIC	-1.67	-	AIC	-3.12	-
SC	-1.53	-	SC	-2.99	-
Model	**(1,2)**		**Model**	**(1,2)**	
GARCH(-1)	0.18	0.13	GARCH(-1)	0.52	0.00
GARCH(-2)	-0.20	0.01	GARCH(-2)	-0.24	0.00
Resid(-1)	0.83	0.08	Resid(-1)	0.64	0.08
Resid(-2)	-	-	Resid(-2)	-	-
AIC	-1.85	-	AIC	-3.16	-
SC	-1.68	-	SC	-2.99	-
Model	**(2,1)**		**Model**	**(2,1)**	
GARCH(-1)	0.42	0.43	GARCH(-1)	1.29	0.00
GARCH(-2)	-	-	GARCH(-2)	-	-
Resid(-1)	1.09	0.06	Resid(-1)	0.45	0.82

Resid(-2)	-0.57	0.22	Resid(-2)	-0.75	0.47
AIC	-1.67	-	AIC	-3.27	-
SC	-1.50	-	SC	-3.10	-

Interpretation

The above table is an output of various GARCH model such as GARCH (1, 1), (1, 2), (2, 1). It shows the GARCH value, ARCH value, their probabilities, AIC value and SC value which is a criterial used for lag selection.

V. RESULTS AND DISCUSSION

•The study found that the data undertaken for study i.e. BSE and NYSE are Normal that are proved through Jarque-Bera test.
•Residual test are conducted on creating the Log series of the data. Residual test's which includes Correlogram Q stat, LM serial correlation test, Hetroskedasticity test by ARCH. The result of residuals test were:
•Correlogram of residuals states that the data used in the study are serially correlated.
•The result of Breusch-Godfrey Serial correlation LM Test states that all the data or variables which are taken for study does not have any serial correlation problem.
•The test of Hetroskedasticity Test by ARCH states that the data does not have the problem of Hetroskedasticity.
•The result of the Unit root test which gives an idea about whether the data follows trend or not. The variables i.e. are Logbse and lognew were used to conduct unit root test. The output states that all the variables becomes non stationary at the level only, so that suggests that data does follow any trend at level.
•The model used for measuring the volatility was GARCH (1, 1) because it was well significant as compared to the other models, because it has highest probability and fulfils all the criteria of selection as compared to other variables.
•The GARCH (1, 1) model which undertakes the variables i.e. are Logbse and Lognew which are the selected stock market, the output of model states that the indices has presence of volatility in the stock market that can be stated through the ARCH and GARCH term which are significant to explain the model. The ARCH and GARCH term both are near to 1 then it can be said that there is presence of volatility in the market.

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