International Journal of Latest Engineering Science (IJLES) E-ISSN: 2581-6659

DOI: 10.51386/25816659/ijles-v6i3p102

Volume: 06 Issue: 03 **May to June 2023** **www.ijlesjournal.org**

Generalized Autoregressive Conditional Heteroskedasticity (Garch) Modeling of the Volatility of Exchange Rate on Stock Indices

[1]Okorafor, U. [2] Are, S. O.,, [3]Adeboun,T. D

[1, 3] Department of Statistics, Yaba College of Technology, Yaba, Lagos, Nigeria.
[2] Mathematics and Statistics Department, Federal Polytechnic, Ilaro, Ogun State, Nigeria.

Abstract
Stock values all over the globe are very volatile. This study is aimed atdetermining if there are volatility transmissions among both the foreign exchanges and stock exchanges of Ghana, Nigeria and South Africa and individual countries' foreign and stock exchanges using Generalized ARCH model Generalized Autoregressive Conditional Heteroskedasticity (GARCH). Secondary data was used. The fitted GARCH models fitted are:6.95E-06 + 0,501944 RESID(-1)^2 + 0.701504 GARCH(-1) + 8.01E-05 LN__USD – NGN + 7.14E-05 LN_RAND_USD, 1.18E-05 + 0,283857 RESID(-1)^2 + 0.634334 GARCH(-1) – 0.000238 LN_GHS_USD – 0.000161 LN_RAND_USD and 2.27E-06 + 0,069782 RESID(-1)^2 + 0.904453 GARCH(-1) + 0.000284 LN_GHS_USD – 0.000154 LN_NGN_USD. The models show that there are volatility transmissions among the Nigeria, Ghana and South Africa stock and foreign exchanges. It is hereby concluded that Generalized Autoregressive Conditional Heteroskedasticity (GARCH) could be used in modeling of the volatility of exchange rate on stock indices.Economic policy makers, government as well as individuals would benefit immensely from the results of this study.

Key Words: *Generalized Autoregressive Conditional Heteroskedasticity, Modeling*

Introduction

The association between exchange rate and the stock returns is a mutualistic one with its composition into international financial markets. Stock returns are mostly introduced as the present value of the cash flow in link to certain organizations and enterprises that are in working economy. According to Kim(2003), inter-temporal relation between returns in stock exchange rates is now of significant interest to economists for different reasons, as both provide hugely towards affecting the level of economic development in a nation. The increasing capital motion and international commerce have made exchange rate a core equity price and business propriety determinant (Kim 2003). Many personal investments and blending into the international money markets has been attainable due to the initiating and extending stock markets in African countries in recent years (Balparda, et al. 2015).One of the basic criteria required to allow free commerce between diverse currencies in an economic community is that one currency must be estimated in terms of the other. According to Howells and Bain (2007), direct exchange rate is the amount of home currency needed to purchase a unit of foreign currency while indirect exchange rate is the amount of foreign currency. Exchange rate is the price of a single currency tendered against the other (Mishkin and Eakins, 2009). Exchange rate can either be fixed or floating and it is usually decided by mechanism of market demand and supply.

According to Lothian and Taylor(1997), before the year 1972, nations in the universe functioned on a stable rate system where every country's currency is estimated in terms of dollar. The importance of exchange rate is due to its incessant modification pertinent to demand and supply of foreign exchange in a particular economy. Its motion indicates exterior trauma and disparity which does not affect movement in reserves and does not require the central bank involvement to curb the procedure of correction. By the adoption of bent exchange rate system, currency pricing is therefore an outcome of forces of demand and supply of the foreign exchange market (Ndungu, 2001).The profit an investor accrues over a speculated period of time is referred to as stock market return. This case is intimately related to the stock prices and the capability of a market to efficiently take in a fresh knowledge as

DOI: 10.51386/25816659/ijles-v6i3p102

Volume: 06 Issue: 03 **May to June 2023** **www.ijlesjournal.org**

regards stock prices. Therefore, rendering the correctness and steadiness of the firm's stock price ascertain its strength(Mwangi and Mwiti, 2011). The investment and output level of an industry can be studied by stock market returns in as much as it can be used to forecast future discount rates and cash flows. Stock return is the profit or deficit of the worth of a share in a specific period often estimated as a percentage. Its constituents are capital gains and any incoming income accepted by the investor from the stock (Mugambi and Okech, 2016).Stock market returns play the role of an index to investors or government in deciding which of the investment choice. According to Wang(2012), investors with various financial strengths have the ability to carry out investments in the stock market in as much as they can get an income that is more than their cost of capital. Stock marketing index is majorly used to estimate stock performance..

The lack of consensus among the various scholars on the associations between foreign exchange rates and the returns of the stock market is reason enough to carry out further examination on the area of study. This paper will seek to identify how foreign exchange rates relate to stock market returns at the considered stock exchanges. It will attempt to give an explanation to the research question, what is the relationship between foreign exchange rates and stock market returns in Ghana, Nigeria, and South Africa respectively. The objectives are to examine if there are volatility transmissions among the Ghana, Nigeria, and South Africa foreign exchanges, to determine if there are volatility transmissions among the Ghana, Nigeria, and South Africa stock exchanges and finally to evaluate if there are volatility transmission between foreign exchange and stock exchange of each market. Volatility is a measure of the degree of uncertainty about the future price or value of a given commodity, share or other financial product. Foreign exchange is the foreign currency or current short-term credit instruments payable in such currency. Stock exchange could be defined is a place where security trading is conducted in an organized system. A stock return is the amount accrued over an exchange within a given period of time. Heteroskedasticity is a term and could be defined as the property of a series of random variables of not every variable having the same finite variance.

Background Study

There are numerous empirical studies both locally and internationally to support the associations between exchange rates and stock market returns, but these studies have produced mixed results. There are numerous empirical works that have been done since the seminar paper of Engel (1982) on volatility modeling, especially in finance, even though a number of theoretical issue are still unresolved (Franses and McAleer, 2002). However, Anders (2006) believes and affirmed that previous researches on the various effects of error distribution assumptions on the variance forecasting performance of GARCH family models is scarce and difficult to come by. Some of the work on volatility modeling estimates a particular GARCH model with one or more error distributions. Available literatures and information tend to capture the asymmetric properties of financial data without taken cognizant and recourse to error distributions. Jayasuriya (2002) critically examined the effect of stock market liberalization on stock return volatility using as a case study Nigeria and fourteen other emerging market data from other countries to estimate asymmetric GARCH model. The study concludes that positive (negative) changes in prices have been followed closely by negative (positive) changes. Ogum et al.(2005) also apply the Nigeria and Kenya stock data on EGARCH model to reflect the emerging market volatility. The result of the study is different from that of Jayasuriya (2002). Though volatility persistence is evidenced in both market of the two countries; volatility responds more to negative shocks in the Nigeria market and the reverse is the case for that of Kenya market. By applying GARCH mode in their studyl, the result evidently shows less volatility persistence and then establishes the existence of leverage effect in the Nigeria stock market, implying that bad news drives volatility more than good news.

Methodology

The longitudinal study was focused on the Nigeria stock and foreign exchange, Ghana stock and foreign exchange and South Africa stock and foreign exchange for the period of 9 years from 2011-2019.Secondary data was used and sourced out from NBS covering the period of 9 years from 2011-2019.The variables used for this study are categorized into dependent and independent variables. The dependent variables and independent variables are interchanged intermittently at each model. The statistical packages used for the analysis of this study are; MS Excel (for collection of time series data) and E-Views for analysis of GARCH modeling analysis.

DOI: 10.51386/25816659/ijles-v6i3p102

Volume: 06 Issue: 03 **May to June 2023** **www.ijlesjournal.org**

Data Analysis and Result Interpretation

Descriptive Statistics

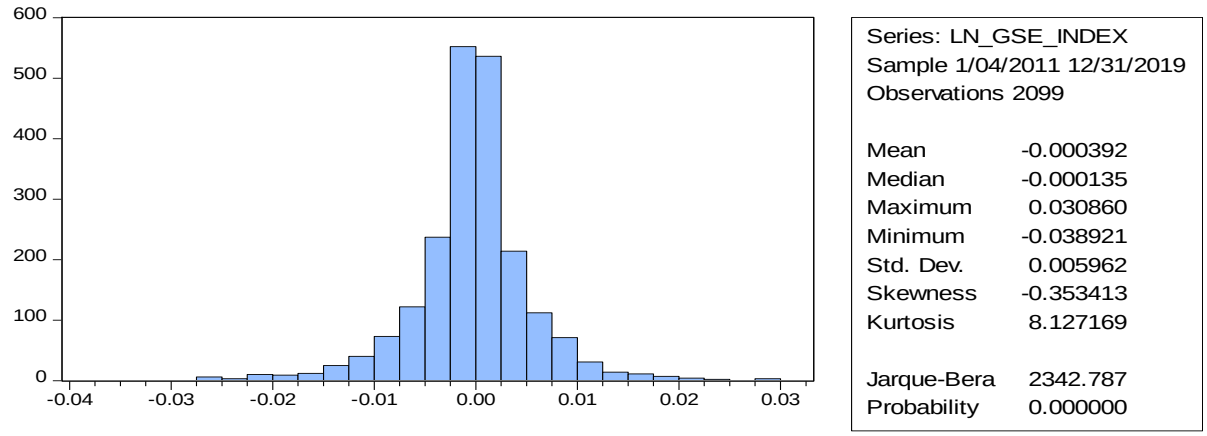

Figure 1: Ln GSEindex

It was noted that the distribution of the Ghana stock exchange index is almost normal from the histogram and the value of its skewness is close to zero. The observed value of 8.127169 for kurtosis in the distribution of the Ghana stock exchange index s during the observed period confirms the presence of fat tails in the distribution. The leptokurtic distribution for the Ghana stock exchange index shows that there are high returns more frequently than expected. A stationarity test was applied to the index series.

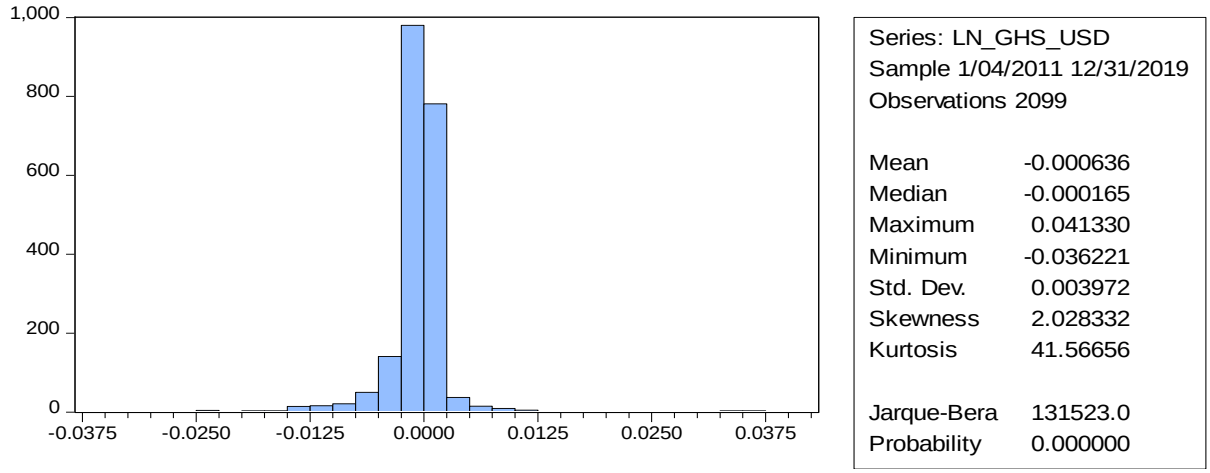

Figure 2: Ln ghsusd

It was noted that the distribution of the Ghana stock exchange index presents kurtosis excess compared to a normal distribution. The observed value of 41.56656 for kurtosis in the distribution of the Ghana stock exchange index s during the observed period confirms the presence of fat tails in the distribution. The leptokurtic distribution for the Ghana stock exchange index shows that there are high returns more frequently than expected. A stationarity test was applied to the index series.

DOI: 10.51386/25816659/ijles-v6i3p102

Volume: 06 Issue: 03 **May to June 2023** **www.ijlesjournal.org**

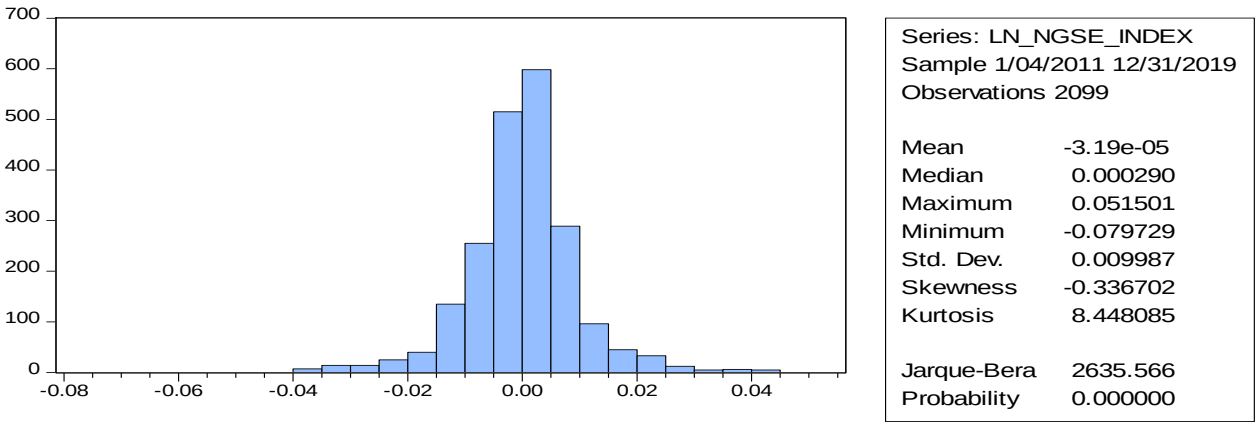

Figure 3: Ln ngse index

It is noted that the distribution of the Nigeria stock exchange index presents kurtosis excess compared to a normal distribution. The observed value of 8.448085 obtained from the analysis of the study for kurtosis in the distribution of the Ghana stock exchange index s during the given period also confirms the presence of fat tails in the distribution. The leptokurtic distribution for the Nigeria stock exchange index shows that there are high returns more frequently than expected. A stationarity test was applied to the index series and the results.

From Figures 1, 2 and 3 as well as Tables 1 and 2, it is evidently clear that there is increment and decrement overtime in the stock three index time plot. This depicts that clustering volatility. Therefore, H_0could not be rejected and therefore conclude that there is volatility transmission among Ghana, Nigeria, and South Africa stock exchanges. From the results, it is evident that there is increment and decrement overtime in the stock three index time plot which depicts that clustering volatility. Therefore, H_0could not be rejected and therefore conclude that there is volatility transmission among Ghana, Nigeria, and South Africa foreign exchanges. It is also evident that there is increment and decrement overtime in the stock three index time plot. Therefore, H_0could not be rejected and therefore conclude that there is volatility transmission among Ghana stock and foreign exchanges, Nigeria stock and foreign exchanges, and South Africa stock and foreign exchanges.

Fitting ARCH Model

In a market economy, the stock exchange of a given country is dependent on its actual foreign exchange (Tables 1,2 and 3). The stock exchange index is the dependent variable and the foreign exchange index is the independent variable in which the variance regressors are the foreign exchange index of the other countries considered.

Table 1: Ghana Stock Exchange

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6) *LN_NGN_USD + C(7)*LN_RAND_USD

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000224	8.30E-05	-2.695726	0.0070
LN_GHS_USD	-0.000202	0.018675	-0.010842	0.9913
	Variance Equation			
C	6.95E-06	3.14E-06	2.215975	0.0267
RESID(-1)^2	0.501944	0.222025	2.260756	0.0238
GARCH(-1)	0.701504	0.036827	19.04843	0.0000
LN_NGN_USD	8.01E-05	0.000113	0.711324	0.4769
LN_RAND_USD	-7.14E-05	0.000138	-0.518084	0.6044

DOI: 10.51386/25816659/ijles-v6i3p102

Volume: 06 Issue: 03 May to June 2023 www.ijlesjournal.org

T-DIST. DOF	2.366631	0.192958	12.26501	0.0000

6.95E-06 + 0,501944 RESID(-1)^2 + 0.701504 GARCH(-1) + 8.01E-05 LN__USD – NGN + 7.14E-05 LN_RAND_USD

Table 2: Nigeria Stock Exchange

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6) *LN_GHS_USD + C(7)*LN_RAND_USD

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.000333	0.000156	2.139857	0.0324
LN_NGN_USD	0.030708	0.025554	1.201656	0.2295
	Variance Equation			
C	1.18E-05	2.25E-06	5.253800	0.0000
RESID(-1)^2	0.283857	0.045555	6.231136	0.0000
GARCH(-1)	0.634334	0.040146	15.80053	0.0000
LN_GHS_USD	-0.000238	0.000379	-0.629099	0.5293
LN_RAND_USD	-0.000161	0.000182	-0.887294	0.3749
T-DIST. DOF	4.056111	0.424155	9.562814	0.0000

1.18E-05 + 0,283857 RESID(-1)^2 + 0.634334 GARCH(-1) – 0.000238 LN_GHS_USD – 0.000161

Table 3: South Africa Stock Exchange

GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1) + C(6) *LN_GHS_USD + C(7)*LN_NGN_USD

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.000528	0.000185	-2.859156	0.0042
LN_RAND_USD	-0.153895	0.017066	-9.017476	0.0000
	Variance Equation			
C	2.47E-06	7.29E-07	3.380937	0.0007
RESID(-1)^2	0.069782	0.013373	5.217942	0.0000
GARCH(-1)	0.904453	0.017284	52.32910	0.0000
LN_GHS_USD	0.000284	0.000154	1.841551	0.0655
LN_NGN_USD	-0.000154	0.000183	-0.842917	0.3993
T-DIST. DOF	11.46490	2.710895	4.229195	0.0000

DOI: 10.51386/25816659/ijles-v6i3p102

Volume: 06 Issue: 03 **May to June 2023** **www.ijlesjournal.org**

2.27E-06 + 0,069782 RESID(-1)^2 + 0.904453 GARCH(-1) + 0.000284 LN_GHS_USD –0.000154 LN_NGN_USD

Discussion of Findings

From the analysis of the time series data and time plot, the trend of the stock exchange time series data tends to increase and decrease intermittently for the considered period (2011-2019), therefore, indicating that there are volatility transmissions among the Ghana, Nigeria, and South Africa foreign exchanges. From the time plot, the trend of the foreign exchange time series data tends to increase and decrease intermittently for the considered period (2011-2019). Therefore, indicating that there are volatility transmissions among the Ghana, Nigeria, and South Africa stock exchanges. From the time plot, the trend of the foreign exchange and stock exchange of the time series data tends to increase and decrease intermittently for the considered period (2011-2019).Therefore, there are volatility transmissions between foreign exchange and stock exchange of each market. The fitted GARCH models are:

(a) 6.95E-06 + 0,501944 RESID(-1)^2 + 0.701504 GARCH(-1) + 8.01E-05 LN__USD – NGN + 7.14E-05 LN_RAND_USD

(b) 1.18E-05 + 0,283857 RESID(-1)^2 + 0.634334 GARCH(-1) – 0.000238 LN_GHS_USD – 0.000161 LN_RAND_USD

(c) 2.27E-06 + 0,069782 RESID(-1)^2 + 0.904453 GARCH(-1) + 0.000284 LN_GHS_USD –0.000154 LN_NGN_USD

Conclusion

There are volatility transmissions in the Nigeria, Ghana and South Africa stock and foreign exchanges, volatility transmission is also present in the stock and foreign exchange of each country and the time series data for each considered stock and foreign exchanges is stationary at level 1 and difference 1.

References

[1] Al-shubiri F. (2010). Analysis the Determinants of Market Stock Price Movements: An Empirical Study of Jordanian Commercial Banks, International Journal of Business and Management, 12(7), 214-221.

[2] Amarasinghe, A. (2015). Dynamic relationship between interest rate and stock price: Empirical evidence from Colombo Stock Exchange. International Journal of Business and SocialScience, 6 (4), 92-97.

[3] Balparda, B., Caporale, G. M. & Gil-Alana, L. A. (2015). The Kenyan Stock Market:Inefficiency, Long Memory, Persistence and Anomalies in the NSE-20. Working Paper No 5-11.Economics and Finance Working Paper Series.

[4] Barnor, C. (2014). The Effect of Macroeconomic Variables on Stock Market Returns in Ghana 2000- 2013). Unpublished Dissertation. Walden University. Available at http://scholarworks.waldenu.edu/dissertations.

[5] Benita, G. &. Lauterbach.B. (2004).Policy Factors and Exchange Rate Volatility: Panel Data Verses a Specific Country Analysis, Research Unit, Foreign Exchange Activity Department, Bank of Israel, Jerusalem.

[6] Bollerslev, T., &Wooldridge, J.M. (1992). "Quasi-Maximum Likelihood Estimation and Inference in Dynamic Models with Time-Varying Covariances", Econometric Reviews, 1, pp. 143- 173.

[7] Chirchir D. K. (2011). The Relationship between Share Prices and Exchange Rates: Evidence From Kenya .Unpublished Doctoral Dissertation: University Of Nairobi.

[8] Cuthbertson, K. (2004). Quantitative Financial Economics: Stocks, bonds and Foreign Exchange. Chichester: Wiley Corporation.

[9] Daferighe, E. & Sunday, C. S. (2012). The Impact of Inflation on Stock Market Performance in Nigeria American Journal of Social and Management Sciences, 3 (2), 76-82.

[10] Dávila, J., Núñez, J.A.,& Ruiz, A. (2009). "Volatilidad del precio de la mezclamexicana de exportación", Economía, Teoríay Práctica, Universidad AutónomaMetropolitana, No. 25, pp. 37-52

[11] Engle, R.F. (1982). "Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of UK Inflation", Econometrica, 50, pp. 987-1008

[12] Fang, H. (2002). Exchange Risk: Whose View? What is Exchange risk, Financial Management, 6 (2) 45-48.

[13] Jorion, P. (1990). The Exchange Rate Exposure ofUS.Multinationals. Journal of Business, (3)331-345.

[14] Jumah, I. M. (2013). Effects Of Foreign Exchange Rate Fluctuation On Stock Returns Volatility: A Case Study Of Nairobi Securities Exchange (NSE) 1996-2012. Unpublished Doctoral Dissertation: University Of Nairobi.

[15] Karolyi, G. A. (2001).Why Stock Return Volatility Really Matters, InstitutionalInvestor Journals Series, 2(1), 1-16

[16] Kim, A. (2003). Determinants of the real exchange rate in a small open economy: Evidence from Canada. Journal of International Financial Markets, Institutions and Money, 23, 163-178.

[17] Kolari, W., Moorman, C. &Sorin M., (2008). Foreign exchange risk and the cross-section of stock returns, Journal of International Money and Finance, 27(7), 1074-1097

[18] Kuwornu, J. K. M. (2012). Effect of Macroeconomic Variables on the Ghanaian Stock Market Returns: A Co-integration Analysis. Agris on-line Papers in Economics and Informatics, 4 (2), 1-12

[19] Liu, M. H. (2013). Analysis of the long-term relationship between macroeconomic variables and The Chinese stock market using heteroscedastic co-integration. Managerial Finance, 3(2), 744-755. u, M. H. (2013). Analysis of the long-term relationship between macro- economic variables and the Chinese stock market using heteroskedastic co integration Managerial Finance, 3(2), 744-755

[20] Muriu, P.W. (2003). Volatility of stock returns -an empirical analysis of NSE. Unpublished MA Thesis: University of NairobiMwangi, M. &Mwiti, J. K. (2015). The Effect of Voluntary Disclosure on Stock

[21] Obura, J. M. &Anyango, C. (2016). Market Returns of Companies Listed at the Nairobi Securities Exchange. International Journal of Business and Social Science, 6 (1), 99-105.Moderating Effect of Interest Rates on Relationship between Foreign Exchange Rate Fluctuation and Performance of Nairobi Securitiesof Nairobi Securities Exchange Market. Universal Journal of Accounting and Finance,4 (2), 27-34.

[22] Olweny, T. &Omondi, K. (2011).The Effect of Macro-Economic Factors on Stock Return Volatility in the Nairobi Stock Exchange, Economics and Finance Review, 1(10), 34-48.

[23] Phylaktis, K. and Ravazzolo, F.(2005) Stock price and Exchange rate dynamics. J. Int. Money Finance. 24, 1031–1053.

[24] Rose, W. (2000). Effect of Currency Unions on Members' Trade: A test for the effects of exchange rate volatility on trade. PhD Thesis: London School of Business.

[25] Shrestha, P. K. and Subedi, B. R. (2015). Determinants of Stock Market Performance in Nepal. NRB Economic Review. NRB Working Paper series, NRB-WP-24. Kenya. Research Journal ofFinance and Accounting, 3(7), 115-127.

[26] Rabemananjara, R. & Zakoian, J.M. (1993). "Threshold Arch Models and Asymmetries in Volatility", Journal of Applied Econometrics, Vol. 8, Issue 1, pp. 31-49

[27] Rydberg, T. H. (2000). Realistic statistical modelling of financial data. International Statistical Review, 68(3):233-258.

[28] Schwert, G.W., &Seguin, P. (1990). "Heteroskedasticity in Stock Returns", The Journal of Finance, 45, pp. 1129-1155 Taylor, S.J. (1986). Modeling Financial Time Series, John Wiley.

[29] Wang F. (2012). Determinants of Chinese Stock Market Returns.University Utara Malaysia.

[30] Wongbangpo, P. & Sharma S. (2002). Stock Market and Macroeconomic. Fundamental Dynamic Interactions: ASEAN – 5 Countries. Journal of Asian Economics, 13(1), 27 – 51.