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Conditional Variance and Interest Rates in Nigeria: Evidence from the Egarch-In-Mean Framework

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Abstract
This study captured the components of Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH-in-mean) framework; conditional variance (volatility), asymmetric effect and volatility persistence and interest rate in Nigeria. This is because of the usefulness of interest rates in measuring the financial conditions, also are major instrument of monetary policy and volatility being one of the most important concepts in finance. The study used real interest rate obtained from Central Bank of Nigeria and National Bureau of Statistic from 1970 to 2018 inclusive. The accommodating EGARCH-in-mean framework was employed in the estimation of the model. The following were found; conditional volatility is negatively and significantly related to interest rate. Also that interest rate volatility in Nigeria is not persistent. Again, there is existence of leverage effect, implying existence of asymmetric effect in the Nigerian financial market due to interest rate volatility. Consequently, the researchers suggest as follows; due to the presence of asymmetry effect, the Bankers' Committee tightens their seat belt to forestall subsequent volatility in interest rate in Nigeria by consistently and regularly reviewing interest rate to accommodate the dynamism of the economy. Again adequate palliative measures be made available to enable investors continue with their economic activity in any business cycle in Nigeria.

Keywords: ***Real Interest Rate, Volatility, Volatility Persistence, Asymmetric Effect, EGARCH***

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I. Introduction

In finance, interest is seen as the price of capital. It can also be viewed as the price charged or expense incurred by engaging borrowed fund. In a broader sense, it is the required rate of return expected by an investor or lender for making available fund for investment or to the needy. It is the opportunity cost of parting with fund to firm. In any economy, there exist the saving-surplus and saving-deficit units. The saving-surplus economic units have less investment in real assets and accumulate surplus or excess. They are the unit whose expenditure is less than their income. While in the saving-deficit units, the investment in real assets are higher and deficiencies are created. They are the economic unit whose expenditure is higher than the income. This scenario is called financial disequilibrium. The doctrine of financial disequilibrium and intermediation means the financial ideology of lending and borrowing. It is the duty of finance to trade off the disequilibrium and make sure intermediation prevails to bridge the gap between the deficit units and the surplus units within the institutional framework and market mechanism to consummate the required financial transactions [8]. The excesses of the surplus units are vented to the deficit unit through issuance of securities by the borrower (saving-deficit unit). Interests play the exact role in the financial markets that price plays in the commodity market. Funds are allocated in the financial market to the end users who are willing and have the capacity to pay the highest possible interest. That is to say that interests play an allocation or distribution function in the financial market, also ensure efficient utilization of fund [17, 5]. However, the interest between the saving-deficit units (borrower) and saving-surplus units (lender) decides the interest rate. Hence, interest rate is the ratio of total interest to the principal for the period.

Interest rates are perceived by managers of firms as one of the sensitive and important factors of financial risk and are hedged just like credit risk [10]. Since interest rate is uncertain, investor will always predict at assumed probability. That means it has some elements of predictability, hence volatility, which is very important to investors [21, 22, 11]. Investors forecast interest rates because the stakes are high, just as they try to predict stock prices for the same purpose. Assuming stock prices is expected to rise, investor will gain by purchasing now instead of postponing the purchase. If the price is otherwise (tend to fall), investors are better off selling than purchasing. This is also applicable to bonds or any marketable asset in the market, which make prediction inevitable in the financial market. This implies that financial institutions cannot engage in meaningful portfolio selection or build up devoid of some predictions or estimations, explicit or implicit, of future trends in

financial asset price. That means there is inverse relationship between asset prices and interest rates, some estimate of future trends in interest rates [20]. Stressing further on relevance of interest to investors in the market; when interest rates are high relative to what they have been, investors generally expect them to decline in the future. Falling interest rates mean rising bond prices, and those investors who are holding long term bonds in their portfolio will reap their just reward, that big capital gains. Therefore, when all rates are relatively high, investors will prefer to hold longs rather than shorts. This is because the capital gains in shorts are relatively low.

On the nexus between conditional variance or volatility and interest, Olan and Sandy [18] re-examined the performance of the Engle [7] tests that differentiate the effect of good and bad news on the predictability of future short- term interest rate volatility with Monte-Carlo simulations and came out boldly to say that volatility is positively correlated with the level of the short term interest rate. The finding validated the capacity that interest rates can exhibit greater volatility as short term rates rise. This case is known as ***level effects***. Again Chan, Karolyi, Longstaff and Sanders [3] comparatively examined variety of single factor continuous-time models of the short-term risk-less rate and revealed that models that permitted the volatility of interest changes is sensitive to the level of the risk-free rate can overpower other models.

The concern of the study is to investigate volatility persistence, asymmetric effect in the interest rate and the relationship between conditional variance (volatility) and annual interest rate using the Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH). The remaining sections are; section 2-Literature Review, Section 3-Data and Methods, Section 4-Analysis and Result, Section 5-Conclusion and Recommendations.

II. Literature Review

In the words of Ezirim [8], the interaction of lenders and borrowers in the financial market determines the rate at which the eventual exchange will be made and the price is called interest rate. In the same vain Ezirim, Ejem, Ogbonna and Chukwu [9] see interest rate as how much deficit agents need to pay for monies borrowed as well as what lenders receive on their accumulated funds, called savings. As earlier stated at the beginning of this paper, interest rates is mainly engaged in the mobilization of financial resources, as well ensuring the efficient utilization of the financial resources in the promotion of growth and development in the economy. Generally, interest rates are useful in measuring the financial conditions and are major instrument of monetary policy.

Volatility is a phenomenon that depicts changeableness of variables under consideration and one of the most important concepts in finance [2]. In this context, there are two features of interest rate volatility; volatility persistence and asymmetric effect. The volatility persistence entails volatility shocks having long memory and its effect lasting for many periods. Simply put, it has to do with how long it will take volatility to revert to its long run average or die out. While asymmetric effect on the other hand is the tendency for bad news (negative news) and good news (positive news) of equal magnitude to producing different impacts on volatility [16, 6]. However, if bad news induces volatility more than goods news of equal size or magnitude, at this scenario, asymmetric effect is seen to be ***leverage effect*** [1].

There are reasonable numbers of theories on the determination of interest rate. Among the theories are; one of the postulations by economists such as Prof. Pigou, Prof. Marshall, Walras, Knight etc. of the classical school of thought is known as ***the Real Theory***. According to the classical school of thought, the Real Theory vehemently argue that interest rate is a function of demand for and supply of savings where the supply of savings, or investment is assumed to be inversely related to the interest rate. It is assumed that equilibrium in interest is found at the intercept of savings and investment; at that level where the income is neutral (has nothing to do) with the equilibrating mechanism at the assumption of full equilibrium. Graphically

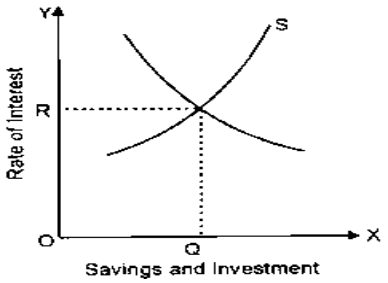


Figure 1: *Graph depicting Real Theory*

Where OR is the equilibrium rate of Interest which is determined at the point at which the supply of savings curve intersects the investment demand curve [14, 15, 8, 21].

Another is ***the Loanable Fund Theory***, otherwise known as the ***Neo-classical Theory***, propounded by the famous Swedish economist Knot Wick-sell and was elaborated by Ohlin, Roberson, Pigou and other new-classical economists. This theory opines that interest rates are to a greater extent relying on the supply of and demand for loanable funds. The loanable fund theory view interest rate as been determined by non-monetary factors. These are funds or monies made available by the saving-surplus units (lenders) of the economy for making up of the deficiencies of the saving-deficit units (borrowers) of the economy. It is assumed that the more the demand for loanable funds vis- a- vis the supply of fund, the more or higher the interest rates and conversely, ceteris paribus. From theoretical postulations, interest rate equilibrium is attained where supply of and demand for loanable funds intercept. Graphically,

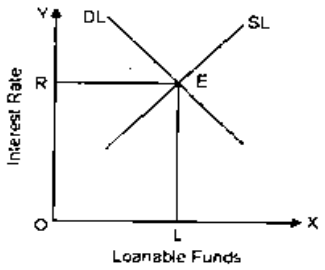


Figure 2: Graph depicting the Loanable fund theory

Where demand curve for loanable funds (DL) and supply curve of loanable funds (SL) intercept at equilibrium point (E). Remember it is an improvement of Real Theory [14, 15, 8, 21].

In the same is ***the Liquidity Preference Theory***. As a postulate of the Keynesian doctrine, the theory explicitly lay bare that it is not the interest rate rather income level that induce the equilibrium in the savings and investment. The mechanism is attacked by the Real theorists by asserting that the interest rate is a mere price seen as an equilibrating factor on the desire to hold wealth in money form and the quantity of money supplied. Succinctly put, supply and demand for money are the determinants of rate of interest. However, equilibrium in interest rate is found at the point of interception of supply of and demand for funds.

Graphically,

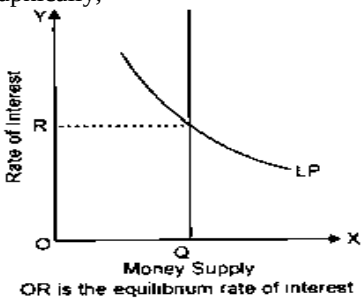


Figure 3: *Graph depicting the Liquidity Preference theory*

The above graph shows that any change in the liquidity preferences function (LP) or change in money supply or changes in both respectively lead to changes in the rate of interest [14, 15, 8, 21]. Again, ***the Expectation Theory*** which asserts that interest rates are expected to be charged as compensation by lenders for the time and risk on fund invested in a project [8].

In Nigeria, despite the importance of the application of the above elucidated theories, the economy is yet to attain to desired level speculated by the economic agents. In the words of Ezirim [8], due to the nature of the Nigerian economy, interest rate is solely determined over years by the Central Bank of Nigeria (the monetary authority). Periods of regulated interest rates have been followed by those of deregulated periods in the country. The periods of deregulation have been few in number and short in duration. However, 1987 witnessed an inroad into the adoption of a policy closely related to the loanable fund theory by deregulating interest rates. By this the monetary authorities allow the forces of demand for and supply of loanable fund to determine the level of interest rates. This policy in no small measure adversely affected the operation of economic units in the economy. The loanable funds market became a sellers' market and thus the suppliers of the loanable funds, mainly the banks, seized the opportunity to exploit the borrowers by giving them what the lenders or saving-surplus units of the economy thought was proper. As a result, interest rates escalated both in the money market and capital market and have not abated till date.

Manipulating the monetary policy, the Central Bank of Nigeria (CBN) in her orthodox posture focused on the level and structure of interest rates. This due to the CBN interest to maximize the sale of government debt in addition to the assumption that financial markets followed the Keynesian-type expectation. The deposit money banks in a bid to push for the sale of government debt, interest rates will escalate, then speculators will expect interest rate to continue rising and hence expect bond prices to fall in the future. As a result, they hold back from purchasing government debt using the language of [12].

Empirically, employing generalized autoregressive conditional heteroscedasticity (GARCH) models, Olweny [19] examined the relationship involving short-term interest rate volatility and interest rate levels. The study laid emphasis on the level of interest and the volatility of interest rates in Kenya. The result found a relationship between the level of short-term interest rates and volatility of interest rates in Kenya. The study was not satisfied the application of GARCH, then recommended further study to done with EGARCH among other variants of ARCH.

III. Data and Methods

The data (Nigerian Real interest rate) used in this study is annual time series data collected from Central Bank of Nigeria Statistical Bulletin and the National Bureau of Statistics for 1970 to 2018. Real interest rate is the lending interest rate adjusted for inflation as measured by the Gross Domestic Product deflator. A graphical description of the data is shown in figure 4 below.

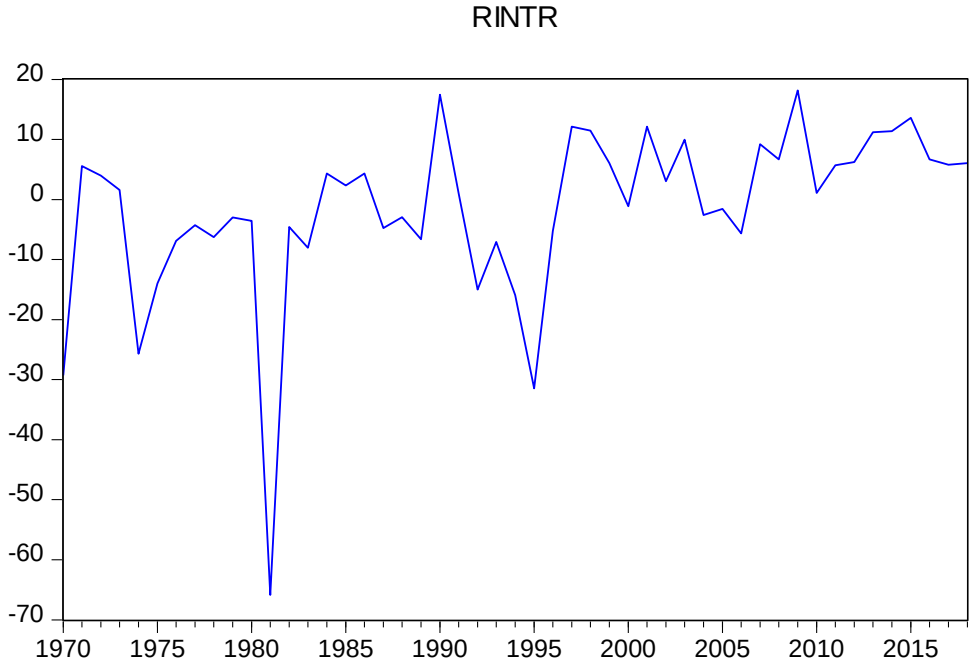


Figure 4: *Plot of Real interest rate for Nigeria*

A cursory look at the figure 1 above suggests the presence of fluctuations or volatility in interest rate in Nigeria. This confirms ARCH effects in the model and validated the choice of EGARCH framework in the estimation of the model.

The choice of EGARCH framework is to accommodate examination of conditional variance (volatility), asymmetric effect and volatility persistence [13]. Other tests are; the ARCH test to check if model is heteroskedastic and Normal Distribution to test first, second, third and fourth moments (Mean, Standard deviation, Kurtosis and Skewness).

The model for volatility using EGARCH framework is specified as follows:

$$\text{In } \vartheta^2_t = \omega + \beta_{in}\, \vartheta^2_{t-1} + \propto \left[\frac{\epsilon t-1}{\vartheta t-1} - \frac{2}{x}\right] + \Upsilon \left|\frac{\epsilon t-1}{\vartheta t-1}\right|$$

Where, ω, β, $\propto$,Υ are constant parameters,

In ϑ^2_t = the one period ahead volatility forecast; ω = the mean level,

β = persistence parameter $\propto$ = volatility clustering coefficient

In ϑ^2_{t-1} = the past variance, Υ = the leverage effect.

Decision Rule

The EGARCH-in-mean model is an improvement of the GARCH. Improvement of the GARCH imposes a non-negativity constant on market variable, and permits for conditional variance to respond asymmetrically to returns innovations of different signs. If γ is negative, leverage effect exists. Implying that, bad news increases predictable volatility more than good news of similar magnitude [1, 4]. In other words, negative value of γ is called the 'sign effect'. If $\propto$ is positive, then the conditional volatility tends to rise (fall) when the absolute value of the standardized residuals is larger (smaller). $\propto$ is called the 'magnitude effect'.

IV. Results and Discussion

4.1. Estimation of Model using EGARCH

The estimation results are shown below in table 1;

Dependent Variable: RINTR				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)				
*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
b_2	-0.028298	0.009212	-3.072030	0.0021
b_1	0.205511	0.029112	7.059366	0.0000
b_0	2.768621	0.438540	6.313275	0.0000
	Variance Equation			
ω	4.967539	0.912555	5.443551	0.0000
$\propto$	-1.968174	0.287656	-6.842113	0.0000
γ	-0.711627	0.242693	-2.932208	0.0034
B	0.273610	0.162980	1.678801	0.0932
Durbin-Watson stat	1.941624			

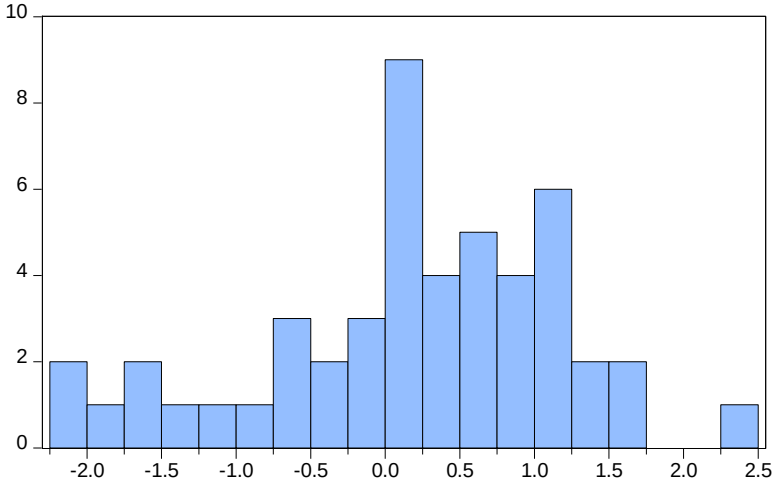
Table 1 above shows as follows; the coefficient of the conditional volatility (b_2) is -0.028298 with probability value (p-value) of 0.0021 at 5% significance level, suggesting that conditional volatility is negatively and significantly related to interest rate. That means volatility exacts negatively on interest rate in Nigeria. This confirms the earlier assertion in the literature review that inverse relationship exists between asset prices and interest rates [20]. This corroborates Olweny [19] and the classical Real Theory that interest rate is a function of demand for and supply of savings where the supply of savings, or investment is assumed to be inversely related to the interest rate. The persistence parameter (β) has coefficient of 0.273610 and p-value of 0.0932 at 5% significance level, which is positive and insignificant; indicating that interest rate in Nigeria is not significantly persistent. Implying interest rate volatility in Nigeria is not persistent. The non persistence of interest rate in Nigeria is justifiable because the regular intervention of bankers committee qua the Central Bank of Nigeria (CBN). The committee from time to time monitors the reaction of interest rate by economic agents whenever there is a perceived crisis or fluctuations or dwindling in the market. For instance, in the midst of the Corona virus (COVID-19) pandemic ravaging the global economy and Nigeria economy in particular, the Bankers' committee of Nigeria chaired by the CBN governor, Mr. Godwin Emefiele reviewed the monetary policy rate from 14% to 12.5% on 28th of May, 2020 as announced on National Televisions. The policy adjustment is aimed at ameliorating the interest volatility induced by pandemic on investors. In fact, it is a palliative measure. This affirms why interest rate volatility is not persistent in Nigeria. Also, from the above table 1, the leverage effect (ϒ) has coefficient of -0.711627 and p-value of 0.0034, which is negative and significant. From the rule of thumb; If γ is negative, leverage effect exists. That is bad news increases predictable volatility more than good news of similar magnitude [1, 4]. This shows that there is asymmetric effect in the Nigerian financial market due to interest rate volatility. For example, the news of the COVID -19 astronomically raised the uncertainties in the prices of securities due to forecasted interest rate volatility in the market.

Table 2: Heteroscedasticity Test: ARCH

Heteroskedasticity Test: ARCH			
F-statistic	2.265907	Prob. F(1,46)	0.1391
Obs*R-squared	2.253424	Prob. Chi-Square(1)	0.1333

Table 2 above depicts that F-statistic has coefficient of 2.265907 with probability value of 0.1391, which insignificant at 5%, rejecting the presence of heteroscedasticity of the model, the model is not homoscedastic.

Table 3: Normal Distribution Test



Series: Standardized Residuals	
Sample 1 49	
Observations 49	
Mean	0.164732
Median	0.212793
Maximum	2.314334
Minimum	-2.208813
Std. Dev.	1.026570
Skewness	-0.545496
Kurtosis	2.896285
Jarque-Bera	2.452080
Probability	0.293452

From table 3, the first moment or mean (average annual rate) is 0.164732 and the second moment (standard deviation) has small value of 1.026570. Also from table 3, maximum value is 2.314334 and minimum -2.208813 revealing a reasonable gap supporting the conspicuous variability of interest rate changes in Nigeria. The third moment (Kurtosis) is 2.896285, which is lower than 3 indicating platykurtic distributions. This suggests that small shocks of either sign are likely to present itself with interest rate volatility in Nigeria. The skewness is -0.545496, which is a negative coefficient, confirming asymmetry in the series. It is important to point out that the skewness is negatively skewed suggesting the distribution has a long left tail. These shows large negative movements in interest rate are not normally followed by the same magnitude of positive movement. Finally, Jarque-Bera coefficient is 2.452080 with probability value of 0.293452, implying normal distribution.

V. Conclusion and Recommendations.

This study, modeling of volatility and interest rate in Nigeria used real interest rate to investigate the relationship between conditional variance and interest rate in Nigeria. It also ventured to ascertain if volatility is persistent and whether asymmetric effect exists in interest rate in Nigeria. After thorough empirical examination, it was found that conditional volatility is negatively and significantly related to interest rate. That means volatility exacts negatively on interest rate in Nigeria. It was also found that interest rate volatility in Nigeria is not persistent. Again, that there is asymmetric effect in the Nigerian financial market due to interest rate volatility and large negative movements in interest rate are not normally followed by the same magnitude of positive movement. Consequently, the researchers suggest that due to the presence of asymmetry effect, the Banker Committee tightens their seat belt to forestall subsequent volatility in interest rate in Nigeria by consistently and regularly reviewing interest rate to accommodate the dynamism of the economy. Furthermore, adequate palliative measures be made available to enable investors continue with their economic activity in any business cycle in Nigeria.

References

[1]. Black, F. (1976). Studies of stock market volatility changes. *Proceedings of the American Statistical Association, Business and economics Section.* 177-181.

[2]. Brooks, C.(2008).*Introductory econometrics for finance (2nd ed).* New York: Cambridge University Press

[3]. Chan, K.C., Karolyi, G.A., Longstaff, F.A. & Sanders, A.B. (1992). An empirical comparison of alternative models of the short-term interest rate. *Journal of Finance*,47, 1209-1227.

[4]. Christie, A.A. (1982). The stochastic behavior of common stock variance- value, leverage and interest rate effects. *Journal of Financial Economics, 10(4),* 407-423.

[5]. Ejem, C.A., Ogbulu, O.M., Ogbonna, U.G, & Fijoh, K.O.(2020). *Financial management and policy: An analytical approach*. Aba: Onemec Publishers

[6]. Emenike, K.O. & Aleke, S.F (2012). Modeling asymmetric volatility in the Nigerian stock exchange. *European Journal of Business and Management, 4(12),* 52-59.

[7]. Engle, R. F. & Ng, V. K. (1993). Measuring and testing the impact of news on volatility. *Journal of Finance, 48(1),* 1749-1778.

[8]. Ezirim, C.B. (2005). *Finance Dynamics: Principles, techniques and applications (3rd ed).* Portharcourt: Markowitz Centre for Research and Development.

[9]. Ezirim, C.B., Ejem, C.A., Ogbonna, U. & Chukwu, U.O. (2019). Do interest rates and savings cause domestic investments in developing economisc? Macrofinamatric evidence from Nigeria. *International Journal of Business and Economics Perspectives*, 14(1), 1-21.

[10]. Graham, J.K & Harvey, C.R. (2001). The theory and practice of corporate finance: Evidence from the field. *Journal of Financial Economics*, 60, 187-243.

[11]. Kuepper, J.(2020). Defiinition of Volatility. *https://www.investopedia.com/terms/v/volatility.asp*
[12]. Levacic, R. & Rebmann, A.(1982). *Macroeconomics: An introduction to Keynesian-Neoclassical controversies*. New York: Macmillian.
[13]. Nelson, D. (1991). Conditional heteroscedasticity in asset returns: a new approach. *Journal of Econometrics, 59(2)*, 347-370.
[14]. Ngugi, R.W. & Kabubo, J.W. (1998).Financial sector reforms and interest rate liberalization:The Kenya experience. *AERC Research Paper 72; African Economic Research Consortium, Nairobi.*
[15]. Nzotta, S.M. (2004). *Money, banking and finance: Theory and practice (2nd ed)*. Owerri: Hudson Jude Nig Publishers
[16]. Okpara G.C. (2012). Volatility modeling and the Nigerian stock return relationship in EGARCH-in-mean framework. *International Journal of Current Research, 3(8)*, 176-185.
[17]. Okpara, G.C. (2015). *Mathematics of finance: An introductory survey (2nd ed)*. Enugu: De-Sanctity Publications
[18]. Olan, T.H. & Sandy, S. (2005). *Testing for asymmetry in interest rate volatility in the presence of a neglected level effect.* The University of Melbourne & The University of Queensland.
[19]. Olwenyi, T. (2011). Modeling volatility of short-term interest rates in Kenya. International Journal of Business and Social Science, 2(7), 289-303.
[20]. Ritter, L.S. & Silber, W.L. (1977). *Principles of money, banking and financial markets (2nd ed)*. New York: Basic Books, Inc Publishers
[21]. Shaihk, S. (2020). Top 7 theories of interest with *diagram https://www.economicsdiscussion.net/theories-of-interest/top-7-theories-of- interest-with-diagram/13937. Available at www.google.com. Accessed on April 30, 2020.*
[22]. Wanger, H.(2020). Why volatility is important to investors. *https://www.investopedia.com/articles/financial-theory/08/volatility.asp*

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