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GARCH Modeling of Interest Rate in Nigeria from 1997 to 2017

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ABSTRACT

This study examines GARCH Modeling of Interest Rate in Nigeria from 1997 to 2017. The objectives of the study were to develop an appropriate GARCH model to fit monthly data on Nigeria Interest rate and to examine the presence of ARCH effect on monthly data returns on Nigerian Interest rate. To achieve the desired objectives of the study, two research questions and hypotheses where set to guide the study. The research design was an ex-post facto design and the data used in the study was on Nigerian deposit Bank Interest rate extracted from the online statistical database of the Central Bank of Nigeria (CBN) between (1997-2017). GARCH models were fitted to the data with the aid of Eview software version 10 and the results shows that asymmetric GARCH (EGARCH and TGARCH) were more appropriate compared to the symmetric GARCH (GARCH (1,1) and GARCH-M (1,1)) in generalized error distributional assumption. Also, the best fitted model was selected using Akaike Information Criteria (AIC) and the model selected was diagnosed using ARCH effect test, QQ-plot and serial correlation test in order to ascertain the model robustness. Sequel to the above findings, it was revealed that there were high probabilities of gain than loss for those that obtained loans from the banks within the study period. Although, the variables used in this study was extremely volatile and this shows evidence that interest rate users were exposed to risk meaning that Bankers, customers of deposit money banks, investments or investors deserved rewards for holding such a risky asset.

Keywords: Interest Rate, GARCH model, money banks

INTRODUCTION

Interest rate is an essential macroeconomic indicator in finance, economics, econometrics and statistics that possess some distinct qualities. Interest rate plays a key role in determining the economic state of the nation. Several studies have been done by statisticians, econometricians and economists to investigate the impact of interest rate volatility on other macro and micro-economic variables of the country. Some of the studies were done as a result of several roles played by interest rate and also to determine the economy of the nation. In another development, the investigations were also carried out to examine the challenges associated with the relationship between interest rate and other economic indicators. Although, Volodymyr (2002) once observed that interest rates exhibit different behavior in different countries under several circumstances. For example, some countries in the world charge their interest levy on deposit bank facilities and other economic condition attached to it. Therefore, it becomes necessary to develop as an appropriate model for modeling variation in interest rate levy in a developing country like Nigeria.

Although, the theoretical importance of interest rate to the economy, transition economies, particularly Nigeria, do very often experience several challenges in modeling interest rate Okoye *et al.*, (2015), like what led to the establishment of Structural Adjustment Programme (SAP) adopted in Nigeria in the year 1986 and first quarter of 2002 under President, Olusegun Obasanjo. The issue of transition and volatility in interest rate which raised serious concerns about its effect on the economy which according to the then President. Nigerian interest rate was one of the highest in the world noting that its rising volatility tendency holds little or no prospect to enhanced industrial sectors as argued by critics of the Olusegun

Obasanjo regime (Okoye, Nwakoby and Modebe, 2015).The problem of high interest rates volatility has been of great concern to Nigerians for a longer period of time as it does not allow foreign investors, companies, individuals and corporate organizations to invest as much as they could, since they cannot profit from the return on their business as much as they earn from doing business in other countries. However, the trend has not ceased to engage the attention of other stakeholders such as econometricians, statisticians and economist in the Nigerian project.

According to Rui (2009), we can only capture the volatility characteristics associated to interest rate by constructing corresponding term structure which has become an important concept in financial modeling, especially for foreign investors, companies, individuals, corporate organizations and private firms to use for evaluation and asset pricing.

Merton (1973), also observed that using Brownian diffusion method in modeling interest rate(short term), had generated a lot of concern among researchers. Similarly, Vasicek (1977) revealed that estimating historical data on interest rate (short term) are usually mean revert to a certain level in the long run and therefore, he further suggested that using the Ornstein-Uhlenbeck process in modeling mean reversion property exhibited by interest rate may not be appropriate. Cox *et al.* (1985), further revealed that the volatility of interest rate increases according to its level and this is referred to as level effect as it is represented in Cox Ingersoll and Ross (CIR) model.

Furthermore, when level effects are included in the diffusion component of the model it may lead to overemphasizing the sensitivity of volatility and changes in interest rate. However, what is more important is that many empirical works show that the term structure provided by one-factor model which is different from real historical term structure. Therefore, in order to solve the problems arising from one-factor model, the multifactor models by Cox *et al.* (1985) suggested that we can add some independent factors in one of the theoretical model.

However, this method was characterized with a lot of irregularities which led Heston and Nandi (1998) to the use of discrete time model with GARCH to capture volatility which according to him is the diffusion process. According to Dritsaki (2017) this model, called the GARCH model was developed in 1982 by Engle. He further explained that it was later generalized by Bollerselv in 1986 as Generalized Conditional Autoregressive Heteroskedasticity. Sharmiri and Isa (2009) further suggested that this method involved modeling mean response with respect to change in covariate of the variable while the variance remains constant with respect to time. Although, this method is often seem to be an unrealistic assumption in application and practice. This seems to be clear in series of financial data where volatility clusters can be seen visually.

Generalized Autoregressive Conditional Heteroskedaticity (GARCH) has a long and outstanding history for been efficient in capturing interest rate volatility but they are not free from limitations. Example, Black (1976) in his study claims that stock market returns are negatively correlated with respect to change in volatility returns. This simply means that volatility tends to rise in response to bad news and fall in response to good news. Conversely, GARCH model assume that only the size of return of the conditional variance should be defined and not the positively or negatively of volatility return, which are unpredicted. Also, interest rate return as an economic indicator is characterized with a lot of challenges. Its markets react “nervously” in the presence of political disorder, economic crisis or possible fear of war or man-made disaster like the case of bank’s risk consideration and other major natural catastrophe that tends to threaten peaceful co-existence, during such a distress period interest rate are mostly volatile.

Definition of Terms

i. **Modeling:** This is simply defined as the abstraction or process of representing mathematical equation or statistical system that can be used to explain certain economic phenomenon.
ii. **Volatility:** This is simply a wide swing or the rate of sudden changes in interest rate from one mood to another.
iii. **Interest Rate:** Interest rate is the amount of money charge on loan facility as interest to the borrower on a loan facility obtained from deposit money banks, typically expressed as percentage charge on the facility, it could be annually or monthly.

iv. **GARCH:** The acronym GARCH represents Generalized Auto-regressive Conditional Heteroskedasticity. It can be used in modeling statistical condition in which a variable violate the normality assumption when they are estimated in a classical regression model. In such assumption the mean of distribution is independent and identically distributed having mean zero and a constant variance estimate.

LITERATURE REVIEW

Conceptual Framework

Under this sub-heading, this study reviews the Concept of Interest Rates, Central Bank of Nigeria (CBN) Interest Rate Regulatory Measures, and effect of Interest Rate fluctuations on Money Lending in Money Deposit Banks and Nigeria Economic Growth

Concept of Interest Rates

According to Okoye, Nwakoby and Modebe (2015), interest rate is one of the economic price variables (for example the exchange rate, wage rate, etc.) which determines the flow of economic activities. They further explained that just like the wage rate refers to as the price of labor charged on the cost of production. As a concept, interest has been defined in a variety of ways even among economists. Jhingan (2001), documents the views of some renowned economists on the concept. For instance, Mill (2006) conceives interest as the remuneration for mere abstinence. According to Mill (2006), since abstinence from consumption is often painful and disagreeable, fund owners should be compensated in the form of interest.

However, Keynes J.M. (2016) definition focuses more on lending rate than the reward associated with it.

Adebiyi (2002), defines the concept of interest as return or yield on equity or opportunity cost to set aside the present current consumption level for the future. Some examples of the interest rate in money deposit banks include; saving rate, lending rate, and discount rate. Also, Jhingan (2003), defines interest as the price that is equal to the supply of credit facilities or savings plus net increase in the amount of money in the economy within certain period. It is also seen as the demand for credit or investment plus net 'hoarding' within certain period. This simply implies that interest rate is the price of credit and like other form of prices; it is determined by the interaction between the forces of demand and supply. In some cases, it has to do with the demand and supply of credit facilities such as Cash (funds).

Similarly, real interest rate represents a fundamental valuation for temporary provision of capital (money) corresponding to a constant price level with respect to time. According to Cottrell (2005), the concept of real interest rate is irreplaceable in the research such that it has mutual relations with inflation. This is because it is assume among creditors that inflation and nominal interest rate influence each other. For similar reasons, the real interest rate is used in broader economic analysis. Bencik (2009), revealed that expected inflation is an unobservable quantity. He further opined that in an ex-post facto analysis, it can be replaced with the actual rate of inflation within the period under investigation, which is equivalent to expectation.

According to Okoye *et al.* (2015), this is considered theoretically less satisfactory, but easier to apply since the assumption of adaptive expectations is proxy for expected inflation in the future by actual inflation in the present. Inflation is very important when dealing with interest rate. This is because when there isan increasing level of inflation over a longer period of time, economic agents recognized the actual value of money in order to prevent the economy from suffering money illusion and then accept increased nominal rates as an alternative to interest rate. Sequel to the above, Bencik (2009) suggested that investment as the main link between interest rate and the real economy should be considered as function of the real interest rate.

However, Okoye *et al.* (2015) opined that there are two major polices of interest rate management and they include: interest rate regulation and interest rate reform. The Interest rate regulation often embodies the practice of interest rate repression and entails the use of quantitative or administrative controls by the monetary authorities to influence the magnitude as well as direction of credit. A characteristic feature of the regulated regime is maintenance of interest rate at levels lower than the rate of inflation (interest rate depression). Depression of interest rate target is to enhance the maintenance of low and negative real interest rate to support economic development through provision of cheap (finance) to industry operators.

METHODOLOGY

Research Design

According to Onwumere (2005) research design can be as a blue print that guides any study, investigation and analysis. Therefore, the design for this study was an ex-post facto design.

Model Specification

According to Black (2002), modeling is the method of identifying the key features of real world economy and making appropriate simplification or assumptions to capture the series. Therefore, the model adopted in the study was derived as shown below:

According to Engel (1982), heteroskedasticity in a return series (y_t) can be modeled using ARCH model having the mean equation in the form:

$$I_t = \varepsilon_{t-1}(I_t) + \varepsilon_t \tag{3.1}$$

Equation (3.1) represents the mean component of the model which is applicable to other GARCH models.

Whereby ε_{t-1} is referred to as expectation on the information available at time t-1, ε_t is the error term generated from the mean equation at time (t) and ε_t is a square of independent and identically distributed (iid) random variables that have zero mean and constant variance, i.e. E(ε_t /I_{t-1}) = 0 and σ_t^2 = E ($\varepsilon_t{}^2$ = I_{t-1}) are nontrivial positive – valued parametric function of I_{t-1} (Atoi, 2014).

The variance equation for an ARCH model of order q is given as thus:

$$\sigma_t{}^2 = \alpha_t + \sum_{1=1}^{q} \alpha_i \varepsilon_{t-1} + \mu_t \tag{3.2}$$

where $\alpha_0 > 0; \alpha_i \geq 0,\ i = 1,\ q = 1$ and $\alpha_i > 0$. According to Atoi (2014), this simply means that the decay rate is usually speedier than what is actually used in estimating financial time series data.

Symmetric GARCH

Two types of GARCH were considered under the symmetric GARCH with respect to their error distribution assumption and they include GARCH and the GARCH-M .

The GARCH (p,q) model in its generalized form is written as: thus:

$$\sigma_t^2 = w + \sum_{t=1}^{q} \alpha_i \ \varepsilon_{t-1}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \tag{3.3}$$

Such that p is the order of the GARCH terms, σ^2 and q is the order of the ARCH term ε_{t-1}^2 where w, α_i and β_j >.0; $\sigma_t{}^2$ is the conditional variance and ε_t disturbance term, the reduced form of equation (3.3) i.e. GARCH (1,1) is given as thus:

$$\sigma_t^2 = w + \alpha_i \varepsilon_t^2 + \beta_j \sigma_{t-1}^2 \quad (3.4)$$

where w, α, and β_j are non-negative parameter to be estimated and $\alpha + \beta < 1$ to be stationary.

Similarly, the GARCH- Mean (GARCH-M) could be specified as thus:

Mean equation (R_t) = μ + w

Variance equation (σ_t^2) = $w + \alpha_1 \varepsilon_{t-1}^2 \ \beta_j \sigma_{t-1}^2$ (3.5)

Where $\alpha_0 \geq_{0,} \alpha_1 \geq_{0,\ \beta \geq 0}$ for σ_t^2 to be positive and these parameters are to be estimated.

Asymmetric GARCH Model

Drisaki (2017) suggested that the main function of an asymmetric GARCH Model is to captured the inadequacies confirmed in symmetric GARCH model and he further opined that these inadequacies include inability of the symmetric GARCH to model leverage effect, the impact of good and bad news and long memory. Therefore, there are two classes of an asymmetric GARCH model to be considered in this study and they include; EGARCH and TGARCH. The Exponential GARCH (EGARCH) model can specified generally as thus:

$$\text{Log}(\sigma_t^2) = \beta_0 + \sum_{1=1}^{q} \left\{ \alpha i \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}^2} \right| + \gamma_{\text{i}} \left|_i \frac{\varepsilon_{t-1}}{\sigma_{t-1}^2} \right| \right\} + \sum_{j}^{p} \beta; \log\left(\sigma_{t-j}^2\right) \quad (3.7)$$

The reduced form of the generalized EGARCH will be stated as thus:

$$\text{Log}(\sigma_t^2) = \beta_0 + \alpha_1 \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}^2} \right| + \gamma_{\text{i}} \frac{\varepsilon_{t-1}}{\sigma_{t-1}^{2}} + \beta_1 \log\left(\sigma_{t-1}^2\right) \quad (3.8)$$

Where $\alpha_{1;}\ \gamma_{\text{i}} \geq_0\ \varepsilon_{t-1} >_0$ and $\varepsilon_{t-1} > 0$ and $\varepsilon_{t-1} < 0$ simply good news and bad news whereas the total effects are given as $(1 + \gamma_{\text{i}})\ |\varepsilon_{t-1}| and (1 - \gamma_{\text{i}})|\varepsilon_{t-1}|$ respectively. $\gamma_{\text{i}} < 0$ is the expectation when bad news has higher impact on volatility. Similarly, the EGARCH model usually has variance stationarity when $\sum_{j=1}^{p} \beta, < 1$ and then the null hypothesis will be rejected. When $\gamma_{\text{i}} = 0$, it shows there is the presence of leverage effect. According to Atoi (2014), this simply means that bad news has stronger effect than good news on the volatility of interest rate return.

The threshold GARCH (TGARCH) model; this generally specify as thus:

TGARCH (p,q) given as thus:

$$\sigma_t^2 = \beta_0 + \sum_{i=1}^{q} \alpha_i\ \varepsilon_{t-1}^2 + \sum_{i=1}^{q} y_i I_{t-i}\ \varepsilon_{t-1}^2 + \sum_{j=1}^{\rho} \beta_j \sigma_{t-j}^e \quad (3.9)$$

where $I_{t-1} = 1$ if $\varepsilon_{t-1}^2 < 0$ and O otherwise $\varepsilon_{t-1}^2 > 0$ Implies good news where $\varepsilon_{t-1}^2 < 0$ bad news and according to Atoi (2014), there exist two shocks of equal size with differential effects on the conditional variance. He further opined that bad news increase volatility when I_i >o which simply means the existence of leverage effect in the jth order and when $I_i > 0$ the news impact is asymmetric.

Error Distribution Assumptions

To further verify that modeling of the returns series on interest rate with Gaussian process for high frequency data time series, the equation (3.2), (3.4), (3.5) and (3.9), will be estimated with a normal, generalized and student's- t distribution by maximizing the likelihood function. For normal distributional assumption it is use as thus:

$$L(\theta_t) = \frac{1}{2}\sum_{t-1}^{T}\left(In2\pi + In\sigma_t^2 + \frac{\varepsilon_t^2}{\sigma_t^2}\right) \qquad (3.10)$$

σ_t^2 is the field in each of the GARCH models.

Similarly, It is also assumed that GARCH models follow Generalized Error Distribution (GED) assumptions and this tends to account for the Kurtosis in returns of the time series data. According to Atoi (2014) this cannot be adequately captured by the normality assumption as it is in equation (3.10) above. Therefore such volatility condition can only be estimated with generalized Error distribution assumption by using the likelihood function below.

$$\text{L}(\theta_t) = -\tfrac{1}{2}\log\left(\frac{\sqrt{\tfrac{1}{v3}}}{\sqrt{\tfrac{3}{v}\left(\tfrac{V}{2}\right)^2}}\right) - \tfrac{1}{2}\log\sigma_t^2 - \left(\frac{\sqrt{\tfrac{3}{V}\left(y_t - X_t^1\theta\right)^2}}{\sigma_t^2\sqrt{\left(\tfrac{1}{\text{v}}\right)}}\right) \qquad (3.11)$$

where V is considered as the appearance of the parameter. This accounts for Skewness in the returns of the series and where V>0 it means that as the value of V increases the greater the weight of the tail. The Generalized Error Distribution (GED) goes back to old ways of normal distribution when V= 0

In another development, the students –t distribution of volatility models are estimated to make the most of the likelihood function of students' – t distribution assumptions

$$\text{L}(\theta)_t = -\tfrac{1}{2}\log\left(\frac{\Pi(\text{r})\sqrt{\tfrac{\text{r}}{2^2}}}{\sqrt{\tfrac{(r+1)^2}{2}}} - \tfrac{1}{2}\log\sigma_t^2 - \left(\frac{\text{r}+1}{2}\right)\log\left(1 - \frac{(\text{y}_t - X_t^1\theta)^2}{\sigma_t^2(\text{r}-2)}\right)\right. \qquad (3.12)$$

In this case r represents the degree of freedom and this controls the tail behavior when

$r > 2$

The Lagrange multiplier (LM) test for the presence of ARCH effect in the residuals ε_t is considered to be tested following the null hypothesis that there is ARCH versus alternative hypothesis that there exist ARCH (ie H_o: $\prod_1 = 0$ Vs H_1: $\prod_1 \neq 0$) up to order q at 5% level of significance using the equation below;

$$\varepsilon_t = \psi + \left(\sum_{i=1}^{q} \Pi_1 \varepsilon_{t-1}^{0} \right) + \mu_t \qquad (3.14)$$

ψ_0 and $\prod_t$ are constant and the error terms respectively. However, the expectation is that there should be no traced of ARCH effect to n^{th} order for us to accept the null hypothesis for GARCH model estimation to be used. Although, the mean equation for stationary return in the series with ARCH effect is specified in a univariate form as:

$$Iy_t = \ell + \varpi\, y_{t-1} + \varepsilon_t \qquad (3.15)$$

where Iy_t is defined as return in the series ℓ is constant, ϖ is the estimated autoregression co-efficient, y_{t-1} is one period Log of the interest rate returns and ε_t is the standardized residuals of the interest rate return at time t.

Time Series Graph

Time Series graph has to do with the pictorial representation of the information or relationship between series of discrete data (numbers) with time (years) in a point in time with order in the form of a graph. It is the representation of sequence of consecutive equal spaced points on a line chart.

ARMA Model Estimation

The ARMA model was estimated by way of extracting the residual from an ordinary least squares regression (OLS) model in order to examine the conditional mean and variance derived from the process. The residual obtained are presented in an equation which is called an ARMA model. However, the model is stated as thus: Supposing an ARMA (1,1) process is considered X_t conditional mean can stated as

$$X_t = \theta_1 X_t + \varepsilon_t + \theta_1\, \varepsilon_{t-1} \qquad (3.16)$$

Test for volatility cluster

This is done by plotting the graph of the transformation of the residual obtained from the ARMA model as stated in 3.5.2

Normality Test

According to Chinyere *et al.*(2015) normality test is done using Jargue and Bera (1980) test defined as the joint test for normality which has to do with kurtosis and skewed statistic to examine whether a data set exhibit normal distribution or not. This test statistics were developed by both Jargue and Bera in 1980. The formula is stated as thus;

$$X^2 \approx \frac{N}{6}\left[S^2 + \frac{(K-3)^2}{4} \right] \qquad (3.17)$$

Where S and K stand for Skewness and Kurtosis respectively and N represents the sample size of the variables used in the estimation.

The test statistic for the null hypothesis was subject to a normal distribution with a degree of freedom 2 and when the distribution fail to conform with the normality test, we apply Abdulkareem and

Abdulhakeem (2016) suggestion that when the null hypothesis for normal distribution fails the alternative GARCH with its error distribution assumptions with fixed degree of freedom can be use in estimating the variable.

ARCH (Heteroskedasticity) Effects Test

This has to do with examining the presence of heteroscedasticity in the residuals of the estimated ARMA and according to Engle (1982), this was done using LaGrange multiplier (ML). Once the residual (ε_t) was obtained from an OLS process, plus the squared residual and a constant, then the q is lag as thus:

$$\varepsilon_t^2 = \alpha_0 + \alpha_i \ \varepsilon_{t-1}^2 + ... + \alpha_q \varepsilon_{t-q}^2 = \alpha_0 + \sum_{1=1}^{q} \alpha_i \Sigma_{t-1}^2 \qquad (3.18)$$

The ARCH model (q) is

$$\sigma_t = \alpha_0 + \alpha_i \ \varepsilon_{t-1}^2 + ... + \alpha_q \varepsilon_{t-q} + \varepsilon_t \ \alpha_0 + \sum_{1=1}^{q} \alpha_i \ \Sigma_{t-1} + \varepsilon_t \qquad (3.19)$$

where; σ_t represents the unconditional variance , α_0 Stands for the constant term, α_i Stands for the co-efficient of the ARCH term , ε_{t-i} represents the corresponding lags of the errors at time t-1, q represents the length of ARCH lags and ε_t stands the error term. The test hypothesis**:** H_o: $\alpha_1 = ... \ \alpha_q = 0$ versus H1: $\alpha_1 = ...\alpha_1 \neq 0$ for some {i=1….q} at least one variable contain presence of ARCH effect. Specifically, the number of observations (n) multiply by R-squared (nR^2) is what defines the test statistics of the joint significance of the q – lagged squared residuals with the $X^2(q)$ degrees of freedom. Therefore, the number of observation multiply by the co-efficient of determination (nR^2) tested versus the Chiq-Square $X^2(q)$ distribution. If $nR^2 > X^2(q)$ of the result obtained, then the null hypothesis of the no presence of ARCH effect. Therefore, it would be concluded that there is the presence of ARCH effect in the ARMA model. However, the opposite of the test statistic above shows there is no ARCH effect in the ARMA model.

Model Parameter Estimation

GARCH model parameters were estimated to arrive at the value of each of the coefficients in the model used in the study

Model Selection Criteria

Model Selection Criterion were estimated using both AIC (Akaike information criteria) and SIC (Schwartz information criteria). The two methods of Model Selection are defined, according to Vee *et al*, (2009)as thus;

$$\text{AIC} = 2K - 2\text{In (LL)} = 2K + \text{In}\left(\frac{RSS}{n}\right) \qquad (3.20)$$

Where K represents the size of the parameters to be estimated, L represents the maximized the likelihood function to be estimated in the model and RSS = $\sum_{1=1}^{n} \varepsilon^2 \eta$ is the residual sum of squares. The Schwartz information criterion is defined as:

$$\text{SIC} = \log\left(\sum \frac{\varepsilon^1}{n}\right) + \varepsilon \log \frac{n}{n} \qquad (3.21)$$

Abdulkareem and Abdulhakeem (2016) suggested we should use Schwartz information criteria (SIC) because Schwartz information criterion levies heavy penalty on models for loss of degree of freedom.

Model Forecasting

The forecasts of the EGARCH Model obtained from our result is given as thus: supposing the forecast origin K and the 1-step ahead forecast of z_{k+1}^2 is given as thus

$$z_k^2(1) = \alpha_0 + \alpha_1 h_k^2 + \beta_1 Z_k^2$$

Therefore, estimating multistep ahead forecasts of the volatility model 3.7 can be written as thus

$$z_{t+1}^2(1) = \alpha_0 + (\alpha_1 + \beta_1)h_k^2 + \alpha_1 h_k^2(e_t^2 - 1)$$

Given that $t = k + 1$ the model yields

$$h_{k+2}^2 = \alpha_0 + (\alpha_1 + \beta_1)h_k^2 + \alpha_1 h_k^2(e_t^2 - 1) \quad \text{with} \quad E(e_{k+1}^2 - \frac{1}{f_h}) = 0,$$

The 2-step volatility forecast is given as thus:

$$h_k^2(2) = \alpha_0 + (\alpha_1 + \beta_1)h_k^2(1)$$

However, the **Normalized mean squared error (NMSE) is given as**

$$MMSE = \frac{1}{k}\sum_{t=t_f}^{N} \frac{(r_t - \hat{r}_t)^2}{\hat{\sigma}^2}$$

Where $\hat{\sigma}^2$ is the variance of the training set (in sample unconditional volatility)

Mean absolute error (MAE)

$$MAE = \frac{1}{k}\sum_{t=t_f}^{N} \left| r_t - \hat{r}_t \right|$$

NMSE and MAE are the metrics used to estimate the error of prediction.

Function (SIGN)

$$\mathrm{SIGN} = \frac{1}{k}\sum_{t=t_f}^{N}\delta_t$$

$$\delta_t = \begin{cases} 1 & r_{t+1}\hat{r}_{t+1} \geq 0 \\ 0 & otherwise \end{cases}$$

RESULTS

Time Plot, ARMA Model Result and Test for Volatility Clustering

Figure 4.1 represents the time plot of the raw data on Nigeria interest rate from the year 1997-2017. it is a result of an Eview output when the raw data is plotted on time graph and this is done to examine whether there exist a trend in the movement of data.

Table 4.1 represents the summary statistic on interest rate and an Estimated Autoregressive Moving Average (ARMA) model to obtain the residual from the test of volatility clustering. The model is represented in equation (3.1).

Time Plot

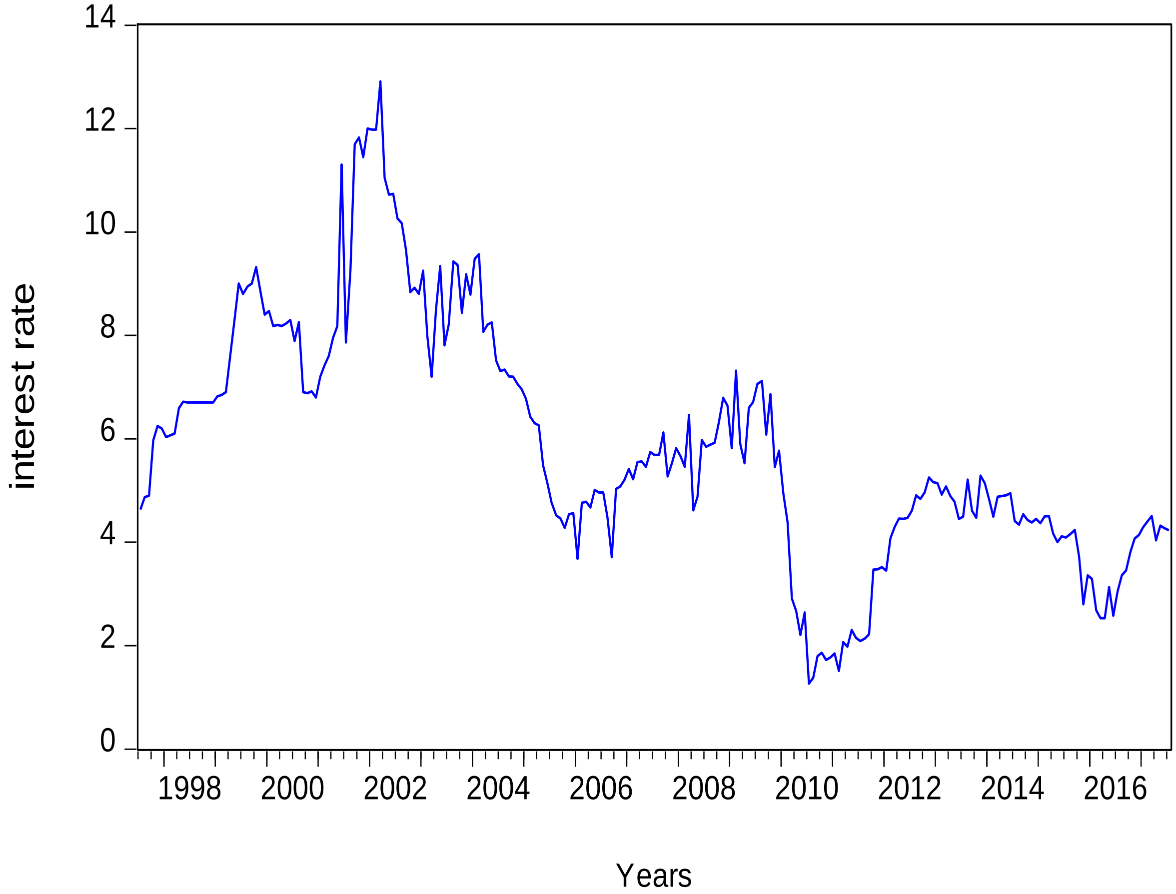

Figure 4.1: Time Plot of Interest Rate 1997-2017

Descriptive Statistics Summary

This illustrates the return of interest rate ascertain the estimated values after computation suited for the ARMA model given.

The ARMA Model as obtained from the linear regression model in equation (3.1), we have;

Interate = 0.205448 + 0.965 * 02 ε_{t-1}^{2} + μ_t

Table 4.1: Summary Statistic of Interest Rate Return

Mean	Median	Min	Max	StdDw.	Skewnes	Kurtosis	JB	P-value
-0.0004	0.0023	-0.7318	0.4467	0.1164	-0.9453	10.8268	648.3	0.000

Source: Researcher's Computations, 2018 E- View Version 10

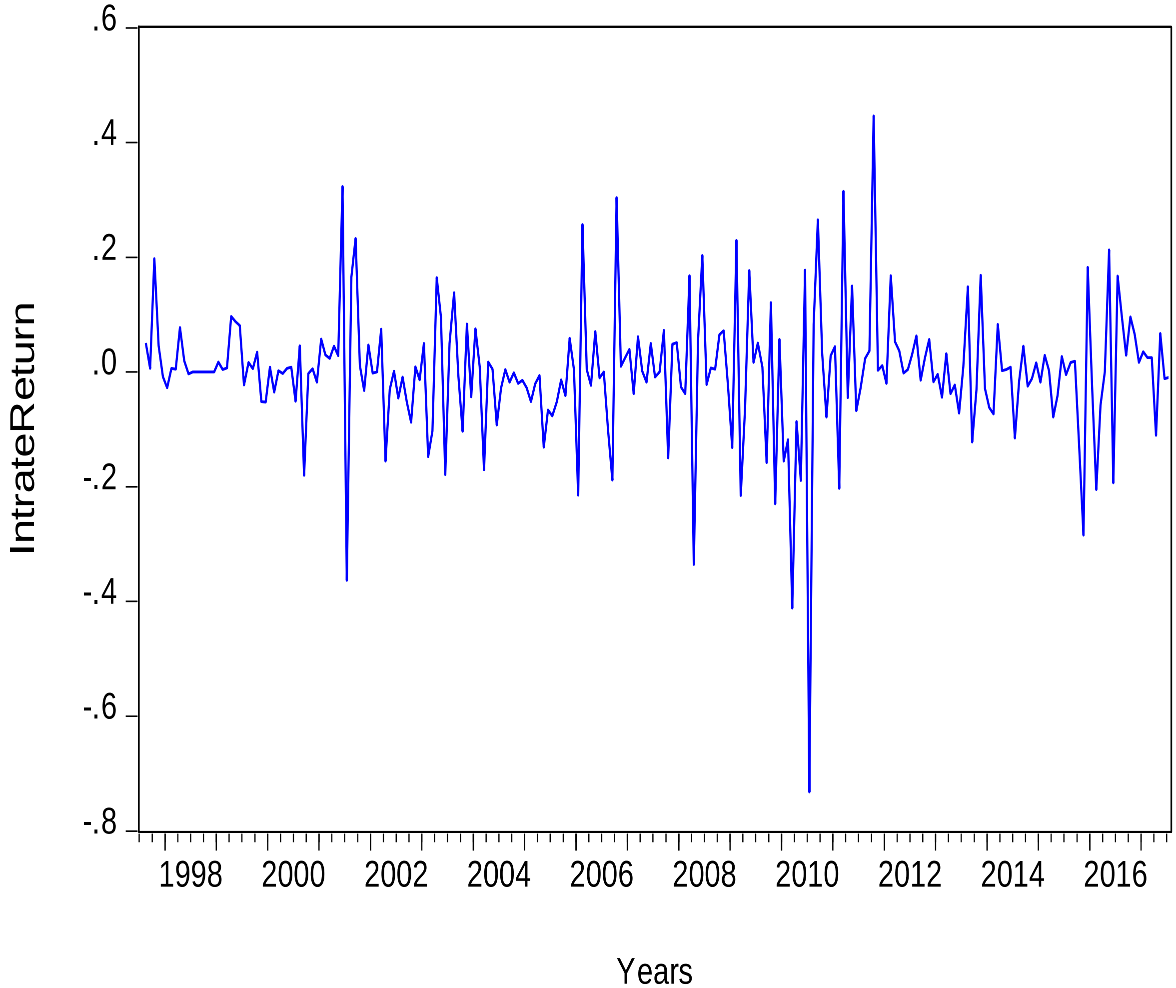

Figure 4.2: Volatility Clustering on the Return of Interest Rate from 1997-2017

Table 4.2: Estimation Results for First order Symmetric GARCH Models with their Errors Distribution Assumption

Model	Equation	Model Parameters	Normal Error Dist.	Student's -t Error Dist.	Generalized Error Dist.	Model with Min AIC Across Errors Dist.
	Mean	Intercept	0.0544	0.0338	0.0180	
			(0.003)	(0.0031)	(0.056)	
		Interate(-1)	-0.0089	-0.0050	-0.0027	
			(0.0027)	(0.0033)	(0.0042)	
GARCH(1,1)		Intercept	0.0013	3.1755	0.0031	
			(0.000)	(0.9993)	(0.0456)	
	Variance	ARCH	0.3329	1121.050	0.0031	
			(0.0001)	(0.9993)	(0.0456)	
		GARCH	0.6303	0.3027	0.3146	
			(0.0000)	(0.0123)	(0.0755)	
	Model Selection	AIC	-1.6900	-1.9840	-2.0426	(-2.0426)
	Technique	SIC	-1.6175	-1.89670	-1.9556	(-1.9556)
	ARCH + GARCH		**0.9631**	**1121.353**	**1.1299**	
		SQRT (GARCH)	0.3866	0.0083	0.4148	
			(0.0590)	(0.9922)	(0.0001)	
GARCH(1,1) Mean	Mean	Intercept	0.0198	0.0201	-0.0154	
			(0.0029)	(0.2147)	(0.3167)	
		Interate (-1)	0.0011	-0.0047	-0.0040	
			(0.0001)	(0.0073)		
		Intercept	0.3541	0.72019	0.0046	
			(0.0000)	(0.9961)	(0.0637)	
	Variance	ARCH	0.3541	256.8011	0.17240	
			(10.000)	(0.9961)	(0.0948)	
		GARCH	0.6286	0.3400	0.550215	
			(0.0000)	(0.0035)	(0.0006)	
	Model Selection Technique	AIC	-1.6988	-1.9826	-1.9739	(-1.9826)
		SIC	-1.6118	-1.8811	-1.8724	(-.18811)
	ARCH + GARCH		**0.9827**	**271.1411**		

Source: Researcher's Computations, 2018 E-View Version 10

Model Selected

Based on the minimum as well as the least Akaike and Schwarz information criterion the best considered model was EGARCH(1,1) in Generalized error distributional assumption and this can be represented as thus:

Mean component: $\left(\overline{X}\right) = 0.0221 - 0.0033 * \varepsilon_{t-1}^{2}$

Variance Component $\text{Log}\left(\sigma_t^2\right) = -0.8566 + 0.5281\left|\frac{\varepsilon_t}{\sigma_{t-1}}\right| - 0.2010\ \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + 0.883\log\left(\sigma_{t-1}^{2}\right)$

Test for the Presence of ARCH Effect

An investigation was carried out to check for the presence of ARCH effect on the selected estimated model and this was done using ARCH-LM test.

Table 4.3 contain the results obtained using the ARCH-LM test for ARCH effect. As it is observed, the n^*X^2>f-statistic and this indicates that the null hypothesis of no ARCH-effect should be accepted at 5% level of significance.

Result of the Test for Serial Correlation

The result in Figure 4.3 indicates that there is no serial correlation as the probability (p-values) is all greater than the standard probability of 0.05 level of significant. Hence, there is the absence of serial correlation.

Table 4.4: The Forecast Result for EGARCH(1,1) Model

Model	RMSE	MAE.	MAPE	VARIANCE PRO	COV. PROP	THEIL U2	SYM MAPE
EGARCH(1,1)	0.0523	0.031	108.585	0.988	0.0033	0.874`	115.41

Source: Researcher's Computations, 2018

DISCUSSION

The study uses Nigeria interest rate data extracted from deposit money Banks as it is shown on Central Bank of Nigeria (CBN) online statistical database. The data extracted spanned from the month of July, 1997 to July, 2017. This gives a total of two hundred and forty (240) data pints. A conditional variance models were fitted to conditionally compounding monthly data on interest rate. Also, a total of twelve (12) models were used in the study under two GARCH model classifications (Symmetric and Asymmetric) alongside with their corresponding three (3) error distribution assumptions. In estimating the model, several conditions were taking into considerations and these conditions were incorporated into the estimation technique. Some of the conditions include; Time plot, summary descriptive statistic, Test for ARCH effect, Model Estimation and selection and model diagnostic test.

The estimated mean (-0.000376) has negative sign, and this simply shows that the variable exhibits a characteristic that is negatively mean reverting in nature. Similarly, the standard deviation (0.116447) obtained measure the degree of risk associated with variable used in the study. Therefore, the study applied GARCH family models with their corresponding error distribution theory with its corresponding fixed degree of freedom are fussed into the GARCH model. This study agrees with the findings of Abdulhakeem (2016) while analyzing oil price – macroeconomic volatility in Nigeria. Also, the degree of volatility persistence in GARCH-M (1,1) according to their order of error distribution assumptions are as thus: GARCH- M (1,1) in Normal (98.27%), in student's- t(-1.9826) and SIC (-1.8811). This result was a confirmation of Deebom and Essi's (2017) findings in modeling price volatility of Nigeria crude oil markets between 1987 and 2017 using GARCH model. It was found in this study that GARCH-M(1,1) in student's –t distribution was considered the best fitted symmetric model comparing the three GARCH-M(1,1) in their corresponding different error distributional assumptions.

CONCLUSION

The study examines an appropriate GARCH model for modeling Nigeria interest rate between 1997-2017. The study compares symmetric and asymmetric GARCH performance in modeling interest rate in Nigeria between 1997-2017 and to estimate the impact of News and volatility, persistence on interest rate in Nigeria. This study extracted data that spanned from 1997-2017 from the Central Bank of Nigeria online statistical database.

In order to contribute to the existing literatures on interest rate of the deposit money banks, this study investigates the estimation ability and performance of univariate GARCH family model for modeling conditional variance interest rate.

It was also revealed that across all the models estimated within the sampled period under all the error distributional assumption, EGARCH in generalized error distribution was considered the most appropriate fitted models that can be used to model volatility of returns on interest rate volatility here is persistent in the entire estimated model and it reveal mean reverting in nature.

The results obtained using ARCH – LM test revealed that $n^*R^2 > X^2(q)$.

RECOMMENDATIONS

This study has provided several important tips on modeling volatility of return in interest rate. Looking at the level of risk that is associated with obtaining facilities in deposit money banks and investment in stocks, and price of an asset with their corresponding return in interest rate, financial trade analysts, investors, companies and Government are advised to be careful while trading or doing business involving interest rate.

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