MODELLING AND FORECASTING DAILY RETURNS VOLATILITY OF NIGERIAN BANKS STOCKS

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Abstract

This study models and forecast daily return volatility of Nigerian bank stocks. Data on daily closing prices for fifteen Nigerian banks were collected between 4th January, 2005 and 31st August, 2012. Daily returns series were then computed for each bank from price, stationarity of the resulting series and normality were tested. Different autoregressive models were fitted for the mean equation. From the mean equation, ARCH effect was tested using Lagragian Multiplier test. To capture the volatility pattern, three symmetric models which are ARCH(1), ARCH(2) and GARCH(1,1) and two asymmetric models EGARCH(1,1) and TARCH(1,1) were considered.. Post estimation and performance evaluation metric was done using the RMSE, MAE and MAPE. The results showed that the return series were stationary but not normally distributed with presence of ARCH effect. Furthermore, results of post estimation revealed that these models were competitive. However, EGARCH (1, 1) predicted daily return volatility of majority of Nigerian bank stocks compare to other volatility models considered. This is an indication of the suitability of asymmetric volatility models compared to symmetric models.

Keywords: Heteroscedasticity, volatility, Lagrange multiplier

Introduction

Investment in stock is essentially a long term investment and every investment carries its own risk. This existential reality is more pronounced in the quest for wealth through investment in stock market (Abdullahi and Lawal, 2011). The stock market has given investors opportunity to invest in securities of quoted companies and reward in form of monetary benefit has

been the major objective of any investor. Returns on these investments are used as major indices to evaluate investment instead of prices. Despite this anticipated return on investment by investors, this return often exhibit volatility that is, it is sometimes large or small depending on price variability. The recapitalization of the banking industry in Nigeria in July 2004 boosted the number of securities listed on the Nigerian Stock Market thereby increasing public awareness and the confidence about the Stock market (Olowe, 2009a). However, since April, 2008, investors have been worried about the falling stock prices on the Nigerian stock mark*et al*though this problem has been attributed to the global economic meltdown (Olowe, 2009a). However, despite this problem, volatility modelling and forecasting have not attracted much attention in Nigeria (Dallah and Ade, 2010). Although, several studies in volatility modelling have been carried out, Ibiwoye and Adeleke (2008) whose work centred on the analysis of price movements in insurance stocks before and after-2005 consolidation. Olowe (2009a) wrote on Stock Return Volatility and the Global Financial Crisis in an Emerging Market: The Nigerian Case. Onwukwe *et al* (2012) modelled the volatility of four Nigerian Firms listed on the Nigerian Stock Exchange. Olowe (2009b) also conducted another study which focused on the impact of the 2005 re- capitalization of the banking and insurance industry on the stock market. Also, worthy of note is another study conducted by Dallah and Ade (2010); their study was on modellng and forecasting of daily returns of the Nigerian insurance stocks. Despite these scholarly studies on volatility modelling, none of these studies model daily return volatility of the each of the Nigerian banks stocks. This serves as a motivation for this study.

Review of volatility models

Several volatility models have been used to study stock return volatility, one of them was the traditionally measure of volatility which was carried out through studies of variance of an assets. This measure of unconditional volatility does not account for time-varying and clustering properties of stock volatility. The became a challenge to analysis of financial time series until the ground breaking work of Engle which brought about revolution to analysis of financial time series with the introduction of an Autoregressive Conditional Heteroscedasticity Model in 1982 (Engle, 1982). In the light of this, the generalized ARCH (GARCH) model as a natural solution to the problem with the high ARCH orders was proposed by Bollerslev (Bollerslev, 1986). In Bollerslev's GARCH model (Generalized Autoregressive Conditional Heteroscedasticity model), in GARCH model, the conditional variance is usually expressed in terms of linear function of past squared innovations and earlier calculated conditional variance. Some other volatility models include the standard deviation GARCH model

introduced of Taylor (Taylor, 1986) and Schwert (Schwert, 1989). The EGARCH or Exponential GARCH proposed by Nelson in 1991(Nelson, 1991). Threshold ARCH or TARCH and Threshold GARCH introduced by Zakoian (Zakoian, 1994) among others volatility models.

Methodology of the study

Data for the study: Data for this study were from daily closing prices of fifteen Nigerian bank stocks traded on the floor of the Nigerian Stock Exchange (NSE)**.** This time series data cover almost eight years starting from 4th January 2005 to 31st August, 2012. These data are available on Cash Craft website (**www.cashcraft.com**). These banks are Access, Diamond, Eco International Incorporated (ETI), First City Monument, Fidelity, First Bank of Nigeria, Guaranty Trust Bank, IBTC, Skye, Sterling, United Bank for Africa, Unity, Wema, Zenith and Union Bank of Nigeria(UBN). The Econometric View Software (E view Version 7.0) was used to enhance data analysis.

Model specification

Computation of return series: The daily returns were computed as the natural logarithm of the simple gross return which is given as:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \qquad t = 2\ldots n \tag{1}$$

where, P_t and P_{t-1} are the present and the previous closing prices and n is the number of observation

ARCH models (Autoregressive Conditional Heteroscedastic model)

The ARCH (p) as proposed by Engle (1982) given by

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2\varepsilon_{t-2}^2 + ... + \alpha_p\varepsilon_{t-p}^2 \tag{2}$$

α_0, α_i, for i= 1, 2…, p are the parameters of the model.

$\alpha_0, \alpha_i > 0$

For ARCH (1) p=1, hence ARCH (1) model can be specified as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 \tag{3}$$

$\alpha_0, \alpha_1 > 0$

But if p=2 that is for ARCH (2), we have

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2\varepsilon_{t-2}^2 \tag{4}$$

$$\alpha_0,\ \alpha_1,\alpha_2 > 0,$$

GARCH (1,1) (Generalized Autoregressive Conditional Heteroscedastic)

GARCH (1, 1) has proposed by Bollerslev (1986) is given by

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta_1\sigma_{t-1}^2 \quad (5)$$

Where $\alpha_0, \alpha_1,\ \beta_1$ are the parameters of the model, $\alpha_0, \alpha_1,\ \beta_1$ are all non negative.

$\sigma_t^2, \sigma_{t-1}^2$ are the conditional and earlier calculated conditional variances respectively.

EGARCH (1, 1) (Exponential Generalized Autoregressive Condition Heteroscedastic)

Instead of directly performing the conditional variance, the EGARCH model is formed in logarithm of the conditional variance. The EGARCH (1, 1) as proposed by Nelson (1991) is defined by:

$$\ln(\sigma_t^2) = \alpha_0 + \beta \ln\sigma_{t-1}^2 + \left[\alpha_1 \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \gamma\left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}}\right)\right] \quad (6)$$

$\alpha_0, \alpha_1, \gamma, \beta_1$ are the parameters

TARCH (1, 1) (Threshold ARCH)

TARCH (1, 1) is an asymmetric model which allows for good and bad news. The threshold-ARCH process proposed by Glosten *et al* (1993) allows different effects of good and bad news (negative and positive return shocks) on the volatility. The conditional variance equation in TARCH (p, q) model is now specified as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta_1\sigma_{t-1}^2 + \phi\lambda_{t-1}\varepsilon_{t-1}^2 \quad (7)$$

$$\begin{cases} \lambda_{t-1} = 1, \varepsilon_{t-1} < 0 \\ 0, \varepsilon_{t-1} > 0 \end{cases}$$

Test for ARCH effect and Model diagnostic check

To test for ARCH effect (Heteroscedasticity) the Lagragian Multiplier Test of Engle was used. The null hypothesis is

$H_0 : \alpha_1 = ... = \alpha_m = 0$ Versus $H_a : \alpha_i \neq 0$ for some i $\in \{1,..,m\}$

The test statistic $$F = \frac{(SSR_0 - SSR_1)/m}{SSR_1(n-2m-1)} \quad (8)$$

Where, $SSR_1 = \sum_{t=m+1}^{T} e_t^2$, where $\hat{e}_t$ is the least square residual of the linear regression.

$SSR_0 = \sum_{t=m+1}^{T} (a_t^2 - \varpi)^2$, where $\varpi = \frac{1}{n}\sum_{t=1}^{T} a_t^2$ is the sample mean of a_t^2.

The test statistic is asymptotically distributed as chi- squared distribution with m degrees of freedom under the null hypothesis. The decision is to reject the null hypothesis if $F > \chi_m^2(\alpha)$, where $\chi_m^2(\alpha)$ is the upper $100(1-\alpha)^{th}$ of the χ_m^2 or the p- value of F less than 5%.

Stationary test (Dickey Fuller Test): The Dickey Fuller test was used in testing for the stationarity of the series.
The test statistic,

$$\text{t ratio} = \frac{\hat{\phi} - 1}{Std(\phi)} = \frac{\sum_{t=2}^{n} p_{t-1} e_t}{\hat{\sigma}^2 \sqrt{\sum_{t=2}^{n} p_{t-1}^2}} \quad (9)$$

The null hypothesis is rejected if the calculated value of t is greater than t critical value.

Goodness of fits criteria: Aikaike Information Criteria (AIC), Log likelihood and Swartz Criteria (SIC) are the most commonly used model selection criteria. These criteria were used in this study.
The AIC values can be computed by the following simple equation,

$$AIC = 2K - 2\ln(L) = 2K + \ln\left[\frac{RSS}{n}\right] \quad (10)$$

$RSS = \sum \hat{e}^2$ is the residual sum of squares .

where, L is the maximized value of the Log- Likelihood for the estimated model and K is the number of independently estimated parameters in the model.

Forecast performance evaluation: The Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE) were used as performance evaluation metrics. The RMSE, MAE and MAPE are defined by:

$$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{T}\left(\hat{\sigma}_t^2 - \sigma_t^2\right)^2}\,..$$

(11)

$$MAE = \frac{1}{n}\sum_{t=1}^{T}\left|\left(\hat{\sigma}_t^2 - \sigma_t^2\right)\right|.$$

(12)

$$MAPE = \frac{1}{T}\sum_{t=1}^{T}\left|\frac{\left(\hat{\sigma}_t^2 - \sigma_t^2\right)}{\sigma_t^2}\right| \times 100 \qquad (13)$$

Results

Results of summary statistics for the return series as shown in **Table 1** showed that the mean returns for majority of Nigerian banks were negative which revealed that these banks incurred losses during the period under study. Results also showed that the return series were not normally distributed for most of the banks (Table1) but were stationary (Table 3).

Table 1: Descriptive Statistics showing the Returns of Nigerian Bank Stocks

Banks	**Statistic**							
	Mean	Minimum	Maximum	Standard deviation	Skewness	Kurtosis	Jacque Bera	Probability
Access	0.00038	-0.0902	0.099	0.026756	0.0354	3.1931	3.2568	0.1962
Diamond	-0.000531	-0.1104	0.0972	0.0293	-0.0206	2.8991	0.7238	0.6964
ETI	-0.0005	-0.1025	0.978	0.0271	-0.1128	3.3032	9.7003	0.0078
FCMB	-0.0002	-0.1012	0.0972	0.0258	0.0102	3.4038	12.4839	0.0019
Fidelity	-0.0003	-0.1090	0.1030	0.0276	-0.0305	3.4166	12.8788	0.0016
First bank	0.0009	-0.0906	0.1014	0.0257	0.1045	3.3642	13.3671	0.0013
GTB	0.0009	-0.1022	0.0970	0.0254	0.0304	3.3724	10.6838	0.0048
IBTC	0.0004	-0.0945	0.0975	0.0260	-0.0213	3.3953	11.4305	0.0033
Sky	-0.0006	-0.0953	0.0788	0.0287	-0.1062	2.7284	7.6406	0.0219
Sterling	-0.00007	-0.1156	0.1262	0.0320	-0.0649	2.4870	15.7653	0.0004
UBA	0.0002	-0.1106	0.0858	0.0273	-0.0712	3.0052	1.5277	0.4659
UBN	-0.0014	-0.1288	0.1266	0.0302	0.0069	2.8792	1.0829	0.5819
UNITY	0.0003	-0.0671	0.0789	0.0233	0.0611	3.5467	22.3997	0.0000
WEMA	0.0004	-0.0719	0.0789	0.0232	0.0656	3.5800	26.6932	0.0000
Zenith	0.0004	-0.0719	0.0789	0.0231	0.0652	3.6026	28.9374	0.0000

Table 2: Parameter estimate of the mean equation, stationarity test and ARCH effect.

			Parameters Estimates					
Banks	Model	Type	ϕ_0	ϕ_1	ϕ_2	ϕ_3	ADF test	ARCH LM Test
Access	AR(1)	ARCH(1)	0.000000025	0.2782***				
		ARCH(2)	-3.57×10^{-8}	0.2594			-	133.59***
		GARCH(1, 1)	-4.12×10^{-9}	0.200131***			33.69***	
		E- GARCH(1, 1)	3.20×10^{-7}***	0.238182***				
		TARCH(1, 1)	0.153×10^{-5}***	0.124470***				
Diamond	AR(1)	ARCH(1)	-2.87×10^{-9}	0.227226***			-	48.74***
		ARCH(2)	-1.46×10^{-7}	0.369744***			27.49***	
		GARCH(1, 1)	-1.52×10^{-7}	0.288721***				
		E- GARCH(1, 1)	1.59×10^{-6}	0.332823***				
		TARCH(1, 1)	-0.001241	0.244553***				
ETI	AR(2)	ARCH(1)	2.03×10^{-8}	-0.2477***	0.0280***		-	12.07***
		ARCH(2)	1.66×10^{-8}	0.0096	0.1349***		24.45***	
		GARCH(1, 1)	6.65×10^{-9}	0.0543**	0.0471			
		E- GARCH(1, 1)	-1.97×10^{-7}	0.0095	0.0401			
		TARCH(1, 1)	-4.03×10^{-8}	0.0678	0.0518			
FCMB	AR(2)	ARCH(1)	-9.15×10^{-8}***	0.2218***	0.0226***		-	15.49***
		ARCH(2)		0.1262***	0.1002***		36.38***	
		GARCH(1, 1)	7.60×10^{-8}	0.1191***	0.0524*			
		E- GARCH(1, 1)	-1.82×10^{-7}	0.1069***	0.0569***			
		TARCH(1, 1)	1.91×10^{-7}	0.1316***	0.0414			
			-0.000263					
Fidelity	AR(1)	ARCH(1)	5.51×10^{-9}	0.2652***			-	66.31***
		ARCH(2)	-1.00×10^{-7}***	0.1694***			32.77***	
		GARCH(1, 1)		0.1641***				
		E- GARCH(1, 1)	-6.40×10^{-8}	0.2465***				
		TARCH(1, 1)	3.34×10^{-5}	0.2532***				
			-2.92×10^{-5}**					
IBTC	AR(1)	ARCH(1)	-7.20×10^{-8}	0.2661***	0.0333***		-	11.08***
		ARCH(2)	-1.54×10^{-7}***	0.1665***	0.0683***		23.58***	
		GARCH(1, 1)		0.1392***	0.0843*			
		E- GARCH(1, 1)	-3.45×10^{-8}	0.1168***	0.0859***			
		TARCH(1, 1)	3.30×10^{-7}	0.1565***	0.0796**			
			0.000183					
Sterling	AR(1)	ARCH(1)	-0.000815	0.1843***			-	44.24***
		ARCH(2)	-1.67×10^{-8}	0.2512***			28.70***	
		GARCH(1, 1)	1.63×10^{-9}	0.2007***				
		E- GARCH(1, 1)	4.35×10^{-7}	0.2120***				
		TARCH(1, 1)	-0.000214	0.1826***				

p<0.05 significant at 5%, **p<0.01, significant at 1%,,p<0.001, significant at 0.1%, ADF = Augmented Dickey Fuller test.**

Table 2 continuation

			Parameters Estimates					
Banks	Model	Type	ϕ_0	ϕ_1	ϕ_2	ϕ_3	**ADF test**	**ARCH LM Test**
UBN	AR(1) ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)		-2.76x10^{-8} -8.18x10^{-8} 0.001812 -4.45x10^{-7} -0.000690	0.2290*** 0.2007*** 0.1791*** 0.3075*** 0.2218***			-30.06***	38.30***
UBA	AR(1) ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)		-0.000251 9.97x10^{-8}*** -9.77x10^{-9} -2.75x10^{-5} 1.70x10^{-9}	0.170387*** 0.294632*** 0.226518*** 0.237321*** 0.226009***			-31.95***	49.23***
Unity	AR(2) ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)		-0.000552 3.70x10^{-87} 1.32x10^{-7}* -0.000229 5.34x10^{-7}*	0.129655*** 0.089430*** 0.128985*** 0.185777*** 0.112616***	-0.014074 0.14660*** 0.019692 -0.010560 0.011259		-3127***	214.79**
WEMA	AR(1) ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)		-0.000571 2.13x10^{-8} 1.13x10^{-7} -6.21x10^{-5} -5.36x10^{-7}*	0.114309*** 0.204762*** 0.122004*** 0.179867*** 0.098245***			-32.56***	42.30***
Zenith	AR(1) ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)		-0.000550 5.83x10^{-8}*** -8.52x10^{-8} -3.46x10^{-5} -7.17x10^{-9}	0.112890*** 0.200479*** 0.122844*** 0.178778*** 0.136955***			-32.71***	52.33***
First Bank	AR(1) ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)		-0.000861** -4.73x10^{-8}*** -1.41x10^{-8} -1.13x10^{-7} -0.000346	0.202053*** 0.220616*** 0.246072*** 0.245015*** 0.235068***	-0.055330* 0.033940*** -0.029463 -0.040027 -0.064020	-0.06415*** -0.07097*** -0.0837*** 0.0823* -0.1072*	-26.08***	21.69***
Guaranty	AR(2) ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)		-0.000270 -7.59x10^{-5} 0.000315 7.95x10^{-7} -7.39x10^{-6}	0.138670*** 0.147178*** 0.150847*** 0.163293*** 0.143216***			-34.23***	41.83***
Sky	AR(1) ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)		-7.01x10^{-8}*** -1.51x10^{-7}*** 1.09x10^{-7} -4.12x10^{-7}*** -0.000274	0.276722*** 0.222888*** 0.184535*** 0.283960*** 0.195823***	0.0004331*** 0.057894*** 0.051307** 0.100936*** 0.050106		-30.07***	11.41***

p<0.05 significant at 5%, **p<0.01, significant at 1%,,p<0.001, significant at 0.1%, ADF = Augmented Dickey Fuller test.**

Furthermore, in order to fit suitable mean equation to the returns series and to determine its order, the plot of autocorrelation (ACF) and partial autocorrelation (PACF) were obtained and the figure obtained revealed that the spikes of the ACF plot decay exponentially towards zero and the spikes of the PACF cut off after lag1 for most of the banks. Therefore , AR(1) was fitted for the return series of Access, Diamond, Fidelity, Sterling, Union Bank, United Bank for Africa, Unity Bank , Wema , Zenith and Skye Bank while AR(2) model was fitted for Eco International Corporation(ETI), First City Monument Bank, IBTC and Guaranty Trust Bank and AR(3) was fitted for first bank respectively.. The parameters of each of the AR models were significant for most of the banks (Table 2). Before entertaining these models fitted to the return series model diagnostic checking using the plot of the ACF and PACF of the residual was also conducted and the results suggested that these models were appropriate. After obtaining the mean equation for different bank stocks, the residuals obtained from the mean equation for each bank were used to test for heteroscedasticity or ARCH effect using the Lagrange Multiplier test. The p values of F were less than 5 % ($p<0.05$) suggesting the presence of heteroscedasticity (Table 2). Moreover, haven established that there is a presence of heteroscedasticity in the residual based on the mean equation; the parameters of the five different heteroscedastic models were estimated. For Access Bank, all heteroscedastic models fitted had all their parameters significant ($p<0.05$). Similar results were obtained for Fidelity Bank, IBTC Bank, Zenith and Skye Bank ($p<0.05$). In addition, for Diamond Bank, FCMB, ETI Sterling Bank, UBN, UBA, Unity Bank, First Bank and GTB all parameters estimated were significant except the leverage effect of the TARCH (1, 1) model ($p>0.05$) . For Wema Bank, the ARCH(2) term, the GARCH(1,1) for EGARCH(1,1) as well as the leverage term of both EGARCH(1,1) and TARCH(1,1) were all insignificant($p>0.05$). Also, for GTB, the GARCH term for both GARCH (1, 1) and EGARCH (1, 1) were also not statistically significant (Table 3**)**

Table 3: Parameter Estimates of the heteroscedastic models, model selection and model diagnostic checking

		Parameters Estimates					Model selection		Diagnostic check
Banks	Models	ω	α_1	α_2	β	γ	AIC	RMSE	P value for ARCH LM test
Access	ARCH(1)	$6.45x10^{-14}$	12.3565***						
	ARCH(2)	$6.57x10^{-14}$	1.5493***	1.454			-7.9975	0.0260	0.9999
	GARCH(1, 1)	$6.66x10^{-14}$	0.2207***	4***			**-8.5314**	0.025995	0.9999
	E- GARCH(1, 1)	-0.2872***	0.2808***		0.8164***		-7.3434	0.026008	0.9999
	TARCH(1, 1)	$-1.97x10^{-12}$	0.1001***		-	0.9854***	-6.66706	**0.025989**	0.9999
					0.1599***	-0.0046	-6.369698	0.026166	0.9999
					0.9099***				
Diamond	ARCH(1)	$8.02x10^{-14}$*	60.8489						
	ARCH(2)	$4.49x10^{-14}$	1.9994***	1.867	0.7191***	0.8516***	-7.599905	0.027918	0.9996
	GARCH(1, 1)	$1.78x10^{-14}$	0.3463***	1***	0.1113***	0.0343	**-7.655313**	0.027833	0.9999
	E- GARCH(1, 1)	-1.6337***	0.8145***		0.7580***		-6.107774	0.027804	0.9999
	TARCH(1, 1)	$2.52x10^{-5}$***	0.2136***				-4.871634	**0.027795**	0.9999
							-4.556943	0.027876	0.9981
ETI	ARCH(1)	$5.62x10^{-9}$	118.4848						
	ARCH(2)	$7.13x10^{-14}$	6.126739*	4.138			-5.713427	0.028557	0.0827
	GARCH(1, 1)	$1.66x10^{-14}$	0.2781***	561*	0.7716***		**-7.357955**	0.026955	0.9999
	E- GARCH(1, 1)	-1.5713***	0.9429***		-0.0527*	0.8729***	-5.643032	0.026902	0.9999
	TARCH(1, 1)	$1.99x10^{-14}$	0.2990		0.7343	0.0619	-5.075035	0.027002	0.9999
							-4.7476	**0.026880**	0.9999
FCMB	ARCH(1)	$1.24x10^{-14}$	11.0464***						
	ARCH(2)	$5.63x10^{-14}$	1.197026**	1.299			-8.446381	0.025514	0.9999
	GARCH(1, 1)	$4.26x10^{-14}$	*	5***	0.7928***		**-8.798390**	0.025472	0.9999
	E- GARCH(1, 1)	-0.5143***	0.2522***		0.4077**	0.9590***	-7.324204	0.025459	0.9999
	TARCH(1, 1)	$1.48x10^{-6}$***	1.2040**		0.8696***	0.0265	-6.052247	0.025470	0.9999
			0.1330***				-5.124419	**0.025453**	0.9667
Fidelity	ARCH(1)	$7.25x10^{-14}$	7.6232***						
	ARCH(2)	$3.39x10^{-14}$	2.8419*	2.664			-8.696639	0.026787	0.9650
	GARCH(1, 1)	$1.62x10^{-14}$	0.2599***	0*	0.7669***		**-9.22782**6	0.026841	0.9999
	E- GARCH(1, 1)	-0.8724***	1.3789		1.1087*	0.9364***	-6.862486	0.026851	.0.9999
	TARCH(1, 1)	$7.22x10^{-14}$	0.2168***		0.7799***	0.0646**	-5.716273	**0.026770**	0.9999
							-6.499939	0.026779	0.9999
IBTC	ARCH(1)	$4.85x10^{-14}$	8.0077***						
	ARCH(2)	$2.60x10^{-14}$	1.4865***	1.268			-8.621960	0.025359	0.999
	GARCH(1, 1)	$1.19x10^{-14}$*	0.2143***	9***	0.8124***		**-8.740713**	0.025278	0.999
	E- GARCH(1, 1)	-1.8191***	0.5429***		0.0051	0.8107***	-6.615409	0.025296	0.999
	TARCH(1, 1)	$2.42x10^{-6}$***	0.1247***		0.8923***	-0.0199	-4.990712	**0.025334**	0.9346
							-5.014630	0.025276	0.8267
Sterling	ARCH(1)	0.0006***	0.44552***						
	ARCH(2)	$9.68x10^{-14}$	1.2118***	1.210			-4.160082	0.031113	0.9999
	GARCH(1, 1)	$2.52x10^{-14}$	0.3337***	5***	0.7395***		**-7.344095**	0.031056	0.9954
	E- GARCH(1, 1)	-0.9984***	0.4792***		-0.0397	0.9128***	-5.969802	0.031081	0.9999
	TARCH(1, 1)	$7.76x10^{-6}$***	0.1907***		0.8015***	0.0394	-4.648352	**0.031069**	0.9952
							-4.427379	0.031111	0.9622

p<0.05 significant at 5%, **p<0.01, significant at 1%,,p<0.001, significant at 0.1%, AIC= Akaike Information Criteria, RMSE = Root Mean Square Error. Bolded values are the least AIC and RMSE respectively.**

Table 3 continuation

		Parameters Estimates					Model selection		Diagnostic Check
Banks	Model	ω	α_1	α_2	β	γ	**AIC**	**RMSE**	**ARCH Test**
UBN	ARCH(1)	9.10x10^{-14}	9.6779***				-7.945856	0.028788	0.9759
	ARCH(2)	7.04x10^{-14}	1.5717***	1.4826***			-7.983555	0.028884	0.9903
	GARCH(1, 1)	3.66x10^{-14}	0.6665***		0.533250		-6.009332	0.028869	0.9999
	E- GARCH(1, 1)	-1.2710***	0.754075***		0.085450*	0.8938***	-4.996161	**0.028654**	0.9999
	TARCH(1, 1)	1.15x10^{-5}***	0.2378***		0.774540***	0.0051	-4.633952	0.028794	0.8589
UBA	ARCH(1)	0.000391***	1.5106*				-4.544428	0.026392	0.9999
	ARCH(2)	3.27x10^{-14}	3.7885	3.7902**	0.761366***		-6.655636	0.026234	0.9999
	GARCH(1, 1)	1.61x10^{-14}	0.2950***		0.056521	0.9219***	-5.308713	0.026266	0.9999
	E- GARCH(1, 1)	-	0.5499***		0.773628***	-0.0055	-4.871902	**0.026252**	0.9999
	TARCH(1, 1)	0.958167***	0.2705***				-5.228174	0.026266	0.9999
		3.65x10^{-14}							
Unity	ARCH(1)	0.190042	2663.760				-5.031529	0.022688	0.9982
	ARCH(2)	4.59x10^{-14}	4.3031*	3.8943*			-6.793193	0.022895	0.9999
	GARCH(1, 1)	7.67x10^{-15}	-0.3978***		0.752314***		-5.878496	0.022684	0.9999
	E- GARCH(1, 1)	-	0.8249***		0.044583	0.2455***	-4.945958	**0.022516**	0.9999
	TARCH(1, 1)	6.504369***	0.3833***		0.751114***	0.2682	-5.864261	0.022711	0.9999
		8.72x10^{-14}							
WEMA	ARCH(1)	0.191319	2262.165				-5.028467	0.022653	0.9957
	ARCH(2)	4.68x10^{-14}	7.9084	6.5867			-6.713150	**0.022420**	0.9999
	GARCH(1, 1)	9.31x10^{-15}	0.4323***		0.745258***		-5.855857	0.022613	0.9999
	E- GARCH(1, 1)	-	0.6883***		0.043536	0.107369	-4.89917	0.022461	0.0537
	TARCH(1, 1)	7.436365***	0.3411***		0.746211***	0.232915	-5.826707	0.022698	0.9999
		1.07x10^{-13}							
ZENITH	ARCH(1)	0.155363	841.926				-5.041059	0.022577	0.5683
	ARCH(2)	1.71x10^{-14}	8.5535**	7.0534**			-6.642927	0.022347	0.9999
	GARCH(1, 1)	9.12x10^{-15}	0.4168***		0.770149***		-5.796728	0.022530	0.9999
	E- GARCH(1, 1)	7.443660***	0.6901**		0.042687	0.107707	-4.908566	**0.022384**	0.0539
	TARCH(1, 1)	-1.76x10^{-13}	0.1754***		0.830136***	0.0017911	-5.564824	0.022486	0.9813
First Bank	ARCH(1)	0.00039***	2.0666**				-4.712494	0.024736	0.5160
	ARCH(2)	2.83x10^{-14}	13.1819	9.1219			-6.275578	0.024737	0.9599
	GARCH(1, 1)	3.18x10^{-16}	0.4772***		-0.7567***		-5.445960	0.024620	0.9999
	E- GARCH(1, 1)	-	0.7273***		-0.0089	0.8657***	-4.933577	**0.024617**	0.9999
	TARCH(1, 1)	1.478662***	0.1310***		0.8187***	0.0424	-4.685766	0.024618	0.7779
		2.51x10^{-5}***							
Sky Bank	ARCH(1)	1.89x10^{-14}	24.4987				-7.724666	**0.027710**	0.9999
	ARCH(2)	2.05x10^{-14}	2.5195***	2.2208***			-7.829220	0.027667	0.9999
	GARCH(1, 1)	6.99x10^{-14}	0.2191***		0.79291***		-7.065225	0.028900	0.9999
	E- GARCH(1, 1)	-	0.1868***		0.180692***	0.9921***	-6.621633	0.027718	0.9999
	TARCH(1, 1)	0.171076***	0.0327***		0.953830***	0.0299***	-4.803140	0.027698	0.6406
		7.30x10^{-7}***							
GTB	ARCH(1)	0.00038***	0.6588***				-4.660222	0.024894	0.6789
	ARCH(2)	0.000324***	0.5634***	0.1530*			-4.667818	0.024873	0..8453
	GARCH(1, 1)	0.000172***	0.2345***		0.4873		-4.639295	0.024859	0.6589
	E- GARCH(1, 1)	-2.5517***	0.6384***		0.0139	0.7159***	-4.669592	**0.024847**	0.9887
	TARCH(1, 1)	0.00019***	0.5192***		0.3321***	-0.0320	-4.669353	0.024878	0.9666

p<0.05 significant at 5%, **p<0.01, significant at 1%,,p<0.001, significant at 0.1%, AIC= Akaike Information Criteria, RMSE = Root Mean Square Error. Bolded values are the least AIC and RMSE respectively.**

Also, the goodness of fit of these heteroscedastic models was examined using Akaike Info Criteria (AIC). Model with the least AIC was considered to be most suitable. Therefore, ARCH (2) proved to be the best in terms of fitness. (Table 3). Model diagnostic check was also performed to examine whether the ARCH effect are still present. The results obtained revealed that the ARCH effect initially present has been successfully removed by all the fitted heteroscedastic models..

Table 3: Parameter Estimates of the heteroscedastic models, model selection and model diagnostic checking

		Parameters Estimates					**Model selection**		**Diagnostic check**
Banks	Models	ω	α_1	α_2	β	γ	AIC	RMSE	P value for ARCH LM test
Access	ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1,) TARCH(1, 1)	$6.45x10^{-14}$ $6.57x10^{-14}$ $6.66x10^{-14}$ - 0.2872*** $-1.97x10^{-12}$	12.3565*** 1.5493*** 0.2207*** 0.2808*** 0.1001***	1.4544***	0.8164*** - 0.1599*** 0.9099***	0.9854*** -0.0046	-7.9975 **-8.5314** -7.3434 -6.66706 - 6.369698	0.0260 0.025995 0.026008 **0.025989** 0.026166	0.9999 0.9999 0.9999 0.9999 0.9999
Diamond	ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)	$8.02x10^{-14}$* $4.49x10^{-14}$ $1.78x10^{-14}$ - 1.6337*** $2.52x10^{-5}$***	60.8489 1.9994*** 0.3463*** 0.8145*** 0.2136***	1.8671***	0.7191*** 0.1113*** 0.7580***	0.8516*** 0.0343	- 7.599905 - **7.655313** - 6.107774 - 4.871634 - 4.556943	0.027918 0.027833 0.027804 **0.027795** 0.027876	0.9996 0.9999 0.9999 0.9999 0.9981
ETI	ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)	$5.62x10^{-9}$ $7.13x10^{-14}$ $1.66x10^{-14}$ - 1.5713*** $1.99x10^{-14}$	118.4848 6.126739* 0.2781*** 0.9429*** 0.2990	4.138561*	0.7716*** -0.0527* 0.7343	0.8729*** 0.0619	- 5.713427 - **7.357955** - 5.643032 - 5.075035 -4.7476	0.028557 0.026955 0.026902 0.027002 **0.026880**	0.0827 0.9999 0.9999 0.9999 0.9999
FCMB	ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)	$1.24x10^{-14}$ $5.63x10^{-14}$ $4.26x10^{-14}$ - 0.5143*** $1.48x10^{-6}$***	11.0464*** 1.197026*** 0.2522*** 1.2040** 0.1330***	1.2995***	0.7928*** 0.4077** 0.8696***	0.9590*** 0.0265	- 8.446381 - **8.798390** - 7.324204 - 6.052247 - 5.124419	0.025514 0.025472 0.025459 0.025470 **0.025453**	0.9999 0.9999 0.9999 0.9999 0.9667

Fidelity	ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)	$7.25x10^{-14}$ $3.39x10^{-14}$ $1.62x10^{-14}$ - 0.8724*** $7.22x10^{-14}$	7.6232*** 2.8419* 0.2599*** 1.3789 0.2168***	2.6640*	0.7669*** 1.1087* 0.7799***	0.9364*** 0.0646**	- 8.696639 - **9.22782**6 - 6.862486 - 5.716273 - 6.499939	0.026787 0.026841 0.026851 **0.026770** 0.026779	0.9650 0.9999 .0.9999 0.9999 0.9999
IBTC	ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)	$4.85x10^{-14}$ $2.60x10^{-14}$ $1.19x10^{-14}$* - 1.8191*** $2.42x10^{-6}$***	8.0077*** 1.4865*** 0.2143*** 0.5429*** 0.1247***	1.2689*** 	0.8124*** 0.0051 0.8923***	0.8107*** -0.0199	- 8.621960 - **8.740713** - 6.615409 - 4.990712 - 5.014630	0.025359 0.025278 0.025296 **0.025334** 0.025276	0.999 0.999 0.999 0.9346 0.8267
Sterling	ARCH(1) ARCH(2) GARCH(1, 1) E- GARCH(1, 1) TARCH(1, 1)	0.0006*** $9.68x10^{-14}$ $2.52x10^{-14}$ - 0.9984*** $7.76x10^{-6}$***	0.44552*** 1.2118*** 0.3337*** 0.4792*** 0.1907***	1.2105*** 	0.7395*** -0.0397 0.8015***	0.9128*** 0.0394	- 4.160082 - **7.344095** - 5.969802 - 4.648352 - 4.427379	0.031113 0.031056 0.031081 **0.031069** 0.031111	0.9999 0.9954 0.9999 0.9952 0.9622

p<0.05 significant at 5%, **p<0.01, significant at 1%,,p<0.001, significant at 0.1%, AIC= Akaike Information Criteria, RMSE = Root Mean Square Error. Bolded values are the least AIC and RMSE respectively.**

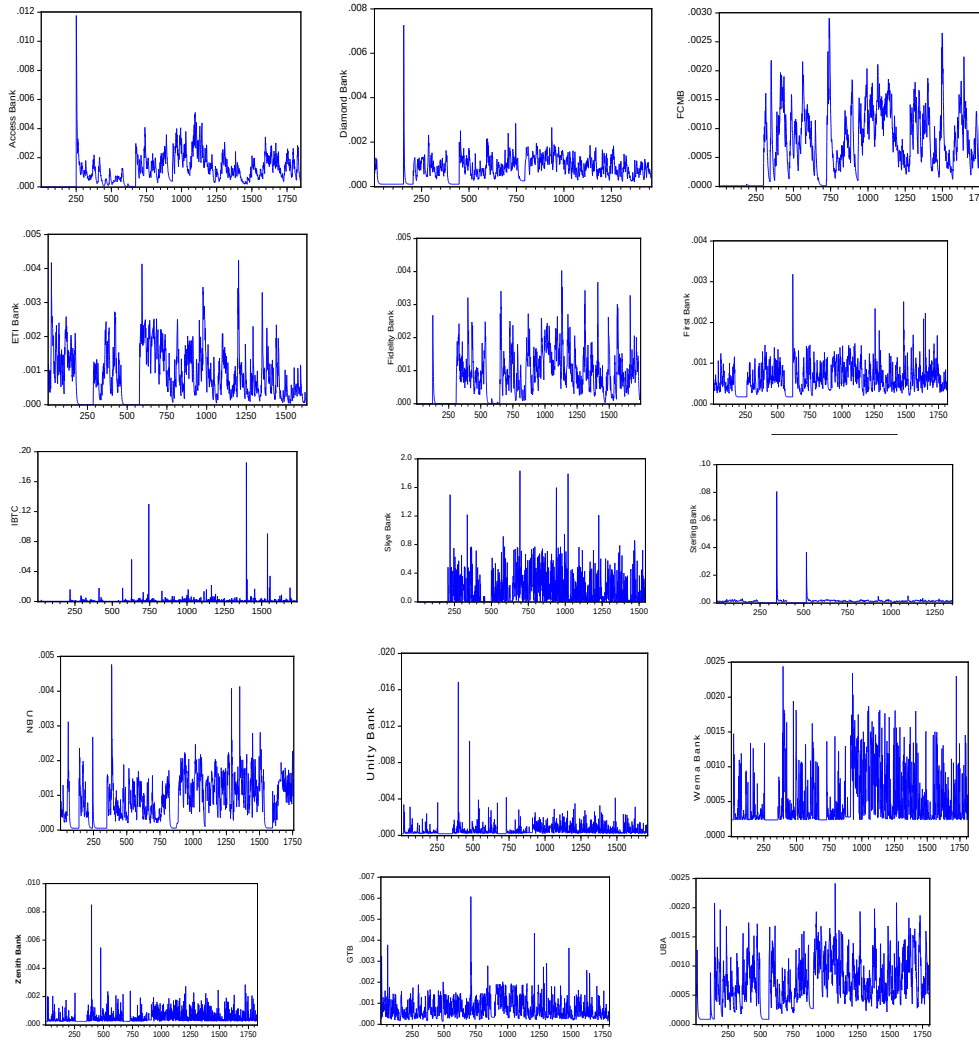
Table 3 continuation

		Parameters Estimates					Model selection		Diagnostic Check
Banks	Model	ω	α_1	α_2	β	γ	**AIC**	**RMSE**	**ARCH Test**
UBN	ARCH(1)	9.10x10^{-14}	9.6779***				-7.945856	0.028788	0.9759
	ARCH(2)	7.04x10^{-14}	1.5717***	1.4826***			-7.983555	0.028884	0.9903
	GARCH(1, 1)	3.66x10^{-14}	0.6665***		0.533250		-6.009332	0.028869	0.9999
	E- GARCH(1, 1)	-1.2710***	0.754075***		0.085450*	0.8938***	-4.996161	**0.028654**	0.9999
	TARCH(1, 1)	1.15x10^{-5}***	0.2378***		0.774540***	0.0051	-4.633952	0.028794	0.8589
UBA	ARCH(1)	0.000391***	1.5106*				-4.544428	0.026392	0.9999
	ARCH(2)	3.27x10^{-14}	3.7885	3.7902**	0.761366***		-6.655636	0.026234	0.9999
	GARCH(1, 1)	1.61x10^{-14}	0.2950***		0.056521	0.9219***	-5.308713	0.026266	0.9999
	E- GARCH(1, 1)TARCH(1, 1)	-0.958167***	0.5499***		0.773628***	-0.0055	-4.871902	**0.026252**	0.9999
		3.65x10^{-14}	0.2705***				-5.228174	0.026266	0.9999
Unity	ARCH(1)	0.190042	2663.760				-5.031529	0.022688	0.9982
	ARCH(2)	4.59x10^{-14}	4.3031*	3.8943*			-6.793193	0.022895	0.9999
	GARCH(1, 1)	7.67x10^{-15}	-0.3978***		0.752314***		-5.878496	0.022684	0.9999
	E- GARCH(1, 1)	-6.504369***	0.8249***		0.044583	0.2455***	-4.945958	**0.022516**	0.9999
	TARCH(1, 1)	8.72x10^{-14}	0.3833***		0.751114***	0.2682	-5.864261	0.022711	0.9999
WEMA	ARCH(1)	0.191319	2262.165				-5.028467	0.022653	0.9957
	ARCH(2)	4.68x10^{-14}	7.9084	6.5867			-6.713150	**0.022420**	0.9999
	GARCH(1, 1)	9.31x10^{-15}	0.4323***		0.745258***		-5.855857	0.022613	0.9999
	E- GARCH(1, 1)TARCH(1, 1)	-7.436365***	0.6883***		0.043536	0.107369	-4.89917	0.022461	0.0537
		1.07x10^{-13}	0.3411***		0.746211***	0.232915	-5.826707	0.022698	0.9999
ZENITH	ARCH(1)	0.155363	841.926				-5.041059	0.022577	0.5683
	ARCH(2)	1.71x10^{-14}	8.5535**	7.0534**			-6.642927	0.022347	0.9999
	GARCH(1, 1)	9.12x10^{-15}	0.4168***		0.770149***		-5.796728	0.022530	0.9999
	E- GARCH(1, 1)TARCH(1, 1)	7.443660***	0.6901**		0.042687	0.107707	-4.908566	**0.022384**	0.0539
		-1.76x10^{-13}	0.1754***		0.830136***	0.0017911	-5.564824	0.022486	0.9813
First Bank	ARCH(1)	0.00039***	2.0666**				-4.712494	0.024736	0.5160
	ARCH(2)	2.83x10^{-14}	13.1819	9.1219			-6.275578	0.024737	0.9599
	GARCH(1, 1)	3.18x10^{-16}	0.4772***		-0.7567***		-5.445960	0.024620	0.9999
	E- GARCH(1, 1)TARCH(1, 1)	-1.478662***	0.7273***		-0.0089	0.8657***	-4.933577	**0.024617**	0.9999
		2.51x10^{-5}***	0.1310***		0.8187***	0.0424	-4.685766	0.024618	0.7779
Sky Bank	ARCH(1)	1.89x10^{-14}	24.4987				-7.724666	**0.027710**	0.9999
	ARCH(2)	2.05x10^{-14}	2.5195***	2.2208***			-7.829220	0.027667	0.9999
	GARCH(1, 1)	6.99x10^{-14}	0.2191***		0.79291***		-7.065225	0.028900	0.9999
	E- GARCH(1, 1)TARCH(1, 1)	-0.171076***	0.1868***		0.180692***	0.9921***	-6.621633	0.027718	0.9999
		7.30x10^{-7}***	0.0327***		0.953830***	0.0299***	-4.803140	0.027698	0.6406
GTB	ARCH(1)	0.00038***	0.6588***				-4.660222	0.024894	0.6789
	ARCH(2)	0.000324***	0.5634***	0.1530*			-4.667818	0.024873	0..8453
	GARCH(1, 1)	0.000172***	0.2345***		0.4873		-4.639295	0.024859	0.6589
	E- GARCH(1, 1)TARCH(1, 1)	-2.5517***	0.6384***		0.0139	0.7159***	-4.669592	**0.024847**	0.9887
		0.00019***	0.5192***		0.3321***	-0.0320	-4.669353	0.024878	0.9666

p<0.05 significant at 5%, **p<0.01, significant at 1%,,p<0.001, significant at 0.1%, AIC= Akaike Information Criteria, RMSE = Root Mean Square Error. Bolded values are the least AIC and RMSE respectively.**

Forecasting performance of these estimated models were investigated using sample data and statistics like Root Mean Square Error was computed. Model with the least Root Mean Square Error was considered to the most suitable in terms of forecasting performance. This is because, the good performance in parameters estimates models and goodness of fit statistics like Aikaike Information criteria (AIC), Swartz Criterion (SC) and other

criteria do not guarantee accurate of forecast of any volatility model but rather forecast evaluation statistics like Root Mean Square Error (RMSE), Mean Absolute Error should be used(Lopez, 2001). Hence, EGARCH (1, 1) was recommended to be most suitable for forecasting daily returns volatility of Nigerian bank stocks. The EGARCH (1, 1) proved to most suitable for all the Nigerian bank stocks with the exception of stocks like ETI, FCMB where the TARCH (1, 1) proved to be most suitable and also ARCH (1) for Skye Bank and ARCH(2) for Wema Bank.



Graph of variance forecast for the fifteen Nigerian bank Stocks

(a) Access Bank

$$\ln(\sigma_t^2) = -3.375377 - 0.341686 \ln \sigma_{t-1}^2 + \left[\frac{1.063123\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.39990 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(b) Diamond Bank

$$\sigma_t^2 = 0.016785 + 2.379012\varepsilon_{t-1}^2 - 0.14659\sigma_{t-1}^2 - 0.020809\lambda_{t-1}\varepsilon_{t-1}^2$$

$$\begin{cases} \lambda_{t-1} = 1, \varepsilon_{t-1} < 0 \\ 0, \varepsilon_{t-1} > 0 \end{cases}$$

(c) ETI

$$\sigma_t^2 = 0.033568 + 0.433438\varepsilon_{t-1}^2 - 0.244684\sigma_{t-1}^2 + 0.546941\lambda_{t-1}\varepsilon_{t-1}^2$$

$$\begin{cases} \lambda_{t-1} = 1, \varepsilon_{t-1} < 0 \\ 0, \varepsilon_{t-1} > 0 \end{cases}$$

(d) FCMB

$$\ln(\sigma_t^2) = -2.553177 - 1.815022 \ln \sigma_{t-1}^2 + \left[\frac{1.921425\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.440235 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(e) Fidelity Bank

$$\ln(\sigma_t^2) = -6.435254 + 0.02368 \ln \sigma_{t-1}^2 + \left[\frac{0.03179\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} - 0.973625 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(f) IBTC Bank

$$\ln(\sigma_t^2) = -2.449423 + 0.978833 \ln \sigma_{t-1}^2 + \left[\frac{1.757316\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.659483 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(g) Sterling Bank

$$\ln(\sigma_t^2) = -1.832742 - 0.199533 \ln \sigma_{t-1}^2 + \left[\frac{0.765354\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.549095 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(h) UBN

$$\ln(\sigma_t^2) = -0.553539 + 0.175128 \ln \sigma_{t-1}^2 + \left[\frac{0.384261\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.904825 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(i) UBA

$$\ln(\sigma_t^2) = -6.270017 + 0.584968 \ln \sigma_{t-1}^2 + \left[\frac{0.380512\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} - 0.629421 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(j) Unity Bank

$$\ln(\sigma_t^2) = 0.001701 + 20.62683 \ln \sigma_{t-1}^2 + \left[\frac{4.934241\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.020324 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(k) Wema Bank

$$\sigma_t^2 = 0.0388109 + 0.177384\varepsilon_{t-1}^2 + 0.026791\varepsilon_{t-1}^2$$

(l) Zenith Bank

$$\ln(\sigma_t^2) = -3.0667 - 0.979099 \ln \sigma_{t-1}^2 + \left[\frac{2.8446\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.6696 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(m) First Bank

$$\ln(\sigma_t^2) = 0.013678 - 0.108813 \ln \sigma_{t-1}^2 + \left[\frac{-0.108813\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.108813 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(n) GTB

$$\ln(\sigma_t^2) = -3.302227 - 0.375943 \ln \sigma_{t-1}^2 + \left[\frac{0.855385\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + 0.113645 \left(\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right) \right]$$

(o) Skye Bank

$$\sigma_t^2 = 0.002207 + 53.93662\varepsilon_{t-1}^2$$

Discussion of findings

The presence of leverage effect observed in the daily returns pattern of most of the Nigerian bank stocks is an indication that the distribution of the daily return pattern of Nigerian bank stocks is asymmetric. These results emphasized the impact of the good and bad news on the returns of Nigerian bank stocks (Table 2). This finding is supported by other similar studies in Nigeria (Dallah and Ade, 2012, Olowe, 2009a). This result is also consistent with studies in other emerging capital markets in other countries of the world (Suliman, 2012, Ztatko, 2008, Moustafa, 2011). Furthermore, the result of model forecasting ability which favoured EGARCH (1,1) for most of the banks as the best of the five competing models(Table 3) is in agreement with study by Dallah and Ade(2008) whose study observed that EGARCH(1,1) performed better than ARCH(1), ARCH(2), GARCH(1,1) and TARCH(1,1) in modelling daily returns volatility of Nigerian Insurance stocks. Similar results have been obtained in other countries of emerging capital market like Egypt (Moustafa, 2011). The result of this study was not in agreement with that by Hien (2008).Study by Hien (2008) favoured GARCH (1, 1) as the best models for modelling volatility of Vietnam stocks. This variation could have been as a result of the time her study was conducted because as at 2008

the effect of the global recession has not been felt. Also, Nigerian bank stocks might not exhibit the same volatility as Vietnam stocks.

Conclusion

This study examined the volatility behaviour of the Nigerian bank stocks. Forecast performance of several variants of conditional heteroscedastic volatility models were evaluated using model evaluation performance measures like the Root Mean Square Error, Mean Absolute Error and Mean Absolute Percentage Error. The results of post estimation evaluation carried out revealed that the asymmetric conditional heteroscedastic models are more suitable for modelling daily returns volatility of Nigerian bank stocks as compared with symmetric conditional heteroscedastic models.

Recommendation

The results of this study had proven to be consistent with other similar studies conducted in other emerging capital markets, but these results should be treated with caution as this study covers the most widely used volatility models. Therefore, further study on other volatility models like a stochastic volatility models and multivariate volatility models with a more updated data is recommended. This will better inform investors and investment analyst in Nigerian as volatility is the major index used to evaluate asset performance and in stock pricing strategy.

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