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Performance of Symmetric and Asymmetric GARCH models in Nigeria's crude oil markets

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Abstract
The study investigated the performance of symmetric and asymmetric GARCH models in Nigerian crude oil markets between 1999 and 2023. The models adopted for the study were the symmetric and asymmetric GARCH Models. The data for the study was the crude oil price in Naira/Dollar from January 1999 to April 2023 sourced for and extracted from the Central Bank of Nigeria (CBN) Statistical Database. The results of the estimation of the models show that an expected non-stationary process exists in price from the time plot of the raw series and returns on Nigerian crude oil price. The series shows continuous trending across the time of the observations (data series) on the vertical axis while the time is on the horizontal axis. The results show that returns on Nigerian crude oil prices using the symmetric and asymmetric GARCH Models confirmed TGARCH as appropriate under the student-t with fixed parameter degree of freedom (df=10) as the model of best fit These were considered based on model performance evaluation using the Akaike information criteria. The summary of the diagnostic test confirmed TGARCH as adequate in modelling Nigeria's crude oil price. This indicates that the shocks associated with Nigerian crude oil prices persist over a long time. In addition, the long memory hypothesis model using the Nigerian crude oil price is stronger and so, this shows evolving situations that portray that those markets are not stable. The study recommended amongst others that the TGARCH model can capture a large impact on volatility, forcing investors and traders to incorporate risk into their market strategies.

Keywords: Symmetric, Asymmetric, GARCH model, Crude oil.

Introduction

Symmetric and asymmetric GARCH models are used to analyze and forecast crude oil price fluctuations. The symmetric GARCH model assumes that positive and negative shocks have the same effect on volatility. This means that a rise in crude oil price will have the same effect on volatility as a fall in price. On the other hand, the asymmetric GARCH model takes into account the fact that positive and negative shocks can have different effects on volatility. For example, it recognizes that an increase in crude oil price may have a greater impact on volatility than a price decrease. This reflects the fact that market participants may react differently to positive and negative news or events. Both models are important for understanding the dynamics of crude oil price fluctuations and can be used to develop more accurate forecasts. Crude oil is one of the most essential commodities in the world and, despite the crusade for green energy and other energy sources, it remains an exclusive product in the international market. Crude oil applications are widespread in daily life and in addition to being non-renewable, the world consumes crude oil every minute because it is difficult to find an alternative source that can match its performance. Over the past two decades, oil has had its ups and downs. In early 1999, the Asian financial crisis broke out and, combined with Iraq's decision to increase its oil production, led to a decline in oil prices. But the market quickly adapted and reached over $34 by the end of 2000. The dot-com bubble of 2001 triggered a new wave of economic panic, keeping it at a low level until early 2002. The global market economy then regained momentum, leading to a few more crises which increased oil prices (Deebom & Essi, 2017). Hence studying macroeconomic variables such as crude oil prices, exposes the financial and economic health of a nation. This in turn prescribes how trade and other financial activities generally influence the nation. (Victor-Edema & Essi, 2020).

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Crude oil prices like other financial time series, for example, stock prices, exchange rate, gross domestic product, etc., often evince the characteristics of volatility clustering (Stanley & Victor-Edema, 2022). The dramatic fall in oil prices that followed has been difficult to model. Even though the price has generally shown a steady level of recovery after the 2008 financial crisis, finding a model that remains successful remains a major challenge, in the face of such unpredictable circumstances. However, the price of crude oil behaves like any other commodity, with fluctuations in times of shortage and surplus. These price fluctuations have a ripple effect on our daily lives, from diesel and gasoline to detergents, medicines, and household appliances. These price fluctuations have a ripple effect on our daily lives, from diesel and gasoline to detergents, medicines, and household appliances.

The risks in the crude oil market are one of the major challenges facing oil-producing countries around the world. However, it has been observed that the risks present in the commodity market generally come from two main sources: either they are caused by the variation in world prices or by the fluctuations in the exchange rate. In this regard, the global crude oil price shock can be attributed to the supply and demand of crude oil or the price itself. Furthermore, the corresponding shocks would be divided into two types: shocks resulting from the interaction between supply and demand, while external demand shocks result from economic difficulties faced by the countries' main trading partners. To model this behaviour and other volatility conditions, models from the GARCH family are introduced. Nonetheless, problems of shocks and volatility remain. Heteroscedasticity is one of the major issues that require urgent attention when analyzing time series of oil prices due to the uncertainty in their development and behaviour. A sufficient set of conditions given in the variance equation is that the constant common factor of the integer must be non-negative. Again, these conditions are sometimes met by the actual price. When encountering GARCH models whose hazard order is greater than one, they provide a satisfactory relaxation condition where the co-effectiveness must be less than zero provided that the other co-efficiencies are sufficiently large.

The study aims to use symmetric and asymmetric GARCH models to model the crude oil markets in Nigeria between 1999 and 2023. Kehinde et al. (2023) defined price volatility as the rate at which the price of a security increases or decreases within a given range of returns. Fang et al. (2014) pointed out that an increase or decrease in the value of stock market returns tends to have a similar effect on the economy, primarily through the money market. A rise in stock prices can stimulate investment and increase demand for credit, ultimately leading to an increase in interest rates across the economy (Spero & Hart, 1990). It should be noted that higher interest rates can put the economy at risk because the change in inflation has a similar effect on the interest rate (Fischer et al., 1981). Such a situation could pose major challenges to the formulation of monetary policy and thus call into question the principle of price stability, which is one of the fundamental objectives of monetary agencies.

According to Ederington et al. (2021), oil price models can be classified into three main categories: structural models, reduced or hybrid models and econometrics. Structural models are primarily used to capture the interaction between initial conditions or supply and demand conditions and factors affecting supply. It tends to focus on longer time horizons which may include macro-type models used for forecasting purposes. Engel (1982) suggested that the autoregressive conditional heteroscedasticity (ARCH) model is an alternative model to the standard deviation method. The ARCH model is the only time series model that can more efficiently and adequately model the heteroscedasticity of the disturbance term in a linear regression equation that includes crude oil price as the dependent variable. Kehinde et al. (2023) also estimated that the ARCH model is a stochastic process with autoregressive conditional variance. This is a simple model that can capture or describe a stochastic process that can be either non-stationary or asymptotically stationary. If the stochastic process shows cluster fluctuations, ARCH models can be applied. Stanley and Victor-Edema (2022) estimated the performance of some symmetric and asymmetric GARCH models on Nigeria's economy. using monthly valued series of the real gross domestic product at constant factor (RGDP), the study compared four different GARCH models based on error distribution and model selection criteria. The result adjudged the threshold GARCH (TGARCH) as the overall best-fit model for the variable under consideration

Materials and Methods

Autoregressive Conditional Heteroskedasticity (ARCH) Models

Studying residuals to confirm heterogeneity is essential in this study The existence of Covariance Conditional has not been Complete Taking this into account leads to misleading results.

Autoregressive conditional heteroskedasticity (ARCH) is used to test the prevalence of heteroscedasticity in the remainder of the return series using the Lagrange multiplicative (LM) test. Engel (1982) proposed the ARCH (Autoregressive Conditional Heteroskedastic Model) model. Each model in the ARCH or GARCH family requires two distinct specifications: the mean and variance equations. According to Engel, the conditional covariance in the return series can be modelled using the ARCH model expressed as the average equation: y_t

$$y_t = E_{t-1}(y_t) + \varepsilon_t \quad (1)$$

or $\varepsilon_t = \varphi_t \sigma_t$

where

ε_t is the error resulting from the average equation at time t

E_{t-1} is the expectation conditioned on the information available at time t-1

φ_t is a series of independent and identically distributed random variables with a mean of zero and a variance of unity. The variance equation for the ARCH model of order q is given as follows:

where

$$\sigma_t{}^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^{\,2} + \mu_t$$
$$= \alpha_0 + \alpha_1 \varepsilon_{t-1}^{\,2} + +\alpha_2 \varepsilon_{t-2}^{\,2} + \alpha_3 \varepsilon_{t-3}^{\,2} + \cdots + \alpha_p \varepsilon_{t-p}^{\,2} \quad (2)$$

Where $\alpha_0 > 0$, $\alpha_i \geq 0$, $\varepsilon_{t-1}, \varepsilon_{t-2}, \ldots \varepsilon_{t-p}$ is independent for each t $i = 1,2,3, \ldots, q$ and represents the number of shifts.

Heteroskedasticity (GARCH) Model

This model differs from the ARCH model in that it includes squared conditional variance terms as additional explanatory variables. This allows the conditional variance to follow the ARMA process. If we write the rest in the form:

$$\sigma_t{}^2 = \beta_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^{\,2} + \sum_{i=1}^{p} \beta_j \varepsilon_{t-j}^{\,2} \quad (3)$$

where p is the order of the GARCH terms, σ^2q is the order of the ARCH terms, ε^2.

or $\beta_0 > 0, \alpha_i > 0, i = 1,2,3 \ldots q-1, \; j = 1,2,3, \ldots, p-1$

$\sigma_t{}^2$ is the $\varepsilon^2{}_t$ conditional variance and disturbance term.

The reduced form of equation 3 is GARCH(1, 1) represented as follows:

$$\sigma_t^2 = \beta_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 \sigma_{t-1}^2 \quad (4)$$
$$R = \mu + \varepsilon_t \quad (5)$$

or, $\varepsilon_t^2 \sim N(0, \sigma_t^2)$

μ is a way back

σ_t^2 is the error variance at time t.

ε_{t-1}^2 is the squared error at time t-1

The three parameters β_0, β_1 *and* β_2 is non-negative and $\beta_1 + \beta_2 < 1$ is to reach the station limits of the model.

Exponential GARCH (EGARCH) Model

$$log(\sigma_t^2) = \beta_0 + \sum_{i=1}^{q} \left\{ \alpha_1 \left| \frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right| + \gamma \left(\frac{\varepsilon_{t-i}}{\sigma_{t-i}} \right) \right\} + \sum_{j=1}^{p} \beta_j \log\left(\sigma_{t-j}^2\right) \quad (6)$$

$\varepsilon_{t-i} > 0$ It includes news about Good while $\varepsilon_{t-i} < 0$ it includes bad news. The sum of their effects is $(1+\gamma_i)|\varepsilon_{t-i}|$ and $(1-\gamma_i)|\varepsilon_{t-i}|$ respectively. When $\gamma_i < 0$ bad news is expected to have a greater impact on volatility. The EGARCH model achieves covariance stability when $\sum_{j=1}^{p} \beta_j < 1$. The importance of this research lies in testing conditional variance using the previously defined GARCH models and the EGARCH(1,1) model, defined as

$$log(\sigma_t^2) = \beta_0 + \alpha_1 \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \gamma \left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right) + \beta_j \log\left(\sigma_{t-j}^2\right) \quad (7)$$

The total effects of good and bad news for EGARCH(1,1) are $(\gamma_1)|\varepsilon_{t-1}|$ and, respectively $(1-\gamma_i)|\varepsilon_{t-1}|$. Not accepting the null hypothesis $\gamma_1 = 0$ shows the presence of leverage, that is, bad news has a stronger effect than good news on the volatility of stock index returns.

Results

ARCH Effect on the Returns on Crude Oil Price gives the predicted model below

$$\mathrm{RCOP_t} = 0.503 + 0.295\varepsilon_t \quad (1a)$$

Table 1: Results of ARCH Effect on the Returns on Crude Oil Price

	LAG 1				LAG 2			
	F-Stat.	p-value	Obs*R-squared	x^2	F-Stat.	p-value	Obs*R-squared	x^2
R crude$_t$	12.93357	0.0000	55.47419	0.0000	6.440863	0.0000	55.86016	0.0000

Table 2: Results of ASYMMETRIC GARCH model for Returns on Crude Oil Price (RCOP)

MODEL	Parameter	NED COEFF	SED COEFF	GED COEFF	STt -FD (df = 10) COEFF	GED (df =1.5) COEFF
EGARCH	C	0.300(0.596)	0.686(0.181)	0.622(0.252)	0.739(0.142)	0.949(0.063)
	ε_{t-1}	0.241(0.000)	0.222(0.001)	0.229(0.001)	0.217(0.001)	0.204(0.002)
	C	1.471(0.004)	1.211(0.039)	1.426(0.015)	1.179(0.039)	1.407(0.031)
	ε^2_{t-1}	0.357(0.004)	0.379(0.016)	0.368(0.001)	0.387(0.019)	0.391(0.019)
	I^2_{t-1}	-0.288(0.000)	-0.229(0.022)	-0.266(0.001)	-0.222(0.023)	-0.245(0.021)
	σ^2_{t-1}	0.584(0.000)	0.639(0.000)	0.591(0.000)	0.647(0.000)	0.593(0.000)
Volatility	$c(4)\varepsilon^2_{t-1} + c($	0.941	1.018	0.959	1.034	0.984
TGARCH	C	0.618(0.284)	0.956(0.071)	0.913(0.101)	0.999(0.054)	1.193(0.022)
	ε_{t-1}	0.218(0.002)	0.202(0.002)	0.201(0.004)	0.200(0.002)	0.188(0.005)
	C	46.082(0.000)	48.599(0.000)	47.531(0.000)	49.491(0.000)	49.685(0.000)
	ε^2_{t-1}	0.067(0.479)	0.108(0.371)	0.089(0.425)	0.116(0.356)	0.114(0.404)
	I^2_{t-1}	0.666(0.000)	0.625(0.008)	0.636(0.002)	0.626(0.011)	0.609(0.012)
	σ^2_{t-1}	0.021(0.836)	-0.036(0.684)	-0.013(0.889)	-0.044(0.615)	-0.039(0.669)
Volatility	$c(4)\varepsilon^2_{t-1} + c(5)\sigma^2_{t-1}$	0.088	0.072	0.076	0.072	0.075

Volatility on Return using a SYMMETRIC GARCH Model

Table 3: Results of SYMMETRIC GARCH MODEL FOR Returns on Crude Oil Price (RCOP)

MODEL	PARAMETER	NED COEFF	STD COEFF	GED COEFF	STDt (df = 10) ED COEFF	GED (df =1.5) COEFF
GARCH (1,1)	C	1.306(0.017)	1.519(0.002)	1,595(0.001)	1.492(0.003)	1.629(0.001)
	ε_{t-1}	0.167(0.003)	0.153(0.012)	0.154(0.010)	0.154(0.011)	0.152(0.011)
	C	54.676(0.000)	54.446(0.000)	54.855(0.000)	53.632(0.000)	55.110(0.000)
	ε^2_{t-1}	0.483(0.000)	0.467(0.001)	0.476(0.000)	0.461(0.000)	0.478(0.000)
	σ^2_{t-1}	-0.133(0.134)	-0.123(0.273)	-0.134(0.207)	-0.12290.267)	-0.133(0.217)
Volatility	$c(4)\varepsilon^2_{t-1} + c(5)\sigma^2_{t-1}$	0.029	0.03	0.02	0.032	0.019

Table 4: Results of descriptive statistics of the raw and return data on Nigerian Crude Oil Price

	COP	RCOP
Mean	61.987	0.679
Median	60.430	2.039
Maximum	132.830	36.736
Minimum	10.750	-50.491
Std. Dev.	28.855	9.741
Skewness	0.281	-1.099
Kurtosis	2.069	7.333
Jarque-Bera	14.405	286.305
Probability	0.0007	0.000
Sum	18099.83	197.520
Sum Sq. Dev.	242297.6	27515.28
Observations	292	291

Table 5: Unit Test on Raw and Return on Crude Oil Price Bench Marks

Variable	t-Statistic	P-Value	Remarks

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COP	-2.732076	0.0698	1(1)
D(COP)	-11.49192	0.000	
RCOP	-12.523	0.000	1(0)

Comparison of Performance of Symmetric and Asymmetric GARCH Model for Estimating Returns on Nigeria Crude Oil Price

The results of the symmetric and asymmetric GARCH model for estimating returns on Nigeria's Crude Oil Price are shown in the tables below.

Table 6: Comparison of the different Symmetric and Asymmetric GARCH model

Model selection criteria	GARCH(1,1),Normal	Student'-t	**GED**	**SWf(df=10)**	**GEDw (df=1.5)**	**Remarks**
Akaike info criterion	7.118663	7.097758	7.10711	7.091294	7.100464	
Schwarz criterion	7.181937	7.173687	7.183038	7.154568	7.163737	
Hannan-Quinn criteria.	7.144014	7.128179	7.13753	7.116645	7.125814	
	EGARCH(1,1), Normal	Student'-t	**GED**	**SWf(df=10)**	**GEDw (df=1.5)**	
Akaike info criterion	7.100007	7.093425	7.10711	7.086993	7.101832	
Schwarz criterion	7.175936	7.182008	7.183038	7.162921	7.17776	
Hannan-Quinn criteria.	7.130428	7.128916	7.13753	7.117413	7.132252	
	TGARCH(1,1), Normal	Student'-t	**GED**	**SWf(df=10)**	**GEDw(df=1.5)**	
Akaike info criterion	7.080828	7.07531	7.083185	7.068743	7.081301	7.068743

Table 5 contains the results of a comparison of the different symmetric and asymmetric GARCH models using the Akaike information criterion. The results obtained show that the asymmetric GARCH model under the students'-t with fixed parameter degree of freedom (df=10) has the Akaike information criterion (7.068743).

Table 7: Model Diagnostic Check for TGARCH

TGARCH (1,1) students'-t with fixed parameter degree of freedom (df=10)				
ARCH –LM	0.019445 (0.889)	0.019 (0.889)	0.304391 (0.7378)	0.614 (0.7357)
Jarque-Bera	33.156 (0.000)			

Discussion

Results of ARCH Effect on the Returns on Crude Oil Price

The ARCH effect test shown in Table 1 above was done on the ARMA process to obtain residuals. However, the results in the predicted model of equation (1a) indicate the ARCH terms are significant at the conventional level of significance. This simply means there is a huddling in the variance or volatility of Nigerian crude oil prices producing a pattern that is determined by market movement. The residual obtained from equation (1a) was subjected to the Langrage multiplier test as shown in table 2 below.

Results of ASYMMETRIC GARCH model for Returns on Crude Oil Price (RCOP)

The result in Table 2 contains the estimates of the asymmetric GARCH model for returns on crude oil price (RCOP). The ARCH components of the mean equations are significant at the conventional level of 5% level of significance in the asymmetric GARCH model for returns on crude oil price. Also, the ARCH and GARCH components of the variance equations are significant at the conventional level of 5% level of significance in the case of both symmetric and asymmetric GARCH models for returns on crude oil price. Also, the leverage effect of the asymmetric GARCH models for TGARCH and EGARCH were all significant at the conventional 5% level of significance. This simply means that the higher leverage effect that occurs due to negative crude oil price return will likely translate to low equity price otherwise resulting in sky rocking of debt-to-equity ratio. Also, it can be deduced that positive shocks reduce the volatility of crude oil price returns and have more impact on the volatility of crude oil prices than the negative return series. The results of the impact of volatility using EGARCH show that for the normal error, distribution is 94.1 per cent, students'-t is 101.8percent, generalized is 95.9 per cent, students'-t with fixed parameter degree of freedom (df=10) is 103.4 per cent and generalized with fixed parameter degree of freedom 98.4 per cent. This simply means that there was a high impact of volatility in estimating Nigeria's crude oil price using students'-t followed by students'-t with a fixed parameter degree of freedom (df=10). Similarly, using the threshold GARCH the results of the impact of volatility for normal error distribution is 8.8 per cent, students'-t is 7.2 per cent, generalized is 7.6 percent, students'-t with fixed parameter degree of freedom (df=10) is 7.2 percent and generalized with fixed parameter degree of freedom 7.5 percent. This simply means that there was a high impact of volatility in estimating Nigeria's crude oil price using normal error followed by the generalized error distribution. A comparison of the different Symmetric and Asymmetric GARCH models was done and the results are shown below.

The table (1) above is an estimation result for the heteroskedasticity test. The test for ARCH effects has the values of Obs. R-squared (nR^2) for both return on crude oil price at lagged one and two respectively. The corresponding chi-squares statistics are less than the F-statistics. The Obs. R-squared is greater than the probability of the chi-square values. Therefore, we can now reject the null hypothesis and conclude that there exists an ARCH effect in the cotton and crude oil export price return series, even when it is tested at a 1% significance level. See the complete estimation results for the test for the ARCH effect in the appendix. However, there is a need for further estimation to model the effect, impact, and persistent volatility in Nigerian crude oil prices to; determine whether conditional heteroscedastic volatility follows symmetric long-tail distributions, capture leverage effects based on the asymmetric properties of the distributions in Nigerian crude oil price. The results of the estimation of symmetric and asymmetric GARCH in Nigerian crude oil prices are shown in the tables below.

Results of SYMMETRIC GARCH MODEL FOR Returns on Crude Oil Price (RCOP)

The results in Table 4.3 contain the symmetric GARCH model for returns on crude oil price (RCOP) under five error distribution assumptions such as the normal error distribution, students'-t, generalized, students'-t with fixed parameter degree of freedom (df=10) and generalized with fixed parameter degree of freedom. The ARCH components of the mean equations are significant at the conventional level of 5% level of significance. This simply means that huddling in the variance or volatility of Nigerian crude oil prices produced a pattern that can be captured in the variance components of the GARCH equations. Also, the results show that the ARCH and GARCH components for the variance equations are significant at the conventional level of 5% level of significance under the five error distribution assumptions. The results of the impact of volatility for normal error distribution is 2.9 percent, students'-t is 3 percent, generalized is 2 percent, students'-t with fixed parameter degree of freedom (df=10) is 3.2 percent, and generalized with fixed parameter degree of freedom 1.9 percent. This simply means that there was high impact of volatility in estimating Nigeria's crude oil price using students'-t with fixed parameter degree of freedom (df=10) follow by the student's. The result below in Table 4.2 is the asymmetric GARCH model for returns on Crude Oil Prices.

Results of descriptive statistics of the raw and return data on Nigerian Crude Oil Price

The descriptive statistics for the raw series show that Mean (61.987), Standard Deviation (28.855), Skewness (0.281), Kurtosis (2.069), and Jarque-Bera (14.405). On the other hand, the descriptive statistics for the returns on the raw series show that Mean (0.679), Standard Deviation (9.741), Skewness (-1.099), Kurtosis (7.333), and Jarque-Bera (286.305). The results obtained show that both raw and return on crude oil price have positive mean and so, this revealed that both raw and return on crude oil price series are positive mean reverting. Also, the results show that the raw series is skewed to the right whereas the return series have negative Skewness estimates which show that they are less than zero indicating that the distribution is negatively skewed which is one of the common characteristics of fairness in crude oil price return series. These features represent the shape of the data distribution for the crude oil variable (Deebom & Essi, 2017). Likewise, the Jarque-Bera Test (JB) test insights for the normality of the data with their respective estimated probability values to include; the raw series on crude oil price is (14.405), whereas that of the return series on Crude oil price (29.02250) respectively. The Jarque-Bera accomplish with a very small corresponding probability value (0.000000) respectively. This, therefore, shows that the null hypothesis of normality should be rejected. This simply means that Nigeria's Crude oil price and its returns did not follow a normal distribution process. Sequence to this effect, Abdulkarem et al. (2017) suggested that the alternative inferential statistic such as in case error distribution assumptions with a fixed degree of freedom will be fussed into the ARCH and GARCH models and the model selection process becomes necessary in this case.

Results of the Comparison of the different Symmetric and Asymmetric GARCH model

The results in Table 4.6 are the model diagnostic check for TGARCH. The result reveals the values of F-statistics (0.019445) to be higher with its corresponding estimated probability value ((0.889) at lag one and two respectively. Hence, the Null hypothesis is rejected therefore it can be concluded that there exists an ARCH effect in the crude oil price return series, even when it was tested at a 1% significance level. However, the Jarque-Bera shows that the presence of normality in the TGARCH model. The result reveals the values of F-statistics (0.019445) to be higher with its corresponding estimated probability value ((0.889) at lag one and two respectively. Hence, the Null hypothesis is rejected therefore it can be concluded that there exists an ARCH effect in the crude oil price return series, even when it was tested at a 1% significance level.

Conclusion

The study tests the performance of symmetric and asymmetric GARCH models in Nigerian crude oil markets between 1999 and 2023. In conclusion, the returns on Nigerian crude oil prices using the symmetric and asymmetric GARCH Models the results confirmed TGARCH as appropriate under the students'-t with fixed parameter degree of freedom (df=10) as the best-fitted model. These were considered based on performance evaluation using the Akaike information criteria. The summary of the diagnostic test confirmed TGARCH as adequate in modelling Nigeria's crude oil price. This indicates that the shocks associated with Nigerian crude oil prices persist over a long period. In addition, the long memory hypothesis model using the Nigerian crude oil price is stronger and so, this shows an evolving situation that portrays that markets are not stable. The study therefore recommends that as there is evidence of persistent shocks related to Nigerian crude oil prices, Nigeria should seek to contain persistent shocks and increase price stability by using the TGARCH model in modeling and forecasting the returns on crude oil prices. It is necessary to develop strong empirical financial and economic reform policies. This is because a stable local financial currency increases confidence in the economy, especially when foreign investors seek to invest in a country's stable economy. For example, exchange rate policies reduce domestic investors' willingness to trade in international markets. Again, evidence of volatility in Nigerian crude oil prices indicates that the goods and services sold in this emerging international market are not stable. Therefore, the TGARCH model is considered suitable for modelling volatility associated with international trade. Finally, based on the comparison, the TGARCH model can capture a large impact on volatility, forcing investors and traders to incorporate risk into their market strategies.

The study identified the TGARCH model as the appropriate model under the students'-t with fixed parameter degree of freedom (df=10) as the best-fitted model for modelling returns on Nigerian crude oil prices using the symmetric and asymmetric GARCH Models. Most studies reviewed neglected the role of the students'-t with fixed parameter degree of freedom (df=10) in estimating model parameters which is very key in concluding the model. Therefore, this serves as a major contribution to knowledge. Also, confirmed that the shocks associated with Nigerian crude oil prices persist over a long period. This is an evolving situation which portrays those markets as not stable.

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