Modeling Fluctuation of the Price of Crude Oil in Nigeria Using ARCH, ARCH-M Models

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Authors' contributions

This work was carried out in collaboration between both authors. Author TEM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AA and TEM managed the analyses of the study. Author TEM managed the literature searches. Both authors read and approved the final manuscript.

Review Article

Abstract

As a mono-product economy, where the main export commodity is crude oil, volatility in oil prices has implications for the Nigerian economy and, in particular, exchange rate movements. The latter is particularly important due to the twin dilemma of being an oil exporting and oil-importing country, a situation that emerged in the last decade. The study examined the effects of oil price volatility, demand for foreign exchange, and external reserves on exchange rate volatility in Nigeria using monthly data over the period from May, 1989 to April 2019. Drawing from the works of Atoi [1] Having realized the potentials of an Autoregressive conditional heteroskedasticity (ARCH) model several studies have use it in modeling financial series. However, when using the ARCH model in determining the optimal lag length of variables the processes are very cumbersome. Therefore, often time users encounter problems of over parameterization. Thus, Rydberg (2016) argued that since large lag values are required in ARCH model therefore there is the need for additional parameters. Sequel to that, this research uses the ARCH-M to solve the challenges. The study reaffirms the direct link of demand for foreign exchange and oil price volatility with exchange rate movements and, therefore, recommends that demand for foreign exchange should be closely monitored and exchange rate should move in tandem with the volatility in crude oil prices bearing in mind that Nigeria remains an oil-dependent economy.

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1 Introduction

Crude oil became an export commodity in Nigeria since 1958 following the discovery of the first Producible well in 1956. Prior to that, exports were mainly on agricultural commodities that comprised groundnuts, cocoa beans, palm oil, cotton and rubber [2]. Palm oil was the leading export from 1946-1958, followed by cocoa beans while groundnut/oil ranked third. From a production level of 1.9 million barrels per day in 1958, crude oil exports rose to 2.35 million barrels per day in the early 2000s [3,4]. However, it had fluctuated between 2.35 and 2.40 million barrels per day between 2011 and 2015 which was far below the OPEC quota due to the socio-political instability in the oil-producing areas of the country. In terms of its contribution to total revenue, receipts from oil that constituted 26.3 per cent of the federally collected revenue in 1970, rose to 82.1 per cent in 1974 and 83.0 per cent in 2008 largely on account of a rise in crude oil prices at the international market [5].

Over the last four years, global oil prices have been dropping and bearing in mind that Nigeria is an import dependent economy, this development is worrisome. Our reviews of the current oil exports also reveal a southward trend due to significant oil theft and lower global demands. Indeed, NNPC (Nigerian National Petroleum Corporation) puts total value of revenue loss due to oil theft at $11bn in 2013.

More importantly, crude oil for the last three decades has been the major source of revenue, energy and the foreign exchange for the Nigerian economy. In 2000 oil and gas export earnings accounted for about 98% and about 83% of federal government revenue. The term volatility has been given different definitions by different scholars across disciplines. In relation to crude oil price, volatility is the variation in the worth of a variable, especially price. Volatility is the measure of the tendency of oil price to rise or fall sharply within a period of time, such as a day, a month or a year [6]. Defines volatility as the standard deviation in a given period. She notes that volatility has a negative and significant impact on economic growth instantly, while the impact of oil price changes delays until after a year. She concludes by saying that it is volatility/change in crude oil prices rather than oil price level that has a significant influence on economic growth. In a nutshell, volatility is a measurement of the fluctuations (i.e rise and fall) of the price of commodity for example oil price over a period of time there has been growing interests in the time series modeling of financial data with changing variance over time in Nigeria. Vishwajith et al. [7] in Pulses, Sahu et al. [8] in rice wheat, Mishra et al. [9,10] used time series models in different crop as well as in fertilizer consumption for forecasting purpose.

Therefore, the dependence of the Nigerian economy on oil proceeds as the major source of revenue is capable of raising suspicion about the impact of oil price volatility on macroeconomic volatility in the country. Macroeconomic volatility implies the vulnerability of macroeconomic variables to shocks. It is the tendency of macroeconomic variables such GDP, inflation, exchange rate, interest rate etc to be unstable and weak in terms of withstanding shock. It is a situation whereby little shock in the economy subjects the macroeconomic variables to fluctuations and uncertainty. In the light of this, many studies investigated the impact of oil price changes on macroeconomic variables in Nigeria. The consensus finding is that while oil price changes have direct significant relationship with many macroeconomic variables, it does not significantly affect output growth [11,12], David et al. [13], Taiwo et al. [14], Apere and Ijiomah [15].

But, majority of the previous studies focused on the impact of oil price level changes on macroeconomic variables. They failed to investigate the impact of oil price volatility on the volatility of macroeconomic variables and thus volatility models were not aptly employed in their analysis. So, there is the need for the evaluation of the impact of oil price volatility on macroeconomic volatility using appropriate models. Also, none of these studies employed the use of daily data and few of them [12,13] employed the ARCH and GARCH models without evaluation. Hence, despite the plethora of studies on oil price-macroeconomy relationship, little or nothing has been done to answer the following questions: 1. which volatility model is most appropriate for modelling macroeconomic volatility in Nigeria and 2. What is the impact of the oil price volatility on macroeconomic variables in Nigeria? In an attempt to answer the aforementioned

questions, the objectives of the study are; to examine the volatility of selected major macroeconomic variables (Real GDP, exchange rate and interest rate) and investigate the impact of oil price shocks on the volatility of the selected macroeconomic variables in Nigeria.

The remaining part of the paper is organized as follows: Section 2 reviews relevant literatures, Section 3 outlines the methodology, Section 4 deals with the preliminary data analysis, Section 5 contains the presentation and discussion of empirical results, while Section 6 covers conclusion and policy implications.

According to Adeniyi [11], when Nigeria gained political independence in October 1960, agricultural production was the main stay of the economy, contributing about 70% of the Gross domestic product (GDP), also employing about seventy percent of the working population and responsible for about ninety percent of foreign government revenue. The initial period of post-independence till mid – 1970s witness a fast advancement of industrialized capacity and output, as the contributions made by the manufacturing sector to GDP rose from 4.8% to 8.2%. This pattern changed when crude oil became very important to the world economy.

These shocks are major sources of aggregate economic volatility and they have large impact on private and public savings because of their economic effects [16]. They are also associated with global business cycles and it manifest in the form of sharp volatility in foreign exchange earnings of primary producing economics as in the case of Nigeria. Such development usually results in macroeconomic instability, in sufficient allocation of resources, recessions and low output growth.

According to Gujarati [17] the awareness of volatility is of crucial importance in many areas. For example, considering it sudden sharp changes in prices investors and traders alike cannot know the appropriate time to invest and when not to as a result of instability in world's prices. This does not guarantee safer investment especially now that crude oil market and other financial market like stock and foreign exchange markets are more dependent on each other than ever before. For traders in these markets or decision markers, volatility in its entirety may not be bad, but its variability may not be good enough because this makes financial planning cumbersome. This is also applicable to the importers, exporters and traders in foreign exchange markets, this variability in the exchange rates may account for excessive losses or profits. According to Gujarati [17] investors in the stock market are obviously interested in the volatility of stock price, for high volatility could mean huge losses or gains and hence greater uncertainty. In volatile markets such as the crude oil markets, it will be difficult for companies to raise capital in the crude oil markets. In crude oil market, when there is a sharp fall in the international oil price and which may lead to corresponding consequent decline in financial receipts as case in the early 1980's when the economy can no longer meet it international financial commitments. These make nations to be tangle with situations that could become a big challenge. So the questions are how do we model financial time series that exhibit such characteristics behavior? For example, how we model time series of crude oil prices? A characteristic exhibited by crude oil prices such that in its level form it could be liken to random walks or called it stochastic process. That is, a situation that shows they are not stationary. Conversely, in the first difference form, they become stationary as it is in the case of other micro economic variable like GDP series. The usual traditional regression tools have proved their limitation in the modeling of high-frequency (weekly, daily of intra-daily) data (Shamiri et al, 2009).

Shamiri et al. (2009), further suggested that assuming the only the mean response could be changing with covariates while the variance remain constant within time varying interval, it will often revealed to be an unrealistic assumption in practice. This fact is particularly clear in special time series data where there exist clusters of volatility such that it is visually detected. Basically, the crux of the problem lies in the fact that the country has extremely relied on this commodity over the years, making its economy a mono-product economy and this has triggered severe structural difficulties for the economy. For example, in 2008 when oil price fell from a peak of $147 to about $37.81 per barrel, the budget witnessed significant cuts in budgeted revenue and expenditure. These cuts had attendant effect on all aspects of the Nigerian economy; apparently budgetary operations in Nigeria are strongly linked to happenings (price, demand and supply) in the international oil market.

Recently, it appears that economic growth plays a key role in industrial innovation [18]. Since the first fluctuations in crude oil prices in 1973s, macroeconomists have viewed sharp movements in the oil price are generally as an important source of economic fluctuations, for example, Hamilton [19] suggests that In the last few decades, nine of the ten recessions in the USA were preceded by large positive increases in crude oil price. Moreover, the very recent highs registered in the crude oil market are causing concern about slowing in the economies of many developed countries. After nearly four years of stability, the crude oil price more than halved in a period of fewer than five months from September 2014. The price of a barrel of Brent crude oil in European countries fell from than $100 p/b in Sept 2014 to less than $46 p/b in January 2015. The oil price has more than halved in less than eleven months since Sept 2014. Besides, the decline was the third largest over the past 30 years, has particularly interesting parallels with the episode in 1985-86, therefore, renewed interest in the impacts of fluctuating oil prices on the economy. Therefore, this relation has captured increasing attention of academic researchers such as: [20,21,22,23] the most influential articles in the field, and others. The impacts of fluctuations in oil prices on economic growth and their mechanism in oil-exporting countries differ from those in the oil-importing countries [24].

According to the EIA global, economic performance remains highly correlated with oil prices. In addition, an oil price increase contributes to a transfer of wealth from oil importing to oil-exporting countries by a shift in the terms of trade. Movements in oil prices, an important factor in the production process, affecting the financial performance and cash flows of the companies, in turn, influencing firms dividend payments, retained earnings, and equity prices [25].

Oil price volatility has been found to have had a more direct effect on the exchange rate of the Naira than probably any other economic variable, this is because crude oil export earnings accounts for a large chunk of Nigeria's foreign exchange (about 90%) and thus ultimately determines the amount of foreign reserves of the country which is alarmingly low (about $30billion from over $60billion in 2008) and continuously keeps depleting.

Although, in the past view decade there have been several forms of different propositions on how to model such characteristics exhibited by price in the form of heteroscedasticity. According to Shamiri et al. (2009), among the models that have be proven to be most successful are the Auto-regressive conditional heteroscedasticity (ARCH) family model originally invented by Engle [26] and the models of stochastic variance (SV) pioneered by Taylor. Engel [26] argues that an adequate volatility model is the one that sufficiently model heteroscadasticity in the disturbance term and also captures the stylized fact inherent in stock return series such as volatility clustering, Autoregressive Conditional Heteroscadasticity (ARCH) effect and asymmetry.

This is one of the reason why we model variance in financial series data as well make forecast, which is very important in many areas where option price is to be examine, value at risk apply and portfolio consideration. Therefore, it becomes necessary to model out of sample forecasting ability as a natural model selection conditions for volatility models. Although, there are numbers of variance forecasting research carried out in this area, some researchers used squared daily returns as a substitute for ex-post variance but this has been proven by Anderson et al. [27] to be an unbiased and above all a noisy estimator. While some other literatures that review competing variance models has been neglected due to other necessary conditions needed for effective volatility model. Meanwhile, very little work has been done comparing different error distribution assumptions, with the remarkable exceptions as opined by Shamiri et al. (2009).

However, none of these studies has actually focused on modeling asymmetric GARCH models forecast with respect to their error distributions. Majority of the previous research studies in this area are often done on the symmetric GARCH model, especially on stock returns, exchange rates etc while this studies focus on both symmetric and asymmetric volatility as well as their various symmetric and asymmetric error distribution assumptions on crude oil export price.

These parametric models for financial asset volatilities have gone through major developments since the original Autoregressive Conditional Heteroscedasticity (ARCH) and Generalized ARCH (GARCH) models.

These models have been extensively used in Nigerian oil Markets. Such time series models with heteroscedastic errors are specifically to modeling data which are highly volatile. Although, many time series observations have non-linear dependence structure, a linear correlation structure is usually assumed among the time series data. Therefore, ARCH type models may not capture such nonlinear patterns and linear approximation models of those complex problems may not be satisfactory. Nonparametric models estimated by various methods such as Artificial Intelligence (AI), can be fit on a data set much better than linear models.

1.1 Statement of problem

Atoi [1] Having realized the potentials of an Autoregressive conditional heteroskedasticity (ARCH) model several studies have use it in modeling financial series. However, when using the ARCH model in determining the optimal lag length of variables the processes are very cumbersome. Therefore, often time users encounter problems of over parameterization. Thus, Rydbery [28] argued that since large lag values are required in ARCH model therefore there is the need for additional parameters. Sequel to that, this research uses the ARCH-M to solve the challenges.

1.2 Aim and objectives

The aim of this study is to establish an appropriate Volatility Model that will adequately predict the data. The specific objectives are to:

- Examine the effect of oil prices on Nigerian economy for the period of May, 1989 to April 2019.
- Develop a time series model and to determine the accuracy of the modify ARCH models.
- Testing the efficiency of the developed model.
- Predict into the future with the model.

1.3 Significance of study

Although a wealth of literatures exists relating oil price and exchange rate to economic growth in Nigeria, little focus on the effect of the oil price on exchange rate in Nigeria. This project seeks to fill this gap in literature as it focuses on the effect of oil price on exchange rate volatility in Nigeria and whether or not it has a significant influence on exchange rate volatility in Nigeria. Thus, this study is of great benefit to the government and policy makers. It reemphasizes the need to diversify and promote the growth of other sectors of the economy, in other to increase economic growth and improve the standard of living for Nigerians.

1.4 Scope of study

The purpose of the study is to model the volatility of crude oil price in Nigeria; It covers the period from May, 1989 to April 2019. Exchange rate volatility is represented by conditional variances which will be generated using Eviews, Gretl, Statgraphic software.

1.5 Definition of terms and concepts

Volatility: Sharp fluctuations in the value of a variable, especially price.

Oil-price: The price in dollars at which a barrel of crude oil is sold for in the international market.

Exchange rate: The price of one currency in terms of another. It can be expressed in one of two ways, as units of domestic currency per unit of foreign currency or units of foreign currency per unit of domestic currency.

Economic growth: This is the growth of the real output of economy overtime.

Exchange rate volatility: It refers to the swings of fluctuations in the exchange rates over a period of time or the deviations from a benchmark or equilibrium exchange rate.

OPEC: Organization of Petroleum Exporting Countries. It consists of twelve members which includes Nigeria.

2 Literature Review

2.1 Review of definational issues

The crude oil price and exchange rates are key research subjects, and both variables generate considerable impacts on macroeconomic conditions such as economic growth, international trade, inflation and energy management. The relationships between the two have been studied, mainly for guidelines of interaction and causality. In past decades, changes in the price of crude oil have been shown to be a key factor in explaining movements of foreign exchange rates, particularly those measured against the U.S. dollar [29].

This section brings together relevant literature regarding oil price and exchange rate. Brief reviews are given with respect to the history of oil prices, history of crude oil in Nigeria, Exchange rate volatility, various exchange rate management system practiced Nigeria, importance of exchange rate stability, measuring of exchange rate volatility and the relationship between oil price and exchange rate in Nigeria. Theoretical and methodological issues on the topic are also looked at.

2.1.1 History of oil prices

Since the ending of the 1940s to the beginning 1970s the international oil price was very steady having only small changes. Then from the early 1970 to the early 1980s the price of oil increased beyond expectation with respect to the rise of OPEC and the disruption in the supply of crude oil.

OPEC first experienced the power it had over oil during Yom Kippor War which started in 1973. OPEC imposed an oil restriction on western countries as a result of US and the Europe support for Israel. Production of Oil was reduced by five million barrels a day. The cut back amounted to about seven percent of the world production and the price of oil increased 400 percent in six months. From 1974 to 1978 crude oil prices were relatively stable ranging from $12 to $14 per barrel. Then between 1979 and 1980 during the Iranian revolution and Iraq war world oil production fell by 10% and caused the rise of crude oil from $14 to $35 per barrel. Oil prices were leading consumers and firms to adopt a more conserve energy. People purchased cars that could manage fuel and organizations purchased machine that were more fuel efficient [30].

Increased oil price also enlarged search and production by nations that were not members of OPEC. Beginning from 1982 to 1985 OPEC wanted to steady the price of oil through production of quotas, but safeguarding efforts, global economic meltdown and wrongful quotas produced by OPEC participant countries contributed to the plunging of oil prices beneath $10 per barrel.

From the Mid – 1980s the fluctuations in the price of oil has occurred more frequent than the past. OPEC has continually been trying to influence oil price to ensure its stability through allocation of production quotas to its member countries but has been unable to stabilize it. OPEC share of the world oil production has fallen from 55 percent in 1976 to 42% today.

Oil prices matter in the economy in various ways. Changes in oil price directly affect transportation costs, heating bills and the prices of goods made with petroleum products. Oil price spikes induce greater uncertainty about the future, which affects households and firms spending and investments decisions. Also

changes in oil prices leads to reallocations of labor and capital between energy intensive sectors of the economy and those that are non-energy intensive sector [31].

2.1.2 Brief history of oil in Nigeria

The search for oil began in 1908 by a German company named Nigeria Bitumen Corporation, but there was no success until 1955 when oil was discovered in Oloibiri in Niger delta by shell-BP. Nigeria started exporting crude oil in 1958 but in major quantity started to flow in 1965, after the establishment of the bonny island on the coast of Atlantic and the pipeline to link the terminal.

In 1970, as the Biafra war was ending there was a rise in world oil price and Nigeria benefited immensely from this rise. Nigeria became a member of Organization of petroleum exporting countries (OPEC) in 1971 and the Nigerian National Petroleum company (NNPC) which is a government owned and controlled company was founded in 1977. By the late sixties and early seventies, Nigeria had attained a production level of over 2 million barrels of crude oil a day. Although there was a drop in production of crude oil in the eighties due to economic down turn, by 2004 Nigeria bounced back producing 2.5 million barrels per day, but the Niger delta crisis and the global economy financial crises reduced Nigeria oil production and the world oil price.

The discovery of oil brought in the eastern and mid – eastern regions of Nigeria brought hope of a brighter future for Nigeria in terms of economic development as Nigeria became independent, but there were also grave consequences of the oil industry, it fuelled already existing ethnic and political tension. The tension reached its peak with the civil war and reflected the impact and fate of the oil industry.

Nigeria survived the war and was able to recover mainly from the huge revenue gained from oil in the 1970s. Nigeria gained a lot from the three year oil boom. There was a lot of money to meet all our development need. The oil revenue which was supposed to be a blessing became a cause because of the corruption and the mismanagement of revenue from oil. The enormous impact of the oil shock on Nigeria grabbed the attention of scholars and they tried to analyze the effect of oil price on economic growth in Nigeria. A set of radical oriented writers were interested in the nationalization that took place during the oil shock as well as the linkages between oil and an activist foreign policy. Regarding the latter, the emphasis was on OPEC, Nigeria's strategic alliance formation within Africa, the vigorous efforts to establish the Economic Community of West African States (ECOWAS), and the country's attempts to use oil as a political weapon, especially in the liberation of South Africa from apartheid.

Many people had hoped that Nigeria will become an industrial nation and a prosperous nation from the benefits of oil but they were greatly disappointed when we Nigeria hit a major financial crisis that led to the restructuring of the economy [32,33].

2.2 Review of theorectical issues

Literature examining the GARCH modeling otherwise called the generalized autoregressive conditional heteroskedasticity model is a very complex concept that captured and measured volatility characteristics exhibited by most micro as well as macro-economic variables. These micro and macro-economic variables could be export prices, exchange rate, Gross Domestic product (GDP) etc. This model measure unequal variance and it effect on other micro or macro economic indicator in the economy.

According to Atoi [1], the first break-through in modeling variable that exhibit such characteristics was championed by Engle [26]. Engle [26] demonstrated that conditional heteroskedasticity can be modeled using conditional variance of the [1].

Engle [26] demonstrated that conditional heteroskedasticity can be modeled using an autoregressive conditional variance of the disturbance term with the linear (combination of the square disturbance in the

recent past second past see Atoi [1] Having realized the potentials of an Autoregressive conditional heteroskedasticity (ARCH) model several studies have using it in modeling model financial series.

However, when using the ARCH model in determining the optimal lag length of variables are very cumbersome. Therefore, often time users encounter problems of over parameterization. Thus, Rydberg (2000) argued that since large lag values are required in ARCH model therefore there is the need for additional parameters.

Olugbenga et al. [34] study the impact of oil price volatility on investment decision making in marginal fields development in Nigeria. The study also investigated the relationship between oil price volatility and marginal field investment analysis in Nigeria. The marginal field's crude oil production was used as a replacement of investment analyze. A monthly data from October, 2015 – April 2016 was considered. The GARCH model, Johansen cointegration and Granger causality tests were used in estimating the results. However, the result showed a significant positive relationship between oil price volatility and crude oil production ($P < 0.05$).

Diverse theoretical relationship between oil price and exchange rates have been established in literature [35]. Oil price fluctuations have received significant considerations for their perceived role in macroeconomic variables dynamism. The consequences of large increases in the oil price on macroeconomic variables have been of great concern among economist and policy makers as well as the general public, since two major oil price shocks hit the global economy in the 1970s [31]. The thought that exchange rate is the most difficult macroeconomic variable to model empirically is debatable. Many papers have suggested that oil price might have a significant influence on exchange rate. The proposition that oil price might be adequate enough to explain all the long run movements in real exchange rate appears to be new [36] Nigeria like other low income countries has adopted two main exchange rate regimes for the purpose of gaining balance both internally and externally. The purpose for this different practice is to maintain a stable exchange rate [37]. A fluctuating real exchange rate stemming from volatile oil prices are damaging to non – oil sector, capital formation and per capita income [38,39]. The consequences of substantial misalignments of exchange rate can lead to shortage in output and extensive economic hardship. There is reasonably strong evidence that the alignment of exchange rate has a substantial influence on the rate of growth of per capita output in low income countries (Isard 2007).

According to Trung and Vinh [40] there are two reasons why macroeconomic variables should be affected by oil shocks. First, oil increase leads to lower aggregate demand given that income is redistributed between net oil import and export countries. Oil price spikes could alter economic activity because household income is spent more on energy consumption, and firms reduce the amount of crude oil it purchases which then leads to underutilization of the factors of production like labor and capital. Second, the supply side effects are related to the fact that crude oil is considered as the basic input to production process. A rise in oil price will lead to a decline in supply of oil due to the fact that a rise in cost of crude oil production will lead to a decline in potential output.

Also, for various reasons known and unknown, oil price increases may lead to significant slowdown in economic growth. Five of the last seven United States of America recessions were preceded by significant increases in the price of oil [31]. Likewise, a factor that has mitigated the rate of growth in some economies was not far from sudden sharp increases in the international price of oil [41]. Analysis of the impact of asymmetric shocks caused by exchange rate and oil price variability on economic growth has been a major concern of both academics and policy makers for a long time now [42]. According to Amano and Norden [43] many researchers suggest that oil fluctuations has a significant consequence on economic activity and the effect differ for both oil exporting countries and oil importing countries. It benefits the oil exporting countries when the international oil price is high but it poses a problem for oil importing countries. According to Plante [44], theoretically the immediate effect of positive oil price shocks is the increase in the cost of product for oil importing countries, this is likely to reduce output and the magnitude of this will depends on the demand curve for oil [45]. Higher oil prices lower disposable income which then leads to a decrease in consumption. Once the increase in oil price is believed to be permanent, private investments will

decrease. But if the shocks are perceived as transitory, oil is used less in production and the productivity of labor and capital will decline and potential output will fall. Similarly, Patti and Ratti [46] shows that oil price increases have a greater influence on the economy than a decrease in oil price.

Also, Rickne [47] posits that political and legal institutions affect the extent to which the real exchange rate of oil exporting countries is affected by international oil price shocks. In a theoretical model succinctly espoused by literature, strong institutions protect real exchange rate from oil price volatility by generating a smooth pattern of fiscal spending over the price cycle. Empirical analysis carried out on 33 oil exporting countries show that countries with high bureaucratic quality, and strong and impartial legal system have real exchange rate that are affected less by oil price. Also according to Mordi and Adebiyi [48] the asymmetric effect of oil price changes on economic activity is different for both oil price increase and oil price decrease. Empirical research suggesting that oil price serves as a major determinant of real exchange rate has yielded somewhat puzzling results for oil exporting countries [47]. Korhonen and juurikkala [49] showed that increasing crude oil prices cause a real exchange rate appreciation in oil exporting countries and this is not shocking, since they earn a significant amount from oil exportation. There is also a significant relationship between real oil prices and real exchange rates for oil importing countries. A study carried out on the Russian economy by Spatafora and Stavrev [50] confirm the sensitivity of Russia's equilibrium real exchange rate to long run oil prices.

Omisakin [51] no an analysis of oil prices stocks on the Nigeria economy using an annual data on seven key macro-economic variables, from 1979-2005, vector Autoregressive model was used in estimating variables and it was pointed out that oil price shocks contribute to variability in the economic price.

The concept and overview of price volatility according to Olugbenga et al., suggested that the econometric terms, volatility is defined as the rate at which the price of a security increases or decreases in a given set of returns. Volatility is measured by returns. It is measured by calculating the standard of deviation of either daily or monthly or the yearly returns of stocks price over a given period of time. It shows the extent to which the price of a certain products may increase or decrease. If the prices of a certain products fluctuate rapidly in a short time period, it indicates volatility is on the increase. If the prices of a certain products fluctuate slowly in a longer interval of time, it clearly shows that volatility is low.

Although, Atoi [1] suggested that an increase or decrease in the value of stock return tends to have a corresponding effect on the economy, mostly through the money market; an increase in product prices can motivate investment and increases the demand for credit, which eventually leads to increase interest rates in the overall economy as supported by [52]. Hence, there is the need to develop an appropriate volatility model to captured variations in product price returns which is of significant policy importance to econometricians and economic managers alike. Most especially, reliable volatility model for crude oil export prices returns that will guide traders, investor, Government agencies etc in their risk control management decisions and portfolio selection.

Modeling can be seen as a process of simplifying system used to simulate some aspects of the real economy [53]. In this context, the real economy could be refers to as price volatility. The characteristics behavior of price to violate the normality assumption (Homoskedasticity) other wises refers to as heteroskedasticity that lead to the introduction of the concept of modeling volatility. Heteroskedasticity, according to Olugbenga et al. [34] is one of the key problems that require attention when performing time series analysis on crude oil price due to uncertainty in the movement of oil prices. The sudden up and down in the movement of crude oil export price is referred to as price volatility. And this can be model econometrically using the residual conditional variance of the regression equation involving crude oil export price as the dependent variable.

Although, according to Ederington et al. [54] Models for oil prices can be classify into three main categories: Structural models, reduced form or hybrid and econometric model. The structural models are basically used in capturing the interaction between primary or supply and demand conditions and factors influencing supply. It tends to focus on longer time horizons which may include macro-type models used for forecasting. The Reduced form or hybrid models on the other hand leverage on the hypotheses about the reduced form to

examine the stochastic behavior of oil prices, whereas the Econometric models hypothesize specific types of time series behavior in the conditional first and second moments of crude oil price series. Reduced form or hybrid and econometric has the tendency to focus on short-term dynamic behavior of crude oil prices.

Olugbenga et al. [34] further opined that an ARCH model is a stochastic process with autoregressive conditional heteroskedasticity. It is a simple model that can capture or described a stochastic process which could either be non-stationary but asymptotically stationary. If the stochastic process shows clustering volatility, then the ARCH models can be applied.

Sequel to that, and many other Lapses and little minor challenges encountered in the ARCH model, [55] independently proposed an extension to ARCH model which was refers to as Autoregressive Moving Average (ARMA). This was done with view to achieving parsimony. And this eventually lead to the development of the model called the generalized Autoregressive conditional heteroskedacity (GARCH), which model conditional variance as a function of its lagged value of the disturbance term of linear regression model.

Although, GARCH model have been proven to be useful in capturing symmetric effect of volatility but the model is bedeviled with some limitations such as relatively non-negative constraints imposed on the parameters to be estimated. Therefore, this study among other things investigates as well test GARCH family model performance in modeling price volatility.

The analysis showed asymmetric effect. Asymmetric effect implies that oil price increase has a clearly different effect from the effect of oil price decline. Mork, Olsen and Mysen [56] confirmed the asymmetric effect for the OECD countries. Lee, Shwan and Ratti [57] also revealed that asymmetric effect is stable in the period before and after 1985 regardless of its dependence on other variables. Similarly, Narayan and Narayan [58] modelled the volatility of daily oil prices using Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) model. They revealed that asymmetric effects are evident, persistent, and permanent in the oil price series. In a trend analysis of crude oil volatility, the Institute for 21st century Energy (2012) showed the evidence that stable energy prices (including crude oil) would boost GDP growth and the economy would perform better in such situation. Hence, volatile energy price poses a significance jolt to the economy.

To examine the importance of thresholds on the relationship between oil price shock and economic growth in Nigeria, Adeniyi [11] applying Multivariate Threshold Autoregressive Model (MTAM) established that oil price shock do not significantly affect movement of macroeconomic aggregates in Nigeria. Olowe [12] investigated weekly oil price volatility of all countries average spot price using EGARCH (1, 1) over the period January 3, 1997 to March 6, 2009. He found that the oil Price return series show high persistence of volatility, volatility clustering and asymmetric properties. Ferderer [59] focused on counter-inflationary monetary policy, sectorial shocks and uncertainty to explain the asymmetric mechanism between oil price changes and economic activity. The analysis shows that oil price increase helps to predict output growth irrespective of monetary policy variables. Also, asymmetric monetary policy responses of oil price decrease can only explain part of the oil price-output relationship but there is significant relationship between oil price and counter-inflationary policy responses. Guo and Kliesen [60] investigated the impact of oil price volatility on macroeconomic activity in U.S. Using Granger Causality Test; they found a significant negative impact of oil price volatility on GDP growth over the period 1984 to 2004. Moreover, the study indicates asymmetric effect of oil price volatility on macroeconomic activities. Examining macroeconomic dynamics in oil exporting countries with the use of Panel VAR, Mohaghegh and Mehrara [61] established that oil shocks are not necessarily inflationary. Further, domestic policies, instead of oil boom causes inflation and money is the main cause of macroeconomic fluctuations. Recently, Ebrahim, Inderwidi and King [62] embarked on theoretical investigation of macroeconomic impact of oil price volatility. The result showed that oil price volatility constitutes a fundamental barrier to economic growth due to its damaging and destabilizing effect on macroeconomy. Precisely, they show that oil price volatility adversely affect aggregate consumption, investment, industrial production, unemployment and inflation particularly in non-OECD countries.

Wilson, David, inyiama and Beatrice [63] examined the relationship between oil price volatility and economic development in Nigeria. Applying Ordinary Least Square and Granger Causality Test, the study shows that there is no significant relationship between oil price volatility and key macroeconomic variables (Real GDP, inflation, interest rate and exchange rate).

Contrarily, the study of oil price shocks and volatility of selected macroeconomic indicators in Nigeria carried out by Taiwo, Abayomi and Damilare [14] using Johasen Cointegration Test and Error Correction Model indicated that crude oil price, stock price and exchange rate have significant influence on the growth of the Nigerian economy.

Oriakhi and Osaze [64] examined the consequences of oil price volatility on the growth of the Nigeria economy within the period 1970 to 2010. With the use of VAR model, the study find that oil price volatility has direct impact on government expenditure, real exchange rate, and real import while real GDP and inflation are indirectly influenced by the oil price volatility. By implication the study shows that changes in oil price determine government expenditure which in turn determines the growth of the Nigerian economy.

Similarly, using monthly data, Apere and Ijomah [15] indicated unidirectional relationship between interest rate, exchange rate and oil price with direction from oil prices. Also, oil price has no significant impact on real GDP. They arrived at this conclusion with the use of EGARCH model, Impulse Response Function and Lag-Augmented VAR for the investigation of the macroeconomic impact of oil price levels and volatility in Nigeria during the period 1970-2009. Over the years, several studies have applied GARCH type models to examine volatility in exchange rates. Elijah and Festus [65] for example explored the impact of exchange rate volatility on private investment and confirm an adverse effect.

Mordi (2006) employing GARCH model argued that failure to properly manage exchange rates can induce distortions in consumption and production patterns and that excessive currency volatility creates risks with destabilizing effects on the economy.

Elijah and Festus [65] examine the effect of exchange rate volatility and inflation uncertainty on foreign direct investment in Nigeria from 1970 to 2005. Adopting GARCH model, the study shows that exchange rate volatility and inflation uncertainty negatively affect foreign direct investment during the period. Similarly, Azeez, Kolapo and Ajayi [66] examined the effect of exchange rate volatility on macroeconomic performance in Nigeria from 1980 to 2010 employing OLS and co-integration techniques. The findings of the study revealed that oil revenue and exchange rate are positively related to GDP while balance of payment is negatively related to GDP. Also, oil revenue and Balance of Payment exert negative effect while exchange rate volatility has positive effect on the economy.

Despite the identified importance of oil price on the macroeconomic activities, no study has incorporated oil price volatility in the modeling of macroeconomic volatility in Nigeria. Also, interest rate volatility is ignored in the modeling of volatility in Nigeria while few studies on exchange rate volatility use monthly data instead of daily data used in this paper. Likewise, the evaluation of volatility models (ARCH and GARCH models) in the examination of the volatility of GDP growth rate has not received the required attention from researchers. This paper therefore, fills the research gap by modeling the volatility of major macroeconomic variables (Real GDP, exchange rate and interest rate) incorporating the effect of oil price volatility with the use of ARCH-M and GARCH models with the use of high frequency data(particularly for exchange rate).

This is considered because review of relevant literature shows that several researchers have neglected the contribution of the error distribution assumptions while modeling market price volatility. The wrong use of an appropriate error distribution in volatility model for financial time series may cause misspecification in volatility model, leptokurtic and autocorrelation behavior of such series. Whereas Klar et al. [67] posited that in appropriate specification of the concept distribution may lead to a sizeable loss of correctness of the corresponding estimators, wrong risk determination, inaccurately priced options and inadequate assessment of value-at-risk (VAR). In modeling volatility these is need to specify the form of the error distribution to be

used in the estimation. Hence, this study seeks to investigate and as well as close gap the vacuum in several literatures by using the three commonly used first order symmetric GARCH family models on the form students-t, normal (Gaussian) and generalized error distribution (GED) with a view to compare them to when it is used in asymmetric GARCH family models, while considering the best fitted model for forecasting volatility with the best error distribution for crude oil export price within the years under consideration.

3 Data and Methodology

3.1 Data

The relationship between two variables will be analyzed by using monthly data over the period from May, 1989 to April 2019. The variables used in this study are the crude oil price and gross domestic product (GDP). Except that of GDP data, is only available in the form of annual data. Consequently, this study has chosen monthly data. The data about GDP is obtained from the base of the international financial statistics data. While data about crude oil price is obtained from the central bank of Nigeria website. For analyzing variables, it will be used Johansen co-integration test, impulse response function, and variance decomposition tests.

3.2 Methodology

This thesis uses three steps estimation procedure for volatility modeling.

   i.   The test for the stationality (unit root).
   ii.   Testing for ARCH effects: Is the series in question volatile?
   iii.   Estimation with ARCH-type Models: This is considered only if the series (real GDP, exchange rate, interest rate and oil price) are volatile.
   iv.   Post Estimation test: This is carried out to verify if the estimated ARCH-type model has captured the ARCH effects in the series. It involves testing for ARCH effects after estimation.

3.3 The test for stationarity (Unit root)

First of all, in our analysis is to ensure the stationarity properties of the economic variables we consider. To do so, we rely on, the Augmented Dickey-Fuller (ADF) test and the Dickey and Fuller test are employed to test for stationarity of the series to confirm the integrational properties of the data series in their levels and I(1). Most of the lag length is determined by using Schwarz Information Criteria (SIC). The null hypothesis in the ADF test is that the series is non-stationary or has a unit root.

3.4 Testing for ARCH (1) effects

The test, following the procedure of ARCH LM test proposed by Engle [26] begins with estimation of AR model as specified in equation (1) below;

$$RR_t = \alpha + \delta_1 RR_{t-1} + \varepsilon_t; \qquad \varepsilon_t \sim II\,D\,(0, \sigma^2) \tag{1}$$

Where:

      RR: is the rate of return of the series,
      α: is the constant term,
      δ: is the coefficient of the return series and
      ε: is the error term

Estimated residual is obtained from equation (1), then the squared of estimated residual is regressed on its lag as follows:

$$\varepsilon_t^2 = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \dots\dots \gamma_q \varepsilon_{t-q}^2 \qquad = \gamma_0 + \sum_t^q \gamma_i \ \sum_{t-1}^2 \tag{2}$$

The ARCH model (q) is

$$\sigma_t = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \dots\dots \gamma_q \varepsilon_{t-q} + \varepsilon_t \gamma_0 + \sum_t^q \gamma_i \ \sum_{t-1} + \varepsilon_t \tag{3}$$

σ_t is the unconditional variance
γ_0 is the constant term
γ_1 is the cofficient of the ARCH term
ε_{t-1} is the corresponding lags of the errors at time t-1
q is the length of ARCH lags
ε_t is the error term

$H_0: = 0$, while $H_1: \neq 0$

The test statistics for the null hypothesis are F-test and nR^2 tests.

The null hypothesis of no ARCH effects is rejected if the probability values (p-values) of these tests are less than any of the conventional levels of statistical significance (10%, 5% and 1%). The rejection of Ho implies presence of ARCH effect in the series. Thus, if ARCH effects are present, the estimated parameters should be significantly different from zero (the series are volatile). However, if ARCH effects are not present, then, the estimated parameters should be statistically insignificant (the series are not volatile).

3.5 Model estimation using symmetric and asymmetric Garch models

In line with the objective of the study, the model adopted for the study was derived as thus:

Supposing we have a regression model given as;

$$Y_t = K_1 X_{1t} + \varepsilon_t \tag{3.1}$$

Where ε_t is the residuals, then

$$\varepsilon_t = \sqrt{h_t \times Z_t} \tag{3.2}$$

$$h_t = \alpha_0 + \sum_{t-1}^p \lambda_i + \sigma_{t-1}^2 + \sum_{j-1}^q \beta_j \ \mu_{t-j} \tag{3.3}$$

While α_0 is a constant term, λi is the co-efficient of βj is the elasticity coefficient and ε_t is the stochastic disturbance term. It is important to note that, for equation (3.1) and (3.3) to exist, them; α_0, λi, σ_{i-t}, $\beta j > 0$ However, GARCH (p,q) is model as thus: The mean is written as

$$X_t = \mu + \lambda x_{t-i} + \varepsilon_t, \qquad \varepsilon_t \sim N(0,\sigma_t) \tag{3.4}$$

Where;

The variance component is written as thus

$$\sigma_t^2 = \sigma_0 + \sum_{t-1}^p \lambda_i \sigma_{t-1} + \sum_{j-1}^q y_j \mu_{t-1} \tag{3.5}$$

The mean equation (3.4) become a standard, for other models alongside with conditional variance components, when p=1 and q=1 then it is consider as a case of GARCH (1,1). Where all the parameters α_0, λ_i, y_j, ≥ 0; σ_t^2 is the conditional variance, α_0, λ_j constant term, λ_j and y_j are coefficients

of the ARCH and GARCH term respectively σ_{t-1}^2 and μ_{t-1}^2 are the squared errors at lag$_{t-j}$ and t-j respectively.

Equation (3.1), (3.2), (3.3) (3.4) and (3.5) provide a priori expectation expected signs and the significant of the value of the co-efficient of the model parameters to be estimated in light of economic theories and empirical evidence. Equation (3.5) is defined as GARCH (p,q) model an extended framework of ARCH(q) model as proposed by Bolleslev (1986) in which it is refers to as the P lags of past conditional variance. The GARCH (p, q) with Z_t as a discrete time stochastic process is defined as:-

$\sum_t = Z_t \sigma_t$ and is weakly stationary with

$E(\varepsilon_t) = 0$ and

$Var(\varepsilon_t) = \propto_0 \left[1 - \left(\sum_{i-1}^p X_I + \sum_{j-1}^q Y_j\right)\right]^{-1}$ Type equation here. $\qquad$ (3.6)

$Cov\ (\varepsilon_t, \varepsilon_t) = 0$ for t$\neq$0

if and only if

$\sum_{i-1}^p \lambda_i + \sum_{j-1}^q y_j < 1$, ($\propto_0 > 0$), for the system be stationary

Also, ARCH in MEAN (ARCH – M) Model as propose by Engle et al (1987) mostly estimate return of financial data series as dependent of the conditional variance of a standard deviation. It model high risk that often accompany high expected return. The simplest form of

ARCH-M model is the ARCH-M model is the ARCH-M (1, 1) written as:

Mean equation:

$Xt = \mu + \lambda \sigma_{t-1}^2 + \varepsilon_t \quad \varepsilon_t \sim N(0, \sigma_t^2)$ $\qquad$ (3.7)

Variance equation;

$\sigma^2 = \alpha_0 + \alpha_1 \sum_{t-1}^2 + \beta_1 \sigma_{t-j}^2$ $\qquad$ (3.8)

3.6 Nature and sources of data

Data used for this study was sourced for from the central Bank of Nigeria (CBN) [68] statistical database website (www.cbn.gov.ng) and Statistical Bulletin. The variables comprised of monthly crude oil export prices (COP), extracted from the month of May, 1989 to April 2019. These make a total of 366 data points. The rate of return or growth rate of the variables is computed using the continuous compounded growth rate formula which is given as

$CROPT_t = \log\left(\frac{CROP_t}{CROP_{t-1}}\right) * 100$ $\qquad$ (3.9)

For t = 1, 2, ….t-j where CROPR$_t$ is the crude oil export price return at time t, CROP$_t$ is crude oil export price at time t and CROP$_{t-1}$ is crude oil export price at time "t-1''. The variable was well differenced (D) to get rid of outlier and as well obtain stationarity within them. The data was analysis using Eviews Software version 9.

4 Results and Discussion

4.1 The test for stationarity without differencing (Unit root)

Null hypothesis: Series has a unit root.

If the absolute test statistic is more than the critical value (absolute) then we can reject null hypothesis and accept alternative hypothesis. But if the absolute test statistics is less than the critical value we cannot reject null hypothesis. Rather we accept null hypothesis.

Null: series has unit root meaning that variable is not stationary.

Alt: series do not have unit root meaning the variable is stationary.

Test statistic and critical value at 5% level the test statistic is less than the critical value meaning we accept null hypothesis and reject alt hypothesis so series has unit root meaning that variable series is not stationary at all case in the diagram above and the p Values are more than 5% at all case.

Table 1. The test for stationarity without differencing (Unit root)

Variables	Level	Test critical values			P Values	Decision
		1% level	5% level	10% level		
CROPR	Constant	-3.448414	-2.869396	-2.571023	0.2493	
		t statistic = -2.089151				
	Constant. trend	-3.983900	-3.42242	-3.134078	0.1160	
		t statistic = -3.134078				
	None	-2.571437	-1.941711	-1.616106	0.3635	
		t statistic = 0.3635				Non stationary
GDP	Constant	-3.959148	-3.081002	-3.324976	0.2322	
		t statistics = 2.143298				
	Constant, trend	-4.728363	-3.759743	-3.324976	0.4786	
		t statistics = 2.153140				
	None	-2.740613	-1.968430	-1.604392	0.3922	
		t statistics = 0.709637				

Table 2. The test for stationarity with differencing (Unit root)

Variables	Level	Test critical values			P values	Decision
		1% level	5% level	10% level		
D(CROPR)	Constant	-3.448998	-2.869653	-2.571161		
		t statistic = -50.16636			0.0001	
	Constant. trend	-3.984726	- 3.422828	-3.134315		
		t statistic = -51.39928			0.0001	
	None	-2.571761	-1.941756	-1.6161077		Stationary
		t statistic = 50.35640			0.0001	at first
D(GDP)	Constant	-4.OO44	-3.0988	-2.6904		difference
		t statistics = 9.073052			0.0000	
	Constant, trend	-4.8000	-3.7911	-3.3422		
		t statistics = 8.798350			0.0000	
	None	-2.7406	-1.9684	-1.6043		
		t statistics = 9.430122			0.0000	

Test statistic and critical value at 5% level the test statistic is greater than the critical value meaning we reject null hypothesis and accept alt hypothesis so series has no unit root meaning that variable series is stationary and the p value: 0.0001 and 0.000 which are both less than 5% .
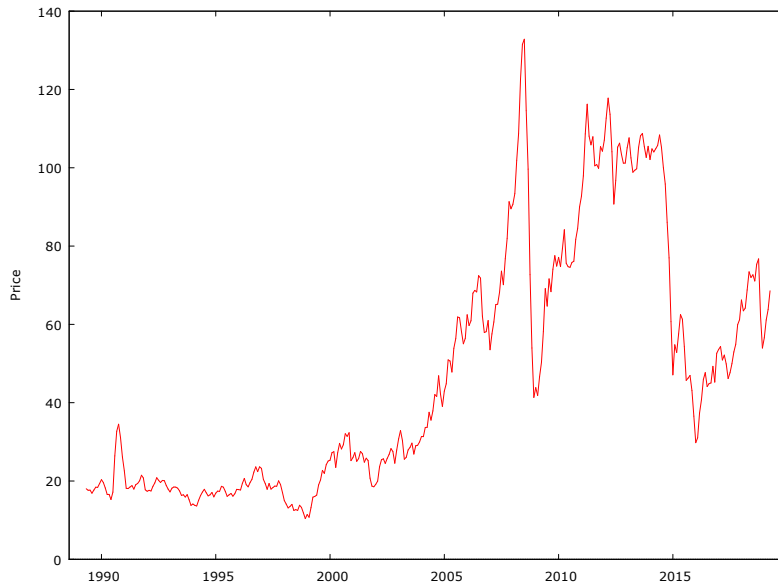
Fig. 1. Time series plot for price/test for volatility clustering
Monthly Price of Nigeria Crude Oil Export Market (US Dollar/Barrel) – From May, 1989 to April 2019

Fig. 1 illustrates the dynamics of crude oil prices series. The behavior of crude oil prices from May, 1989 to April, 2019 and this reveal an upward trend which later falls within the year 2014-2016.
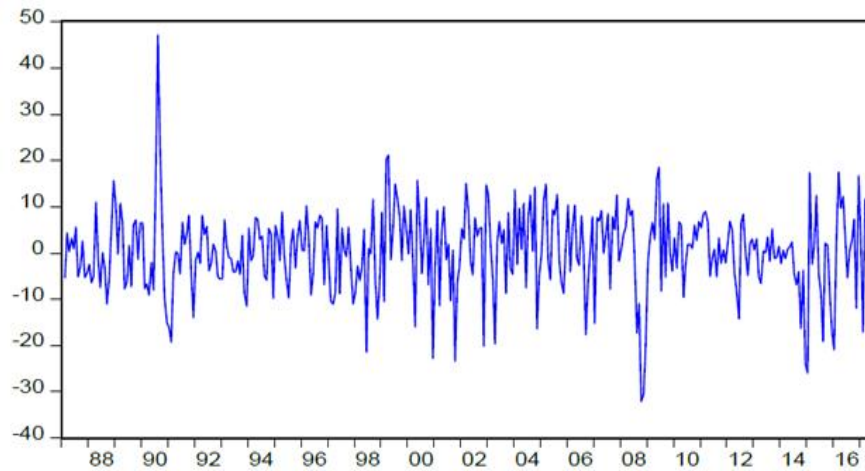
Fig. 2. Test for volatility clustering
Fig. 2 Monthly Price Return of Nigeria Crude Oil Export (US Dollar/Barrel) – From May, 1989 - April, 2019

Fig. 2, clearly show evidence of volatility clustering in the returns series of crude oil export price US dollar/Barrel and the crude oil export price exhibit sharp increase with a corresponding sharp decrease.

4.2 Descriptive statistics of crude oil price return series

This is done to tested normality and to examine whether the variable under the study is useful for analysis.

Table 3. Discriptive statistics table

Mean	Median	Min	Maxi	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Prob. value
46.9843	3.69000	10.41000	132.8300	31.65392	-0.78092	3.363378	42.67033	0.00000

Table 3 shows the descriptive statistic for the data variable and its return series covering the period of May, 1989 to April, 2019. The Margins between the minimum and maximum values of the series indicate evidence of variability of the trend of the series within the period under coverage.

4.3 Test for ARCH effect

Both the F-statistic and n*R2 test in Table 4 indicate the existence of ARCH effect on an increase in the variable even at 1% level of Significance for the first order autoregressive process. The test for higher order lags is neglected reasoning been that Lag one test is adequately enough for the modeling of volatility models considered in the study.

Table 4. Estimation results for test for ARCH effect

Heteroskedasticity test: ARCH	Lag 1
F-Statistics	14.97779
Prob. Value at 5%	0.0001
$n*R^2$	13.899549

Table 5. Estimation results of the first order symmetric ARCH models in error assumption distribution

Modes	equation	Model parameter	Normal error distr.		Student's t error distr.		Generalized error distr.		Model with minimum AIC&SIC error distr.
			Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	
	Mean	Intercept	0.095962	0.5445	0.008471	0.9565	0.006281	0.9681	
		GCROP(1)	0.995195	0.0000	.0026111	0.0000	1.002164	0.0000	
ARCH (1,1)	Variance	intercept	0.114865	0.1932	0.119298	0.2527	0.127300	0.2521	
		ARCH	0.215231	0.0000	0.144500	0.0000	0.231965	0.0000	
		GARCH	0.670844	0.0000	0.7455009	0.0000	0.613596	0.0000	
		AIC	-2.107316		-2.109125		-2.108618		-2.109125
		SIC	-2.053784		-2.056886		2.044380		-2.056886
		ARCH+GARCH	0.93003		0.93669		0.932771		
		SQRT(GARCH)	0.183998	0.4079	0.179470	0.3952	0.171953	0.4257	
	Mean	Intercept	-0.001029	0.4579	-0.001649	0.6297	-0.006137	0.9694	
ARCH (1,1) M		GCROP(-)	0.176889	0.0028	0.168910	0.0029	0.172617	0.0030	
	Variance	intercept	0.007450	0.0028	0.168910	09.002	0.172616	0.0030	
		ARCH	0.215656	0.0000	0.194859	0.0029	0.232898	0.0003	
		ARCH M	0.714029	0.0000	0.741093	0.0000	0.700232	0.0000	
		AIC	-2.104649		-2.108278		2.105657		-2.108278
		SIC	-2.040411		-2.043334		-2.030713		-2.043333
		ARCH+ARCH- M	0.929685		0.935952		0.93313		

4.4 Model fitness and selection

From the fifteen models (symmetric and Asymmetric) estimated above, models were selected on the basis of Schwarz information criterion (SIC) as supported by Alhassan et al. [69] in order to select the best model for forecasting. The results are presented in the Table 6.

Table 6. Model fitness and selection

First ARCH model	Error distrbutional assumptions			Mimimum SIC
	Normal error distr.	**Student's t error distr.**	**Generalized error distr.**	
ARCH (1,1)				
	-2.107316	-2.101125	-2.108618	-2.101125
ARCH-M (1,1)	-2.104649	-2.109268	-2.105657	-2.109268

Conclusively, the best fitted selected model are written as shown below: for the first order symmetric ARCH model in student's-t error distribution.

Mean Equation:

CROPR = 0.0042292 + 0.2513*CROPR(-1)

Variance Equation:

GARCH = 0.000803 + 0.171429*RESID(-1)^2 + 0.798778*GARCH(-1)

Mean Equation:

CROPR = 0.001982 + 0.843639*CROPR(-1)

Variance Equation:

Log(GARCH) = -0.765 + 0.617*ABS(RESID(-1)/@SQRT(GARCH(-1))) – 0.021940*RESID(-1)/@SQRT(GARCH(-1)) + 0.843639Log(GARCH(-1))

4.5 Test for ARCH effect

This is done in conformity with the residuals of the m students as review in the concept of homoscedasticity as account for, in Arch effect model. This was estimated using the ARCH –LM model and the results are shown below.

Table 7. Heteroskedasticity test for the five best fitted GARCH family model

Model	Heteroskedasticity test: ARCH	Lag 1	Lag 2	Lag 3
ARCH(1,1) in student's-t	F-Statistic	0.583883	0.398243	0.353985
Error Distribution	Prob. F(1.0123)	0.586371	2.115806	4.524236
ARCH-M(1,1) in Stdent's-t	F-Statistics	0.552177	0.390809	0.376347
Error Distribution	Prob. F(1.0123)	0.554607	2.378527	4.748895

5 Discussion of Results

The monthly crude oil price data for this study spans from May, 1989 to April, 2019 with the total data points of 366, conditional variance models were fitted to continually, compound monthly exchange rate. Two models (2) were estimated using the first order ARCH family model in its three error distribution assumptions. In the estimation of the models, certain conditions were taken into considerations and this incorporate the pattern as shown by the variable. These include the following: Time series plot, Descriptive statistic, Test for ARCH effect test, ARCH family model Estimation and Model diagnosis test.

In the estimation as shown in Fig. 1 illustrates the dynamics of crude oil prices and its return series. The behavior of crude oil prices from May, 1989 to April, 2019 and this reveal an upward trend which later falls

within the year 2014-2016. Also, Fig. 2, clearly show evidence of volatility clustering in the returns series of crude oil export price US dollar/Barrel and the crude oil export price exhibit sharp increase with a corresponding sharp decrease. This also shows that crude oil export return price US dollar per Barrel has not been actually stable within the sample period under this study. The return series follow an unsteady pattern and the returns series confirmed that there is an evidence of volatility clustering. This is also supported by Abdulkareem et al. [70] findings. The period of high volatility, accompany with period of relative calmness the preliminary investigations show that the variable exhibit unusual fluctuation using time series plot then after transformation the trend in the graph became stationary with an increasing volatility clustering.

In another development, the variable was subjected to descriptive test for normality and the result shows that the variable violates all the characteristics of variables that are normally distributed. Table 1 shows the descriptive statistics for all the variables and their return series covering from January, May, 1989 to April, 2019. The mean (46.9843) have positive signs, meaning it is mean reverting. The standard deviation (31.65392) measure the riskiness of the series under the study. The Higher the standard deviation, the increase in volatility of the crude oil prices return and the risky the investment in this trade. The large difference between minimum and maximum return series is a clear evidence of the level of price variability in fairness to trading in crude oil market within the sample period. Again, the coefficient of skewness (-0.78092) is less than zero indicated that the distribution is negatively skewed which one of the common characteristics of fairness in crude oil price return series while the Kurtosis (3.363378) is greater than three (3). However, the Kurtosis of a normal distribution is 3 which mean the distribution not normal. And the Jarque-Bera (42.67033) accomplish with a very small corresponding probability value (0.000000), the Null Hypothesis of Normality is rejected and the alternative inferential statistic as suggested by Abdulkarem et al. [71] become necessary with their corresponding error distribution assumptions and fixed degree of freedom fussed into the ARCH and GARCH models.

A look at the Table 4 reveals the values of F-statistics (14.9779) to be higher with its corresponding chi-squares statistics less than the Obs. R-squared (nR2) (13.899549) i.e. the Obs. R-squared is greater than prob. Chi-square. Hence, the Null hypothesis is rejected therefore it can be concluded that there exist ARCH effect in crude oil export price return series, even when it was tested at 1% significance level. See complete estimation results for the test for ARCH effect. This confirmed Abdulkarem et al. [71] assertion about variables that can be estimated using GARCH family model.

Tables 5 and 6 presents comprehensive analysis on crude oil export price in dollars per Barrel while selection were done only with the model with the least Schwartz information criterion. The symmetric models in the Table 4 reveal that all the ARCH Coefficients in the three error distribution assumption are statistically significant at the 5% levelof significance. This evidently confirmed the presence of ARCH effects and this support the fact that the previous month's crude oil export price information can actually influence the present month crude oil export price return. That is crude oil export price volatility is influence by its own ARCH and GARCH.

Similarly, it is clear that @ SQRT (GARCH) coefficients are not significant and it does not provide much needed information on the volatility of return series. However, the results in ARCH (1,1) and ARCH-M (1,1) shows that the sum of the ARCH and GARCH coefficients are less than one. This indicates that using ARCH (1,1) and ARCH-M(1,1) in modeling characteristics exhibited by volatility of crude oil export price within the sample period reveal a mean reverting condition.

Also, considering the degree of effect or persistence in ARCH (1,1) according to the order their of error distribution assumptions such Normality, student's-t and the generalized error assumptions. The ARCH (1,1) in Normal error distribution have (93.003%), ARCH(1,1) in Student's-t gives have (93.669%) and ARCH(1,1) in Generalized error distribution have (93.2771%). This follows that ARCH (1,1) in Normal error distribution have the highest volatility persistence, follow by ARCH (1,1) in student's-t and ARCH (1,1)in generalized error distribution. Meanwhile ,the degree of effect or persistence in ARCH-M(1,1) are as follows: ARCH-M(1,1)in Normal error distribution is (92.9685%), ARCH −M (1,1) in student's-t (93.5952%) and ARCH-M(1,1) in Generalized error distribution is (93.313%). This shows that using

ARCH-M(1,1) in modeling volatility, ARCH-M(1,1) in normal error distribution have the highest level of volatility persistence or effect, follow by the ARCH-M(1,1) in Generalized error distribution and the ARCH-M (1,1) in student's-t distribution. Using the ARCH-M (1,1), it shows that increased risk leads to a higher return.

Finally, comparing the two models on the basis of fitness and performance using the Schwartz information criteria, ARCH (1,1) in student's error distribution assumption has the value (-2.056886) with the Akaike information criteria(AIC) of -2.101125 and ARCHM(1,1) in student's-t error distribution (-2.043333) with the Akaike information criteria(AIC) (-2.109268) were chosen as the best fitted symmetric models for estimating crude oil export prices within the sample period.

Model fitness and selection are done as reveal in Table 6. In Table 6, ARCH and ARCH-M in student's-t error distribution were considered best fitted symmetric models since they have the least Schwarz information criterion across the models while in the asymmetric GARCH models.

6 Conclusion

This study provides analytical insight on the modeling of macroeconomic volatility in Nigeria. The paper evaluates the plausibility of symmetric and asymmetric volatility models and investigates the impact of oil price volatility on the volatility of two major macroeconomic variables (real GDP and the price of oil).

The findings of the study reveal that the asymmetric models ARCH-M outperform the symmetric models ARCH, meaning that the asymmetric effects are important in modeling the volatility in Nigeria. Oil price volatility also plays a significant role in the determination of the macroeconomic volatility. By implication, the Nigerian economy is vulnerable to both internal shocks and external shocks. Since the oil price volatility significantly impacts on the volatility of all the variables considered, it is a major source of macroeconomic volatility in Nigeria. Hence, fluctuations in oil price bring about instabilities in the Nigerian economy.

Although different models fit different environments, the study recommends that more credence may be given to asymmetric models for modeling macroeconomic volatility in Nigeria. Oil price may be considered as relevant variable in the analysis of macroeconomic fluctuations in Nigeria. Therefore, the Nigerian economy may be diversified by revamping other sectors such as the agricultural sector and the industrial sector in order to reduce over-dependence on the oil sector.

7 Recommendations

In the words of Jin (2008), opined that volatility increases the risk and uncertainty of external transactions and predisposes a country to volatility related risks.

Considering the level of risk that accompany external trade and investment in stocks and price of commodities with its corresponding return series, investors, financial analyst and Government are advice to be careful and such the following recommendations were suggested as thus:

- When modeling price volatility different error distributional assumptions should be specifically incorporated into the system as incorrect error specification may lead to incorrect estimation, which could cause loss of efficiency in the model.
- Also, investors should not close their eyes to the impact of news while forming prospect on investment as the higher the standard deviation in the descriptive statistic of the return series maybe vulnerable risks.
- Government should look for new ways to diversify the economy from total dependence on oil and non-crude oil such as agriculture to explore other sectors like the manufacturing sector to reduce price volatility in the economy and its overall effect on other macroeconomic indicators.

- Exchange rate between Nigeria and her foreign trading partners should be regulated to currency variability which may in turn affect other Macroeconomic indicator.

Competing Interests

Authors have declared that no competing interests exist.

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