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Empirical Analysis of the Nexus between Crude Oil Price Volatility and Selected Economic Sectors in Nigeria

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Abstract: *Fluctuations in the global price of crude oil has become a major concern for many economies who depend majorly on oil export for foreign exchange earnings. This study therefore investigates the impact of crude oil price volatility on some selected economic sectors (transport, agricultural and manufacturing sectors) in Nigeria from 1981q1 to 2015q4. Adopting the exponential generalized autoregressive heteroskedasticity (EGARCH) model, the empirical result shows that a certain period of low volatility is followed by another period of low volatility. Meanwhile, a period of high volatility is followed by another period of high volatility. Crude oil price has a negative impact and is statistically significant to transportation sector, manufacturing output, and agricultural sector respectively. Based on the findings, the study recommends that the government should reform the economy and diversify her export revenue base as a means of minimizing reliance on crude oil and petroleum product. Some of these reforms include fiscal prudence, reform in budgetary operations, export diversification, revival of non-oil sectors, which will further shield the economy from the impact of oil price fluctuations. The study further recommends that policy makers of net oil exporting countries like Nigeria should give support to the restructuring of their economies in such a way that their non-export will boost their domestic economy.*

Keywords: Agriculture; ARCH and GARCH; crude oil price; transportation; manufacturing output
JEL Classification: E31; E32; L90; O14; Q10; Q31

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1. Introduction

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Crude oil plays a vital role in every economy, as it remains a primary source of energy for transportation, agriculture and manufacturing industries. This makes a rise in the price of oil a significant influence on economic conditions. Crude oil price changes result from the interaction of the forces of demand and supply of oil in the global commodity markets (Arezki et al., 2017). Hamilton (2009) documented an inverse relationship between oil price changes and the growth rates of real GDP.

Volatility can also be articulated as a percentage and computed as the yearly standard deviation of the percentage change on a daily basis (Orji, A, Ogbuabor, J.E and Anthony-Orji, O.I. 2016 and Obodoechi, Orji & Anthony-Orji, 2018). By inference, the higher the degree and the number of changes in price over time, the higher the occurrence of volatility. According to Chen and Hsu (2012), fluctuation in the price of crude oil may produce future uncertainty about the path of the price of oil, causing a consumer to defer permanent purchases of long-lasting goods and delay investments. As an outcome, the increase in the price of oil has a tendency to lessen the profits of non-exporting firms, leading to a decline in their fundamental values.

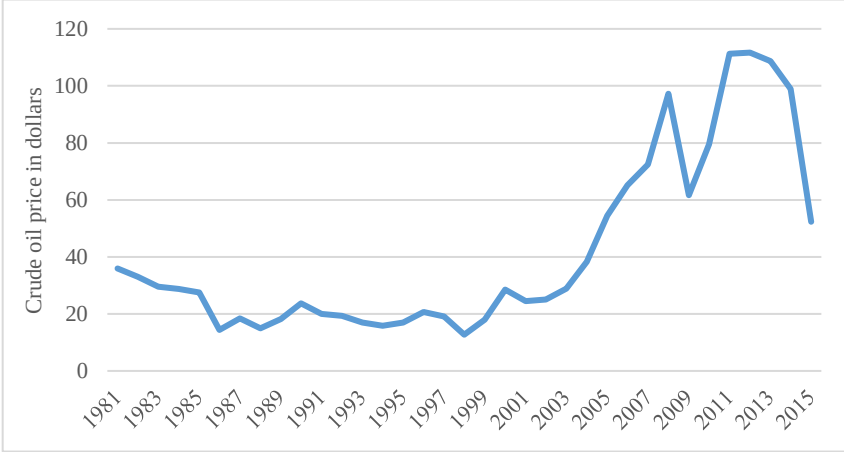
In the 19th and early 20th century, seven oil giants formed a cartel in 1920 known as the rise of the seven sisters to exert power over the price of oil. Following this, the Organisation of Petroleum Exporting Countries (OPEC) was formed comprising several national oil companies. Between the 1920s and 1960s, international oil companies kept the price of crude oil stable, notably below $40 per barrel until the 1970s when OPEC started its plan to control crude oil price. The year 1973 marked the first attempt the cartel sought to exercise its control over crude oil prices. The crude oil price rose from the first time in Nigeria from $3 to $11.6 per barrel in response to the uncertainties created by the Grab-Israel war, which erupted in October 1973. The resultant rise in the price of crude petroleum generated a total of about N9.2 billion in revenue for Nigeria in 1994 as the country exported 108 million tonnes of crude oil in the same year.

According to Erygit (2009), the urbanisation and transformation of the international economy have led to an increase in the demand for oil because oil is the livelihood of the economy. As a result of the daily use of oil, there was an increase in its demand. To this effect, the crude oil market has and continues to experience ongoing changes because it is crucial to the world and its market (Ogundipe, Ojeagaa and Ogundipea, 2014). According to Guo and Kliesen (2005), oil price shocks raise doubt about future prices of oil and thus delay business outlay. In Elder and Serletis (2010), indecision about oil price is argued to induce optimising firms to postpone irreversible investment decisions as long as the expected value of information surpasses the expected short-run return to current investment. Therefore, both positive and negative shocks in the price of oil increase uncertainty in the economy, thereby causing investment to stagnate.

Fluctuations in the price of crude oil especially high crude oil price also harm the agricultural sector. This sector consumes a lot of oil to power the many machines, such as tractors and croppers, necessary for agricultural production. With the high use of oil in agricultural activities, a rise in the price of crude oil increases expenses and reduces productivity, reflecting reliance on antiquated methods. The poor contribution of agricultural output to the economy was a result of the neglect following the discovery of crude oil.

The manufacturing sector is also affected, as an increase in crude oil price in the form of fuel, gas or diesel reduces production due to increased production costs resulting in lower consumer demand. The rise in the price of crude oil has affected the cost and quantity of raw materials purchased for production. The rise and fall in the price of crude oil also concern the transportation sector. This industry is significantly dependent on oil for all transportation activities. The crude oil price increase is transferred to the price of petroleum products and from the side of the consumer (household, industry, and government), the energy bill increases, while from the side of production, firms have to compete with an increase in unit costs. Figure 1 shows the Global crude oil price from 1981 to 2015.

Figure 1: Global crude oil price (1981 - 2015)



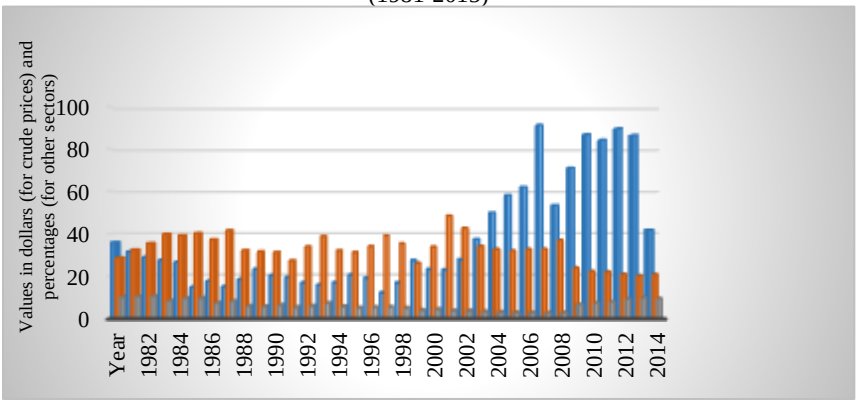
Source: OPEC Bulletin 2015

From the graph above, the X-axis represents the years, while the Y-axis represents the crude oil price for the various years. The price of crude oil fell from $35.93 to $28.83 per barrel from 1980 – 2003, and there was an increase from $38.625 to $108.66 per barrel between 2004 and 2013. There was a relative decline in the global price of crude oil after 2013, from $108.66 to

$52.38 in 2015, which impacted negatively on the macroeconomic environment of the Nigerian economy.

From Figure 2, the fall of the price of crude oil from $36 to $27.69 in the period from 1980 to 2003 led to an increase in agricultural output from 28% to 42% and a fall in manufacturing output from 9.8% to 3.3%. From 2004 to 2013, the global price of crude oil increased from $37.41 to $89.84 which led to a reduction in agricultural output from 32% to 20.9% and a small increase in manufacturing output from 3.06% to 9.03%. From 2014 to 2015, the price of crude oil fell from $86.79 to $41.45%; agricultural output responded with an increase from 20.2% to 20.8% and a fall from 9.7% to 9.56% in manufacturing output.

Figure 2: Global crude oil price, agricultural output and manufacturing output (1981-2015)



Source: OPEC Bulletin 2015

Crude oil price volatility affects the Nigerian economy in every aspect. For example, when there is a rise in the price of fuel, transportation would increase for all entrepreneurs. As a result, the cost of goods and services will increase. Also, employers would not want to employ due to the very high cost of production. Moreover, employees would agitate for an increase in salaries and wages due to the increase in the cost of living. Over-dependency on oil has made revenue earning from crude oil fall drastically since 2012 because the US, Nigeria's top consumer of crude oil, has reduced their dependence on oil. This has made the county embark on the search for a new buyer. The reduction in the consumption of Nigerian oil by the US economy has devaluated the naira, depleted federal and state funds, depleted external reserves, spurred inflation, and caused project deferral in the oil and gas sector, not to mention the loss of jobs.

According to Eneji, Mal-lafia and Nnandi (2016), high crude oil prices are likely to make production costlier for businesses and make it more

expensive for individuals or households. At the macro level, an increase in the price of oil is commonly thought to raise inflation and shrink economic growth. Regarding inflation, the price of oil directly affects the prices of goods made with petroleum products. The prices of crude oil indirectly affect the costs of transportation, agriculture, manufacturing, and investment. The increase in the cost of transportation, manufacturing, agriculture and investment can at one time or the other affect the prices of a range of goods and services, as producers transfer production costs to the consumers. The supply of and demand for goods other than oil can restrain the growth of the economy as a result of rising oil prices. Increases in the price of oil can discourage the provision of other goods because they increase the cost of producing and can reduce wealth by bringing down the demand for other goods, as well as induce uncertainty about the future. Also, the rise in the price of crude oil has caused the agricultural sector not to be able to fulfil its traditional role of feeding the population, providing the raw material needs for industries and substantial exports.

Nigeria's economy and national budget are in severe decline as a result of the oil price drop in June 2014, $105.79 to $30.77 in February 2016. State governments have less money to manage the affairs of the public, and the external reserves are depleting rapidly. Debt servicing has gone up, particularly external debt and Nigeria needs significant funds to tackle the budget deficit. The government has tried to control the economic problem of oil price fluctuation by trying to diversify the economy through export promotion and by increasing agricultural and manufacturing output, employment, protecting the naira and maintaining the inflow of foreign investment. However, despite these strategies, the government is still struggling to achieve its aims to increase its agricultural and manufacturing product and solve transportation problems. The economy is still struggling to survive because it has not sufficiently diversified its economy and the oil, which is the primary source of revenue for the Nigerian economy is fluctuating.

As a result of these problems, this paper addresses the question, 'what is the impact of crude oil price volatility on the transport sector, agricultural output and manufacturing output in Nigeria from 1981q1-2015q4?'. The choice of the period marks the period of over-dependence on oil revenue that crowded out the agricultural sector and other sectors in the economy. This study contributes to the literature by being the first to empirically estimate and analyse the impact of crude oil price volatility on selected economic sectors (transport sector, agricultural sector and the manufacturing sector) in Nigeria together. This study looks at how crude oil price volatility has affected the different non-oil sectors in the Nigerian economy in order to help the government and policymakers make policies that will diversify the

economy. This will also enable Nigeria to increase export of non-oil products and enhance the performance of its economy.

The exponential generalised autoregressive conditional heteroscedasticity (EGARCH) model was adopted to address the core objectives of the study. The empirical result shows that a certain period of low volatility is followed by a period of low volatility, and a period of high volatility is followed by a period of high volatility. The crude oil price has a negative impact and is statistically significant to the transportation sector, manufacturing output, and the agricultural sector.

2. Review of the Literature

The impact of crude oil price on the transport sector and agricultural and manufacturing output has received theoretical and empirical attention in different economies over the past decades. The Earliest theoretical works on the relationship between crude oil price and transportation, agricultural and manufacturing output include the works done by Corden and Neary (1982), IMF (2007), Collier and Hoeffler (2001), Hotelling (1931), Kaldor (1939), Working (1949), Brennan (1958), Telser (1958), Ball and Mankiw (1994) and Hamilton (2009).

According to Corden and Neary (1982) and Corden (1984), the Dutch disease shows that a real exchange rate appreciation is a result of an outer increase in resource prices or resource output which results in a fall in the manufacturing sector. This effect occurs mostly as the resource movement effect and the spending effect. The resource movement effect results from the perfect mobility of capital and labour from the manufacturing sector to the oil and services sectors and the spending effect can be seen as the negative outcome of real exchange rate appreciation on the manufacturing sector production. The effect occurs as a result of increases in oil prices, which generate rises in wages and profits and causes an increase in aggregate demand in the economy. According to IMF (2007), the greater part of resource-rich economies are growing nations, and the link between the removal and development is a contentious issue. There is little agreement about the transmission channels from the misuse of non-renewable natural resources to sustainable development outcomes, and about the basics to escape the resource curse, let alone if the curse argument is a valid one.

According to Hotelling's theory, non-renewable resource owners will produce only if it yields greater returns than bonds and other interest-bearing securities. From the assumptions of the theory, markets are efficient, and the owners of the non-renewable resource are motivated by profit. Despite the large implications of Hotelling's theory, the suggestion is quite simple. It recommends that if markets are capable and that the owners of the non-

renewable resource are motivated by profits, they will produce a tight supply of their product if it gives more than bonds or interest-bearing instruments.

According to Ball and Mankiw (1994), asymmetric increase in oil prices occurs as a result of positive trends in inflation. Studies of this theory found that price of products and services that include oil, gasoline, manufacturing, agricultural and bank deposit rate will increase more in response to raw materials than when they decrease or fall in the reduction of costs. With this feature, real shocks in the price of a firm's output cause more significant changes than the shocks of an adverse price of the same size as the firm's product. The theories of Kaldor (1939), Working (1949), Brennan (1958) and Telser (1958) are the dominant model of commodity forward and future prices. It relates the commodity's current and expected price via the optimality condition of a representative firm with storage technology. The storage firm equates the value of selling the marginal barrel of oil at the price it would fetch in the spot market to the value of the carrying-period spot price of oil. This should equal the expected value of a barrel of oil in the following period, less the physical storage cost of carrying that marginal unit as inventory, plus the marginal convenience yield derived from having another unit of the commodity as inventory. This value is discounted to the current period by the required rate of return that is appropriate for the non-diversifiable risk embedded in such a transaction. Hamilton (2009) maintains that a key mechanism through which oil price shocks affect an economy is through disruption in the expenditure of consumers and firms on non-oil goods and services.

2.1 Empirical Literature

There is a lot of empirical literature on oil price volatility and economic sectors. Nevertheless, most of the early and notable works on the subject have been devoted to an optimistic appraisal of the future of the industry. This section will be divided into foreign studies and domestic studies for easy understanding.

Studies such as Gounder and Barleet (2007), Eltony and Al-Awadi (2001), Raguindin, Reyes (2005) and Mohammad and Mehdi (2012) revealed that policymakers should consider shocks in the price of oil as a major source of volatility for many variables in the economy. Again, shocks in the price of oil also determine the expenditure of the government. Also, Sadorsky (1999) researched the dynamic interaction between economic variables and oil price using US data on industrial production. The study found that changes in oil price and volatility in the price of oil have a significant negative impact on real stock returns. Mohd, Tan, and Hafizah (2013) examined the impact of oil price volatility on macroeconomic variables in Pakistan. The study found that in the long-run, the consumer

price index and the trade deficit rise due to negative oil price shocks. Also, Emmanuel, Charles and Christopher (2015) studied the effect of oil price on domestic investment and found that the effect of oil price shocks on investment was negative.

Focusing on domestic studies Alley, Asekomeh, Mobolaji and Adeniran (2014), Agbede (2013), and Charles & Michael (2010) examined the effects of shock in the price of oil and volatility on output, price and exchange rate on the economic growth of Nigeria and Kenya. The studies revealed that shocks produce uncertainty and undercut efficient fiscal management of crude oil revenue, which is the adverse effect of shocks in the price of oil. Also, Charles & Michael (2010) revealed that oil shock on output is even in nature, and the impact of price decrease is significantly higher than that of the oil price increase. Furthermore, the GDP of Nigeria is affected by changes in prices, and the exchange rate in the long-run and also oil price shock affects the GDP growth of both countries.

Mgbame, Donwa and Onyekweni (2015) examined the consequences of the volatility in the price of oil on economic growth and development of the Nigerian economy. Their result shows that volatility in oil price impacted directly on real import, real government expenditure, real exchange rate, inflation rate, and unemployment level.

Binuomote and Odeniyi (2013) examined the effects of crude oil on agricultural productivity in Nigeria between 1981 and 2010. The result revealed that the major determinants of agricultural productivity in the long-run are exchange rate, capital, labour and trend, while the price of crude oil is the most important determinant of agricultural productivity in the short-run. Olomola (2006) and Olomola and Adejuma (2006) examined the effect of shocks on the price of oil on real exchange, output, inflation, and the money supply in Nigeria using the VAR model. They found that the shocks in the price of oil controls the real exchange rate significantly. It does not affect inflation and output in Nigeria. Akpan (2007) investigated shocks in the price of oil and the key macroeconomic variables in Nigeria. The study found that oil price shocks positively and significantly increase inflation and directly increase real national income through higher export earnings.

Eneji, Mai-Lafia and Nnandi (2016) employed vector autoregression analysis in secondary time series data. They found that the real GDP, exchange rates, Unemployment, Balance of payments and interest rates in Nigeria are not significantly affected by the fluctuation in the price of oil. Negative shocks in the world oil market have a significant impact on price fluctuations. Ayadi (2005) employed vector autoregression (VAR) model from 1980 to 2014 and found that changes in the price of oil affect the real exchange rates, which, sequentially, affect industrial production. The study concluded that increases in industrial output are not caused by increases in oil prices in Nigeria.

Muritala, Taiwo and Olowookere (2012) examined the impact of the price of crude oil, price of the stock and some macroeconomics variables on the economic growth of Nigeria from 1980 to 2010. It was found that the price of crude oil, stock price, and exchange rates have a significant effect on the Nigerian economy. Similarly, Donwa, Mgbame, and Onobun (2015) examined the relationship between oil price volatility and Nigeria's economic growth. From their findings, Nigeria was able to have increased economic growth from high global prices in the short-run, and in the long-run uncertainty of oil price and overdependence on oil had an adverse effect. Also, Alhassan and Kilishi (2016) employed the GARCH model and its variant (GARCH-M, EGARCH, and TGARCH) with daily, monthly and quarterly data in analysing the macroeconomic variables and oil price volatility. They found that all the macroeconomic variables are highly volatile (real GDP, interest rate exchange rate, and oil price).

Muhammad (2013) investigated the variables which may cause volatility in the price oil and how much these variables cause the volatility in the price of oil. The researcher used monthly secondary data from 1973 to 2011, which was analysed using the GARCH (1,1) model. The researcher found that oil demand has a significant effect on the price of oil. Ebele (2015) investigated the impact of crude oil price volatility on economic growth in Nigeria within the period of 1970 to 2014. From the result, the study revealed that oil price volatility has a negative impact on economic growth. Rolle and Uffie (2015) examined the direct and indirect impact of oil volatility in Nigeria's economy. The study adopted the methodology of Vector Autoregression and Dynamic simulations of forecasting error variance decomposition. The study found that oil price volatility significantly stimulates most of the macroeconomic variables and Nigeria's public expenditure.

Madueme and Nwosu (2010) investigated the effects of oil price shocks on the Nigeria macroeconomic performance within the period from 1970-2008 using the Engle-Granger (EG) test. They found that the crude oil price contributed positively to Nigeria's economic growth during the sample period. Finally, Afees and Ismail (2012) examined the performance of volatility models for oil price using returns of WTI (West Taxes Intermediate). The study adopted the asymmetric GARCH model, which appears to be superior to symmetric ones in dealing with oil price volatility. The result revealed evidence of leverage effects in the oil market and concluded that ignoring these effects in the price modelling will lead to serious bias and misleading results.

Other studies have only succeeded in investigating how oil price has affected the macroeconomic variables and the aggregated sectors in the economy. Furthermore, previous studies have failed to look at how oil price shocks affected the disaggregated non-oil sectors like agricultural sectors, manufacturing sectors and how it impacts on the infrastructural investment

and capital inflow (foreign direct investment) in the economy. The gap this study fills is to investigate how the oil price volatility and oil price shock affect selected economic sectors in Nigeria, i.e., how oil price shocks impact on each sector separately.

3. Methodology

The objective of this study is to examine the impact of crude oil prices on the transportation sector, agricultural and manufacturing output, knowing that all these non-oil sectors use crude oil in different forms. The study made use of quarterly data from 1980q1 to 2015q4 sourced from the Central Bank of Nigeria's (CBN) Statistical Bulletin 2015, World Development Indicator (WDI) 2015 and Organisation of Petroleum Exporting Countries (2015) statistical table. Following Hamilton (1983), Hooker (1986), Gisser (1985) and Laser (1987), the cause of fluctuation in the growth of GNP is the result of volatility in oil prices. As shown in equation 1, this study will adopt a simple framework used by Hamilton (2005) to investigate what the effect of energy supply disruptions should become from examining a production function relating the output Y produced by a particular firm to its inputs of labour N, capital K, and energy E:

$$Y = f(N, K, E) \tag{1}$$

The empirical exercise is now to estimate the impact of oil price volatility and shock on the disaggregated economic activities in Nigeria.

Engle (1982) suggested the ARCH (autoregressive conditional heteroskedasticity) model as an alternative to the standard time series treatments. According to Engle volatility, clustering is a period of high volatility which continues for a while after a period of increased volatility. The ARCH model takes the high determination of volatility into consideration, and the ARCH is one of the most regular tools for characterising changing variance and volatility. Another approach led by Bollarslev (1986) broadened the ARCH model into GARCH (generalised ARCH) model. The good feature of this approach is that a GARCH model with a small number of terms appears to perform more or better than an ARCH model with many conditions. However, neither the ARCH nor GARCH model can capture this asymmetry.

As a result, the exponential GARCH (EGARCH) model was developed by Nelson (1991), who demonstrates the existence of asymmetry in volatility on the direction of real growth. The EGARCH model allows for the testing of asymmetries; the technique is widely used for its impact to dictate the extent to which one variable impact on another. The EGACH model 2 shall

be used to test the impact of crude oil price on the transportation sector, agricultural and manufacturing output in Nigeria.

$$h_t = \gamma 0 + \sum_{i=1}^{p} \delta j h_{t-1} + \sum_{j=1}^{q} \gamma j u^2{}_{t-1} \quad (2)$$

EGARCH (p, q) model is given by

$$Log(\delta_{t2}) = \alpha + \beta In(\delta_{-1}) + \frac{\gamma \mu_{t-1}}{\sqrt{\delta 2_{t-1}}} + \alpha \left[\frac{\mu_{t-1}}{\sqrt{\delta 2_{t-1}}} - \sqrt{\frac{2}{\pi}} \right] \quad (3)$$

where σ_{t2} = conditional variance
σ_{t-1} = 1st lag of the coefficients
μ_{t-1} = 1st lag of the residual
$\beta, \alpha, \gamma, \Pi$ = parameters

3.1 The Model

The EGARCH model will be used to capture the broad objectives, which are to examine the impact of crude oil price on the transportation sector, agricultural and manufacturing output in Nigeria. The models 4, 5 and 6 specification in their general form are as follows:

$$GET_t = f(COP, REXR, INF, BOP).....(3.4)$$

$$AGO_t = f(COP, REXR, INF, BOP).....(3.5)$$

$$MNO_t = f(COP, REXR, INF, BOP).....(3.6)$$

where GET = government expenditure on transportation proxy of the transport sector
AGO = agricultural output
MNO = manufacturing output
COP = crude oil price
REXP = real exchange rate
INF = inflation
BOP = balance of Payment

Equation (4), (5) and (6) is transformed into the conditional mean equations 7, 8, and 9 as

$$GET_t = \beta_1 + \beta_2 COP + \beta_3 REXP + \beta_4 INF + \beta_5 BOP + \mu t.....,\mu t \sim iiN(0, \sigma t2)....(7)$$

$$AGO_t = \beta_1 + \beta_2 COP + \beta_3 REXP + \beta_4 INF + \beta_5 BOP + \mu t.....,\mu t \sim iiN(0, \sigma t2)...(8)$$

$$MNO_t = \beta_1 + \beta_2 COP + \beta_3 REXP + \beta_4 INF + \beta_5 BOP + \mu t.....,\mu t \sim iiN(0, \sigma t2)...(9)$$

where β_1, β_2, β_3 β_4, β_5 and β_6 represents the intercept and slope parameters of the model.

The easiest form of the GARCH (p, q) as shown in model 9b is the GARCH (1,1) model. And the variance equation has the form::

$$h_t = \frac{\gamma 0}{1-\delta} + \gamma 1 \sum_{j=1}^{\infty} \delta^{j-1} \mu_{t-j}^2 \tag{9}$$

It will be better to estimate the GARCH (1,1) model as an alternative to ARCH models of high-order because by using GARCH(1,1) we have fewer parameters to approximation and therefore lose the lesser degree of freedom. Following Nelson (1991), the EGARCH model will be used to model volatility with the conditional variance equation (10) specified as:

$$\log(h_t) = \alpha + \sum_{j=1}^{m} \beta j \left| u_{t-j} \Big/ \sqrt{h_{t-j}} \right| + \sum_{j=1}^{n} \theta j \frac{u_{t-j}}{\sqrt{h_{t-j}}} + \sum_{i=1}^{n} \delta \log(h_{t-i}) \tag{10}$$

where α, β, θ and δ are parameters to be estimated, the left-hand side is the log of the variance series. This makes the leverage effect exponential instead of quadratic, and there the estimate of the conditional variance is guaranteed to the non-negative.

If then, the GARCH-M are co-integrated, by definition $\mu_t \sim I(0)$. Thus, we can express the relationship between the variables with an ECM specified as equation (11) below:

$$\Delta Y_t = a_0 + b_1 \Delta X_t - \mu_{t-1} + Y_t \tag{11}$$

3.2 Diagnostic test

3.2.1 Unit root test

A series Y_t is integrated of order one (denoted by $y_t \backsim I(1)$ and contains a unit root if y_t is non-stationary. A non – stationary time series y_t might need to be a difference more than once before it becomes stationary. Then, a series y_t that becomes stationary after d (denote by $y_t \backsim I$ (d) if yet is non-stationary but is stationary; = y_t-y_{t-1} and in constructing a time series data, the now-stationary property will be determined for each variable, each of the series in the level difference. Using the Augmented Dickey-Fuller (ADF) Test, all variables were tested at levels. Consider the equation (12) below:

$$\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + \alpha \sum_{i=1}^{p} \Delta Y_{t-1} + \mu_t \quad (12)$$

3.2.2 Co-integration test

Johansen's approach of co-integration will be used, since n > 2, as a result of multiple equations. i.e. having more than two equations in the model which is a very serious problem that cannot be resolved by the EG approach, by the EG single-equation approach. The Johansen approach of multiple equations can be written as equation (13) below:

$$Z_t = A_1 Z_{t-1} + A_2 Z_{t-2} + A k Z_{k-1} + U_t \quad (13)$$

4. Empirical Results and Discussion

4.1 Unit Root Tests

Before carrying out the test for ARCH effects and the exponential generalisation autoregressive conditional heteroscedasticity (EGARCH) test, a unit root test was first conducted to examine the stationarity properties of the variables in the study. While the EGARCH approach to co-integration does not necessitate the pretesting of the variables for unit root, it is imperative to perform unit root tests to verify whether the variables are not integrated of an order higher than one to avoid spurious results. Table 1 shows order of integration of the variables.

Table 1: Test for the order of integration

Variables	**Phillips-Perron**				
	Level	**Test critical value @ 5%**	**1st Diff**	**Diff Prob**	**Order of Integration**
AGO	-1.760	-2.882	-5.823*	0.000	I(1)
MNO	-1.568	-2.882	-5.947*	0.000	I(1)
GET	-1.585	-2.882	-5.998*	0.000	I(1)
COP	-1.468	-2.882	-4.313*	0.0006	I(1)
REXR	0.669	-2.882	-5.142*	0.000	I(1)
INF	-2.914*	-2.882	-5.365	0.046	I(0)
BOP	-3.112*	-2.882	5.470	0.028	I(0)

The results of the Phillips-Perron test are reported in Table 2, and the lag truncations for the Bartlett kernel were chosen according to the Newey and West (1987). Analytically, the results from the unit root tests show that Balance of Payment (BOP) and Inflation (INF) are integrated of order zero

I(0) indicating that there is no present of a unit root in their level form. While, Agricultural output (AGO), Manufacturing output (MNO), Government expenditure on transport (GET), Crude oil price (COP) and Real Exchange rate (REXP) are integrated of order one I(1) indicating that there is no present of a unit root in their first difference.

4.2 Cointegration Test

This test identifies the number of stationary long-run relationships that exist among the set of integrated variables. It offers two tests, namely the trace test and the Max-Eigenvalue test. The trace statistic shows the null hypothesis that there are at most *r* number of co-integrating relationships among the variables. A rejection of the null hypothesis means that there are more than *r* numbers of co-integrating relationships. On the other hand, the null hypothesis associating with the Max-Eigenvalue is rejected when the Max-Eigenvalue statistic value exceeds the critical value at every level of r (see Table 2). Trace test indicates four (4) co-integration equations at 5% level, and the Max-Eigenvalue test also indicate one (1) co-integrating equation at 5% significant level. This shows that there is a long-run relationship.

Table 2: Unrestricted Co-Integration Rank Test (Trace)

Hypothesised No of CE(s)	**Eigenvalue**	**Trace Statistics**	**0.05 Critical Value**	**Prob****
r0	0.403	190.261	125.615	0.000
r1	0.238	120.655	95.754	0.0004
r2	0.224	83.923	69.819	0.003
r3	0.165	49.713	47.856	0.033
r4	0.100	25.439	29.797	0.146
r5	0.065	11.198	15.495	0.200
r6	0.015	2.108	3.841	0.147

Note: The test indicates 4 co-integrating equations at the 0.05 level.

Table 3: Unrestricted Co-Integration Rank Test (Maximum Eigenvalue)

Hypothesised No of CE(s)	**Eigenvalue**	**Trace Statistics**	**0.05 Critical Value**	**Prob****
r0	0.403	69.606	46.231	0.000
r1	0.238	36.732	40.078	0.114

r2	0.224	34.210	33.877	0.046
r3	0.165	24.274	27.584	0.125
r4	0.100	14.241	21.132	0.346
r5	0.065	9.090	14.265	0.279
r6	0.015	2.108	3.841	0.147

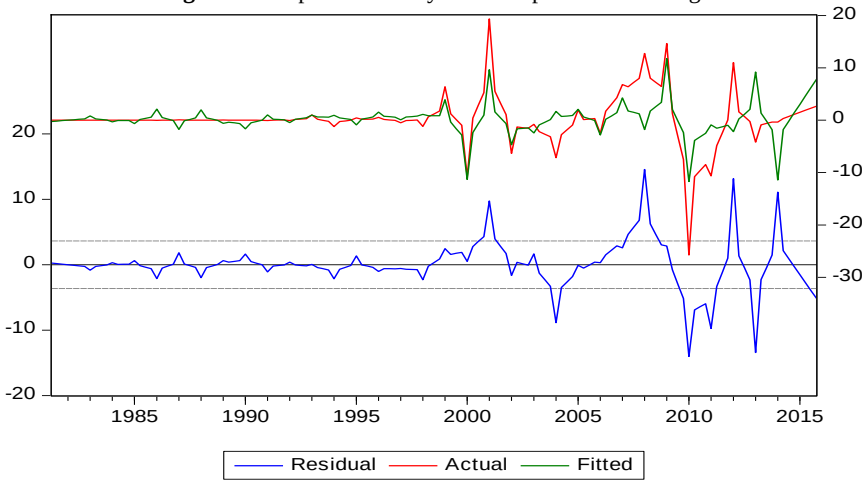
Note: The test indicates 4 co-integrating equations at the 0.05 level.

4.3 Test of Hypotheses

The objective of the study is to examine the impact of crude oil price volatility on the transportation sector, agricultural output and manufacturing output in Nigeria. To achieve this, several hypotheses are analysed.

H_o1: *Oil price volatility does not significantly impact on the transport sector in Nigeria*

Figure 1: Oil price volatility and transport sector in Nigeria



From Fig 3 certain periods have higher volatility and are riskier than others. This means that the expected value of the magnitude of the disturbance term can be greater at certain periods compared to others. There are also certain periods of low volatility, which is followed by a period of low volatility and therefore have a lower risk than others. It is observed that large changes in crude oil price seem to be followed by other significant changes and vice versa. Table 4 shows the impact of oil price volatility on the transport sector in Nigeria.

Table 4: Impact of oil price volatility on the transport sector in Nigeria

Variable	Coefficient	Std. Error	z-Statistic	Prob.

C	612.302	351.767	1.741	0.082
D(COP)	1536.399	75.411	20.373	0.000
D(REXR)	1886.642	128.238	14.712	0.000
INF	45.239	16.436	2.752	0.006
BOP	0.072	0.016	4.384	0.000
	Variance Equation			
C(6)	1.157	0.636	1.819	0.069
C(7)	1.899	0.188	10.114	0.000
C(8)	-0.496	0.152	-3.275	0.001
C(9)	0.876	0.035	25.352	0.000

Since the coefficient of C8 is negative and statistically significant, it means that there is a leverage effect and that is there is a negative correlation between crude oil price and transportation in Nigeria. When the price of crude oil increase, it will increase the cost of fuel, gas and diesel, thereby increasing the cost of transportation in Nigeria. From the above result, we reject the null hypotheses, therefore accept the alternative hypotheses. The increase in government expenditure on road transport is because of the rise in the crude oil price which will affect the pump price in the form of fuel, kerosene and diesel. The result of the test also shows that a positive shock of crude oil has more effect than negative shock, thereby rejecting the null hypothesis and accepting the alternative hypothesis.

H_o2: *Oil price volatility does not significantly impact on agricultural output in Nigeria*

Figure 2: Oil price volatility and the agricultural output in Nigeria

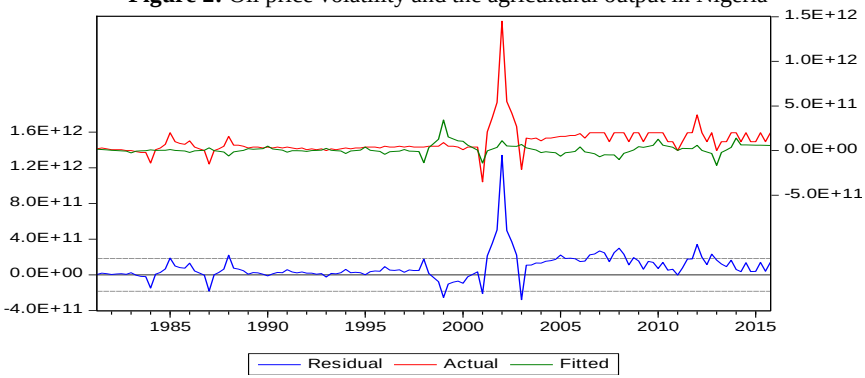


Fig 4 also shows that a period of high volatility is followed by a period of high volatility and a period of low volatility is followed by a period of low volatility. It is then observed that large changes in crude oil price seem to be followed by significant changes while low changes in crude oil price will also follow low change. Table 5 shows the impact of price volatility in the agricultural sector in Nigeria.

Table 5: Impact of oil price volatility in the agricultural sector in Nigeria

Variable	Coefficient	Std. Error	z-Statistic	Prob.
D(COP)	2.71E+09	2.28E+09	1.191	0.234
D(REXR)	1.18E+10	1.91E+09	6.192	0.000
D(INF)	-1.90E+09	9.09E+08	-2.090	0.037
D(BOP)	-50882.38	765238.0	-0.066	0.947
D(GCE)	-8.36E+08	1.72E+08	-4.869	0.000
	Variance Equation			
C(6)	4.681	1.693	2.765	0.006
C(7)	0.964	0.124	7.772	0.000
C(8)	-0.259	0.111	-2.341	0.019
C(9)	0.897	0.034	26.133	0.000

LOG(GARCH) = C(6)+C(7)*ABS(RESID(-1)/@SQRT(GARCH(-1)))+C(8)*RESID(-1)/@SQRT(GARCH(-1))+C(9)*LOG(GARCH(-1)

Since the coefficient of C8 is negative and statistically significant, it means that there is a leverage effect and that is there is a negative correlation between crude oil price and agricultural output in Nigeria. When the price of crude oil rises, it will reduce the output of agricultural production as a result of the increase in the price of crude oil in the form of fuel, gas and diesel that will be used in machines, tractors and coppers for power generation. The negative shock of the price of crude oil has more effect than the positive stock on the conditional variance (dependent variance). From the results, we reject the null hypothesis; we therefore accept the alternative hypotheses.

H_o3: *Oil price volatility does not significantly impact on manufacturing output in Nigeria*

Figure 3: *Oil price volatility and manufacturing output in Nigeria*

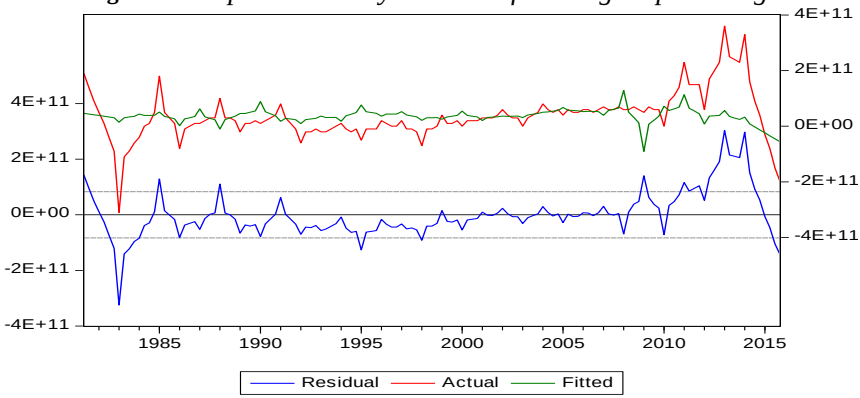


Fig 5 also shows that large changes in crude oil price brings about other significant changes and have higher risk and shocks, while low changes in crude oil price bring about other low changes and have a lower risk and shocks. This is called volatility clustering.

From Table 6, since the coefficient of C8 or *RESID(-1)/@SQRT(GARCH(-1)) is negative and statistically significant, it means that there is a leverage effect, that is there is a negative correlation between crude oil price and manufacturing output in Nigeria. When the price of crude oil rises, it will also increase the price of manufactured goods in the market as a result of the reduction of manufacturing output in Nigeria. The negative shock has more effect than the positive shock on the conditional variance. From the result, we reject the null hypothesis; we therefore accept the alternative hypotheses.

Table 6: *Impact of oil price volatility on the manufacturing sector in Nigeria*

Variable	Coefficient	Std. Error	z-Statistic	Prob.
D(COP)	1900.231	61.601	30.848	0.000
D(REXR)	1975.994	105.479	18.734	0.000
INF	8.216	17.7487	0.463	0.643
BOP	0.079	0.02826	2.796	0.005
C	5156.372	455.978	11.308	0.000
	Variance Equation			
C(6)	5.989	0.751	7.9778	0.000
C(7)	1.829	0.316	5.793	0.000
C(8)	-1.285	0.229	-5.599	0.000
C(9)	0.600	0.045	13.185	0.000

5. Conclusion and Policy Implications

This study shows that oil price volatility has a significant effect on the agricultural output in Nigeria. Therefore, there is a need to ensure that the economy is diversified, the refineries are working at maximum capacity, and there is the provision of alternative sources of energy. Again, there is a need to provide support to farmers and organic fertilisers to cushion the effect of high oil prices on agricultural product. Furthermore, to reduce the country's vulnerability to oil price volatility, policymakers must adopt risk management instruments such as shoring up the country's external reserves and hedging against fluctuating oil prices.

The country should come up with new reform policies and diversify its export revenue base as a means of minimising reliance on crude oil sales and petroleum products. Some of these include fiscal prudence, reform in budgetary operations, export diversification, the revival of non-oil sectors of the economy, accountability and corporate governance. This will further shield the economy from the impact of oil price fluctuations.

For Nigeria to experience higher economic growth, the economy should leverage its non-oil sectors, such as agriculture, manufacturing and infrastructure, which would eliminate some dependence on crude oil – a market that shows tepid signs of recovery. The economy should also introduce agricultural policies that will create a platform for Nigeria to diversify from its reliance on oil exports. The government should adopt a prudent fiscal policy in relation to oil prices. This could be done through the elimination of some taxes on crude oil and gradual removal of oil price subsidies. The removal of fuel price subsidies is necessary since the increase in government expenditure is as a result of oil price subsidy only work to reinforce the negative impact of oil price increases on the economy.

Policymakers of net oil-exporting countries like Nigeria are also recommended to boost to the restructuring of their economies in such a way that its non-oil exports will boost her economy. The national income should be enhanced by diversifying the export base of the economy from oil to non-oil since the country's trade opening is not significantly impacting the economy at present. Besides, efforts should be made to refine all the derivatives of oil at home while manufacturing activities should be promoted since primary product exports have suffered in terms of trade.

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