OIL PRICE VOLATILITY AND BALANCE OF PAYMENTS (BOP): EVIDENCE OF NIGERIA

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Abstract
This study examines the effect of oil price volatility on Nigerian Balance of Payment (BOP) from 1980 to 2017, using the Autoregressive Distributed Lag (ARDL) bound testing technique, and the Autoregressive Conditional Heteroscedasticity (ARCH)-type model (EGARCH-M) to examine the nature and behaviour of Nigeria's oil (Bonny light) price volatility. The results from the ARCH-type model (EGARCH-M(1,1)) indicate that the Nigeria's oil price volatility is not mean reverting, with negative shocks generating more impact than positive shocks, which is determined negatively by global oil supply and negatively by world oil demand. Equally, while the result of the ARDL bound test confirms the presence of co-integrating (long-run) relation between Balance of Payment and oil price volatility (and oil export and economic growth), the result from the ARDL model indicates the presence of significant negative relationship between oil price volatility and Balance of Payments in Nigeria, thus indicating the negative effect (deficit) of oil price volatility on Nigeria's BOP, due to the overreliance and dependence of the economy on oil export. The study therefore recommends the diversification of Nigeria's export basket, for enhanced participation of non-oil products, coupled with the adoption of the Petroleum Industry Bill (PIB), so as to enhance the productivity and performance of the country's oil and gas industry, and making it internationally competitive

Keyword: ARCH-type model, ARDL, Balance the of Payment, Oil Price, Oil Price Volatility
JEL Classification: Q43, F32, C22, P43, P45

1.0 Introduction

Nigeria's economy can be conveniently labeled a "*consuming economy*", not because goods and services are not being produced, or export of goods and services does not take place, but rather because the economy is import-dependent, with poor export base, basically constituting of a single primary product (oil), whose earnings essentially self-service, finance and maintain the consumption expenditure of government. This evident as the importation of non-oil products account for more than 30% of total trade, and more than 50% of the total exportation, respectively, while total importation of oil and non-oil products accounts for 70% of total exportation and exportation of oil and gas, and above 50% of total trade. However, oil export constitutes more than 90% of the total export base, and receipts from exporting oil account for more than 50% revenue source for the government (Central Bank Nigeria CBN], 2017).

With oil export being the mainstream of Nigeria's export basket, constituting more than 90% oil export, coupled with inflows from oil export accounting for more than half of the revenue accrued to the government, and equally massively importing refined petroleum and other related products, the economy has continue to battle with dwindling and unstable oil revenue, alongside negative trade or merchandise balance, which therefore translates to deficit in Nigeria's Balance of Payments (BOP), since inflow from oil export dominates the current account (Sakanko & David, 2017), and oil export accounts for more than 50% of total trade (CBN, 2017). The dwindling nature of inflow from oil export which is basically due to the instability and volatile nature of oil price has also caused the economy-crushing debt services burden (Matthew & Adegboye, 2012), depreciation of the exchange rate (Matthew and Adegboye, 2012; Aliyu, 2009; Agri, Inusa & Kennedy, 2016; Thankgod & Maxwell, 2013; Isah, Dikko & Ejiemenu, 2015; Alhassan & Kilishi, 2016; Ugwuanyi, 2011), declined domestic demand and the inability of the economy to tailor its import needs to the available foreign earnings (Nwanosike, 2010 cited in Nwanosike, Uzoechina, Ebenyi & Ishiwu, 2017). The deficit effect of oil price on the balance of payments in Nigeria is demonstrated in figure 1.

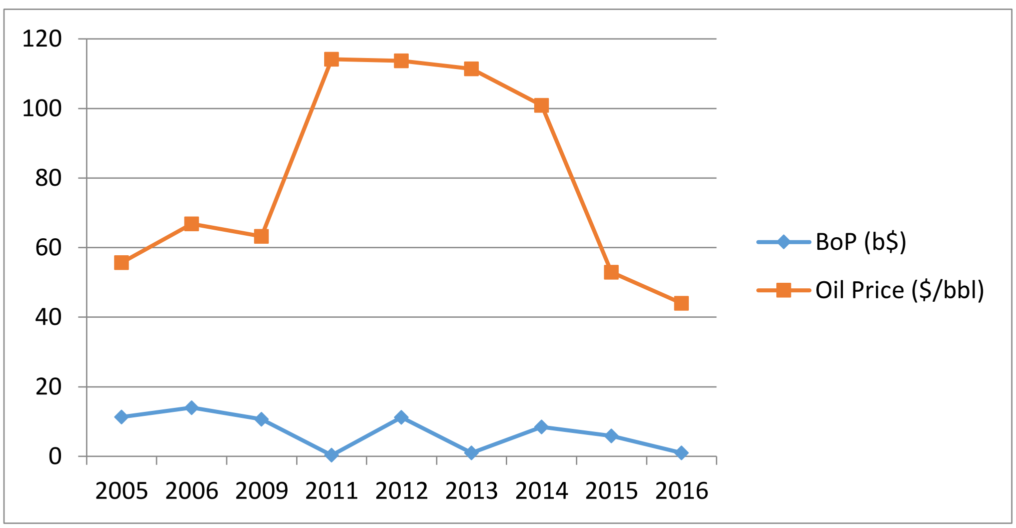

Fig. 1: Balance of Payments and Oil (Nigerian Bonny Light) Price

Figure 1 shows Bop and Nigeria Bonny light oil price in Dollar from 2005 to 2016. It is clearly shown that in the Nigerian situation, the disequilibrium of BOP is largely attributed to the fluctuation in oil prices. For example, Nigeria's overall Balance of Payments (BOP) indicated a surplus of ₦1.4881 trillion, equivalent to $11.32404 billion in 2005, ₦1.7876 trillion, equivalent to $14.01894 billion in 2006, and ₦1.7479 trillion, equivalent to $11.18799 billion in 2012, which represents 10%, 9.6% and 0.2% of the nominal GDP respectively, when oil (Bonny light oil) price averaged at $55.67 per barrel (bbl), $66.84 per bbl, and $113.66 per bbl respectively. Accordingly, with the sharp fall in the price of oil in 2009, from average of $100.60 per bbl. in 2008, to $63.25 per bbl. in 2006, the overall Balance of Payments (BOP) of Nigeria showed a deficit of ₦1.5637 trillion, equivalent to $10.61787 billion. Equally, decline in oil (Bonny light) price from average of $114.15 per bbl. in 2011, to $111.36 per bbl. in 2013, $100.85per bbl. in 2014, $52.95 per bbl. in 2015, and $44.02 per bbl. in 2016 leads to Nigeria's overall Balance of Payment (BOP) showing deficits corresponding to ₦154.2 billion, ₦1.3293 trillion, ₦1.1501 trillion, and ₦247.8 billion, equivalent to $988.1 million, $8.4525 billion, $5.8535 billion, and $980.8 million, respectively (Organisation of the Petroleum Exporting Countries [OPEC], 2018; CBN, 2017).

Furthermore, though the recent decline in oil production in Nigeria was largely attributed to the vandalization of oil pipelines and the activities of militants in the oil-rich Niger Delta region of Nigeria, coupled with political instability and change in government, has been alleged to have caused the inflow from oil export to deteriorate, it is however inconsequential as statistics showed that oil production only declined from 1,754 bbl/d (barrel per day) in 2013 to 1,748 bbl/d in 2015, which entails a 0.34% decline in oil, when oil exchanged for $111.36 per bbl. and $52.95 per bbl. respectively (OPEC, 2018), hence having a lesser effect on oil export. It is however imperative to state that oil price greatly affect the BOP stance of Nigeria, and other components of the external sector since inflows into the current account were dominated by crude oil and gas exports, accounting for more than 90 percent of total exports and more than 60 per cent of total inflows (Ogwu, 2018; Adegbesan, 2018), and it has been empirically established that it is one of the most volatile prices which has a significant impact on macroeconomic behaviour of many developed and developing economies (Alhassan & Kilishi, 2016).

Fluctuations in the price of oil have not only aid the disequilibrium of Nigeria's BOP balance, as depicted in BOP deficit in periods of negative shocks (falling prices) in oil prices, and surplus in the face of positive shocks (rising prices) in the prices of oil, but also disrupting the balance in the external economy and internal economy. This is evident as fall in oil price is usually accompanied by disruption in the Nigeria's exchange rate (Agri, Inusa & Kennedy, 2016; Isah, et al., 2015; Alhassan & Kilishi, 2016), this is because oil is the mainstream of Nigerian export basket, as it constitutes more than 90 percent of total export (CBN, 2017), hence the determinant for the demand for Nigeria's currency. Oil price volatility is also responsible for determining the revenue and expenditure of the government since inflow from its export accounts for more than 50% revenue source of the federal government (CBN, 2017).

In addition, budgeting in Nigeria which is being hinged on expected price per barrel of crude oil is also affected with uncertainty in crude oil prices. Government being the largest spender in Nigeria's economy, oil price volatility engenders instability and uncertainty in government capital and recurrent expenditure (Aigheyisi, 2018), this which have a multiplier effect on the economy. More often, rise in the price of oil is usually accompanied by increased government expenditure, coupled with enhanced budgetary performance, which translates to increase in both private consumption and investment. However, with decline in oil price, Nigeria is usually faced with decline in government expenditure and deficit budgeting, which tend to increase the government's debt, occasionally matched with fall in private investment and consumption, and generally economic downturn (as in the case of recession experience in Nigeria in 2015 – 2017).

Evidently, most accessible studies regarding oil price volatility were either concerned with its impact on the economy (see Soundarapandiyan & Ganesh, 2017; Sartori, 2016; Qianqian, 2011), economic growth, exchange rate or other macro-economic factors (see Alhassan & Kilishi, 2016; Aigheyisi, 2018; Oyeyemi, 2013; Oghenebrume, 2018; Saddiqui, Jawad, Naz & Niazi, 2018; Makau, 2017; Ugwuanyi, 2011; Matthew & Adegboye, 2012; Hashimova, 2017; Umoru, Ohiomu & Akpeke, 2018; Broni-Bediako, Onyije & Unwene, 2018; Wu & Yu, 2017). Only few (see Rammadhan, 2000; Huntington, 2015; Elamin, 2016; Jawad, 2013) narrowly based their study on oil price volatility and Balance of Payments (BOP), even though they were unable to effectively and efficiently examine the subject matter appropriately. This is due to the use of inappropriate estimation technique (see Elamin, 2016; Jawad, 2013), absence of the test for the stationarity of data used (see Huntington, 2015; Elamin, 2016) and the negligence of important post-estimation diagnostics such as the test for autocorrelation, heteroscedasticity, stability, normality, etc (see Elamin, 2016; Jawad, 2013; Rammadhan, 2000), which would ascertain the plausibility of the model estimated. In essence, this study will therefore fill the gap by explicitly assessing oil price volatility and BOP movement in Nigeria, by using the appropriate estimation technique(s), performing all the required pre-estimation and post estimation test/diagnostics, and extending the scope of the study from 1980 – 2017. The remainder of this paper is organized as follows. Section two includes a review of literatures regarding oil price volatility and Balance of Payment and section three describes the method and data. Section four provides the results and discussion, and section five concludes the paper.

2.0 Literature Review

The volatility or fluctuation of oil price is the extent to which the worth of oil inclines and decline over a period of time (Daddikar & Rajgopal, 2016). It 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 (Ogiri, Amadi, Uddin & Dubon, 2013). The oil market is therefore said to be very volatile when the market prices of oil tend to change very quickly over a relatively short time or period, while assumed to have low volatility with relative stability at prices. Oil price volatility, which of course may be negative (a fall) or positive (a rise) usually emanate from changes in either the supply of or the demand for oil (Adugbo, 2018; Yan, 2012; Jawad, 2013), though in practice, it is unlikely for demand for oil to exceed its supply, except the rise in demand is motivated by fears of supply shortages (Ugwuanyi, 2011). Since the supply (production) of oil by Organisation of Petroleum Exporting Countries (OPEC) and non-OPEC producing countries hinges on geological, economic and political factors (Stevens, 2016), and however depends on the extraction rates, depletion, new discoveries, and developments in extractive technologies that allow enhanced recovery of oil. In essence, changes in OPEC production quotas and temporary supply disruptions due to technical factors, political factors or natural disasters tends to affect the supply of oil, and hence oil prices (Ugwuanyi, 2011).

On the other hand, the Balance of Payments (BOP) (or balance of international payments) account is a periodic report that summarizes the flow of all economic transactions (visible and non-visible) consisting of imports and exports of goods, services and capital, as well as transfer payments such as foreign aid and remittances that a country's individuals, companies and government bodies complete with individuals, companies and government bodies outside the country over a defined period of time, such as a quarter or a year (Kenton, 2017). It serves as the indicator of the country's demand and supply of currency, potentials as a business partner for the rest of the world, and economic performance based on international economic competition. Since the Balance of Payments account follows the double entry bookkeeping system, in essence recording all receipts from abroad or sources of fund for a nation (such as exports or the receipts of loans and investments) as credit or positive and all payments made to abroad or use of funds (such as for imports or to invest in foreign countries) as debit or negative (Imoisi, 2012), it entails that the account is balanced, although, in practice, statistical discrepancies arise due to the difficulty of accurately counting every transaction between an economy and the rest of the world (Kenton, 2017), however when all the components of the Balance of Payment account (current and capital/financial account) are included, they must sum to zero with no overall surplus; or positive BOP, when sources of fund or receipt from abroad exceed use of fund or payments; or deficit BOP, when receipts from abroad is less than payments made (Imoisi, 2012).

Oil price volatility usually results in disequilibrium in the BOP of economies, irrespective of either being an exporter or importer of oil. For instance, while positive volatility in oil price should be considered good news in oil exporting countries, it is however bad news for oil importing countries and the reverse being the case in the situation of negative volatility in oil price (Ugwuanyi, 2011; Aleksandrova, 2016; Jawad, 2013). In essence, in the face of negative oil price volatility, oil importing countries usually experience surplus trade in the current account component of the BOP, or even deficit in overall BOP balance when country's export is below its exportation (Soundarapandiyan & Ganesh, 2017), while experiencing deficit trade with rise in oil price (Qianqian, 2011), especially when the demand for oil is very high in the country, and constituting a large percent of total importation into the country. Accordingly, negative oil price volatility tend to cause components or even the overall BOP balance in oil exporting countries to be negative or deficit, especially in countries that depend solemnly on the inflow from exportation of oil and have not diverse export basket, constituting majorly the export of oil, (for instance Nigeria), while recording surplus in trade balance or the overall BOP balance during positive oil price volatility (Adugbo, 2018), at the expense of deficit trade in oil importing countries.

Nigeria being an oil producing and exporting country, which depends wholly on inflow from oil export, as it serves as more than 50% of the revenue source accrued to the government, coupled with an unvarnished export basket which comprises of more than 90 percent oil and gas export (CBN, 2017), volatility in the price of oil is however significant in hampering both the internal and external balance of the economy (Ogwu, 2018; Adegbesan, 2018). For a long period of time, Nigeria's economy has continued to experience a lack of diversified export basket for a very long period of time (Nwanosike, et al., 2017), due to the discovery of oil which reduced the percentage of non-oil (basically agriculture) contribution to the export basket, coupled with an inflexible import basket as a result of the inability to independently refine oil product matched with the high demand for foreign products, at the expense of domestically produced (Nwanosike, et al., 2017). In addition, with the export of oil, is the largest component of trade or merchandise balance, and consequently, the overall BOP's balance of Nigeria, changes in the inflow from export, due to fluctuations in the price of crude oil have the ability to disrupt the balance of the BOP, due to the over-reliance of inflow from oil export (Ugwuanyi, 2011). Perhaps, the high dependency on importation in Nigeria tend to also cause the disruption in the BOP balance, this is significant due to the high dependency of Nigeria's economy on importation (Nwanosike, et al., 2017). The high demand for foreign products is obvious, as statistics indicates that importation of both oil and non-oil products accounts for more than 70 percent of total export and total oil and gas export, and 50% of total trade (CBN, 2017).The implication of this mismatch in export and import, especially in the face of decline in oil price will obviously result to deficit in the Nigeria's BOP balance, due to the insignificant contribution of non-oil export which is less than 10% (CBN, 2017) in total export.

Albeit, it is worth mentioning that with factors such as exchange rate disequilibrium (especially appreciation of exchange rate which make importation cheaper and export dearer), inflation, interest rate, economic growth, gross capital formation, oil production etc. influence the equilibrium in the Balance of Payments (BOP) significantly, however, in the case of Nigeria, the volatility in oil price played the most significant role. This is palpable as Nigeria's BOP indicated surplus amounting to ₦1.4881 trillion, equivalent to $11.32404 billion in 2005, with oil price (Nigerian Bonny light oil) averaging at $55.67 per barrel (bbl), which is synonymous to the ₦1.7876 trillion (equivalent to $14.01894 billion) and ₦1.7479 trillion (equivalent to $11.18799 billion) surpluses in 2006 and 2012, with oil price averaging at $66.84 per bbl, and $113.66 per bbl. respectively. Nevertheless, with the sharp fall in the price of oil in 2015 from $111.36 per bbl.

recorded in 2013, to the tune of $52.95 per bbl., the Nigerian BoP showed a negative or deficit balance amounting ₦ 1.1501 trillion corresponding to $5.8535 billion (OPEC, 2018; CBN, 2017).

Empirically, though numerous accessible studies regarding oil price volatility have been conducted, however studies relating to oil price volatility and Balance of Payments (BOP) are very scanty. Few of the studies which were raised to examine oil price volatility and/or BOP movement are usually not dedicated wholly and purely on the oil price volatility and BOP balances. For example, Rammadhan (2000) used Engle-Granger and Johansen-Juselius methods for co-integration/long-run, short-run Error Correction Model (ECM), single and simultaneous equations models, and simultaneous forecasting methods to examine the effects of oil price fluctuations on the BOP of Golf Co-operation Council (GCC) countries over the period of 1970 – 1997. The results indicate that oil price volatility impact the BOP of the GCC countries negatively, as represented by reduced oil revenues, oil export and trade balances, which is due to the strong influence of oil prices on GCC exports and growth in oil consumption of major trading partner, and the presence of long-run relationships between oil exports and imports in all GCC countries (excluding Kuwait), as well as imports and components of final expenditures in all GCC members (except the UAE), as shown by Engle-Granger and Johansen-Juselius methods of co-integration. Similarly, Huntington (2015) examined the nature of relationship between crude oil trade and current account of 91 countries over the period of 1984-2009. The results from the study shows net oil export as a significant determinant of current account surpluses. Accordingly, the author also discovered that net oil imports often do not influence current account deficits, although a rule of exception applies to relatively rich countries, where higher oil imports contributing more to current account deficits. In addition, Elamin (2016) employed a quantitative analysis to examine the effect of oil price drop on Sudanese budget and Balance of Payments. The results however show that Sudan being a net importer of oil since the secession of South Sudan in 2011, benefited from the drop in oil price, as represented in budget support, and surplus trade balance, although the benefit did not translate to domestic fuel prices and cost of transportation.

3.0 Method

Interpolated quarterly time series data from 1980-2017 was used in this study, to examine oil price volatility and Nigeria's Balance of Payments (BOP). Data for oil price (measured by the annual spot price of Nigerian Bonny light crude oil in dollar per barrel), oil demand (measured by world oil demand) and oil supply (measured by the total export of crude oil and petroleum products per 1,000 bbl. per day), were collected from the Annual Statistical Bulletin (ASB) of the Organization of Petroleum Exporting Countries (OPEC), while data for Balance of Payments (measured by the annual change in reserve) and inflow of oil export (measured by the annual inflow from the export of oil and gas) were obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin. Similarly, data on economic growth (measured by GDP growth rate) is collected from World Bank Development Indicators (WDI).

The Autoregressive Conditional Heteroscedasticity (ARCH) type models and Autoregressive Distributed Lagged (ARDL) bound testing technique for co-integration were employed to assess the volatility behavior and determinants of Nigerian oil (Bonny light), and the presence of co-integration (long-run) relationship among oil price volatility and Balance of Payment (BOP) respectively.

To test for ARCH effect, it begins with the estimation of a simple Autoregressive (AR) model (mean equation) by OLS, which is then subjected to ARCH LM test for heteroscedasticity postulated by Engle (1982) to compute the R^2 times T (or nR^2). Since the test statistics follows a X^2 distribution with q degrees of freedom, the rejection of the null hypothesis of homoscedasticity, (constant variance) suggests evidence of ARCH effects. However, if otherwise, that is ARCH effects are not present, then, the estimated parameters should be statistically insignificant (the series are not volatile). Following on, with establishing the presence of ARCH effect the ARCH (q) model will simultaneously model the mean equation and the variance equation as;

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$$OilPrice_t = a_0 + b_1 OilPrice_{t-1} + \mu_t \quad | \qquad \mu_t \sim iiD\ N\ (0, \sigma^2) \qquad \textbf{(1.1)}$$

Where $OilPrice_t$ and $OilPrice_{t-1}$ denotes oil price at time t and one period lag of oil price (oil price at a past period); identities a_0, b_1 and μ_t represents the intercept, slope of the lag of oil price and the error term (which is assumed to be independently distributed with zero mean and constant variance σ^2). Using OLS to obtain the residuals $\hat{\mu}_t$, and then run an auxiliary regression of the squared residuals ($\hat{\mu}_t^2$) upon the lagged squared terms ($\hat{\mu}_{t-1}^2, \dots, \hat{\mu}_{t-q}^2$) and a constant as in;

$$\hat{\mu}_t = \gamma_0 + \gamma_1 \hat{\mu}_{t-1}^2 + \cdots + \gamma_q \hat{\mu}_{t-q}^2 + \omega_t \qquad \textbf{(1.2)}$$

And then compute the R^2 times T (or nR^2). Under the null hypothesis of homoskedasticity ($\gamma_0 = \gamma_1 = \cdots = \gamma_q$), the resulting test statistic follows a X^2 distribution with q degrees of freedom. Rejection of the null suggests evidence of ARCH effects. 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). Following on, with establishing the presence of ARCH effect the ARCH(q) model will simultaneously model the mean equation in **Equation (1.1)** and the variance equation with the following specification;

$$\sigma_t{}^2 = \gamma_0 + \sum_{j=1}^{q} \gamma_j \mu_{t-j}^2 \quad \textbf{(1.3)}$$

Where μ_{t-j}^2 is the ARCH term; $0 \leq \sum_{j=1}^{q} \gamma_j < 1$ for a stationary series and as $\sum_{j=1}^{q} \gamma_j \rightarrow 1$ it means the series exhibit slow mean reverting, while as $\sum_{j=1}^{q} \gamma_i \rightarrow 0$ means fast mean reverting. However, the estimated coefficients of the γs have to be positive for positive variance. Therefore, due to certain drawbacks in ARCH model, its variant, the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model was developed by Bollerslev (1986). The GARCH model incorporates the lags of the conditional variance in the variance equation, as in;

$$\sigma_t{}^2 = \gamma_0 + \sum_{i=1}^{p} \lambda_i \sigma_{t-i}^2 + \sum_{j=1}^{q} \gamma_j \mu_{t-j}^2 \quad \textbf{(1.4)}$$

For stationary series $0 \leq \sum_{i=1}^{p} \lambda_i + \sum_{j=1}^{q} \gamma_j < 1$, the mean reverting process in the case of GARCH model is as $\sum_{i=1}^{p} \lambda_i + \sum_{j=1}^{q} \gamma_j \rightarrow 1$ then the model exhibits slow mean reverting, while as $\sum_{i=1}^{p} \lambda_i + \sum_{j=1}^{q} \gamma_j \rightarrow 0$ the model has fast mean reverting. Thus it is clear that for $p = 0$, the model reduces to ARCH(q). Another variant of the ARCH-type model is the GARCH-M (GARCH-in-Mean) which allows the conditional mean to depend on its own conditional variance (or standard daviation), that is the inclusion of the conditional variance (or standard deviation) in the variance equation to enter into the mean equation in **Equation (1.1)** as;

$$OilPrice_t = a_0 + b_1 OilPrice_{t-1} + \theta\sigma^2 + \mu_t \quad \textbf{(1.5)}$$

Similarly, other variants of the ARCH-type model are the Threshold GARCH (TGARCH) and Exponential GARCH (EGARCH) which captures asymmetries by including in the variance equation, a multiplicative dummy variable to check whether or not there is statistically significant difference when shocks are negative and make the leverage effect exponential instead of quadratic, and therefore guaranteeing the estimates of the conditional variance to be non-negative respectively. The specification of the conditional variance equation (for a TGARCH(l,1)) is given by:

$$\sigma_t{}^2 = \gamma_0 + \lambda\sigma_{t-1}^2 + \vartheta\mu_{t-i}^2 d_{t-1} + \delta\mu_{t-1}^2 \quad \textbf{(1.6)}$$

Where; d_t takes the value of 1 for $\mu_t < 0$, and 0 otherwise. So “good news” and “bad news” have a different impact. Good news has an impact γ, while bad news has an impact of $\gamma + \vartheta$. If $\vartheta > 0$ we conclude that there is asymmetry, while if $\vartheta = 0$ the news impact is symmetric. While the conditional variance equation for EGARCH model is given as;

$$log(\sigma_t{}^2) = \gamma_0 + \sum_{j=1}^{q} \zeta_j \left| \frac{\mu_{t-j}^2}{\sqrt{\sigma_{t-j}^2}} \right| + \sum_{j=1}^{q} \xi_j \frac{\mu_{t-j}^2}{\sqrt{\sigma_{t-j}^2}} + \sum_{i=1}^{p} \delta_i log(\mu_{t-i}^2)$$

(1.7)

Where; γ_0, ζ_j, ξ_j and $\delta_i$are parameters to be estimated. The log of the variance series makes the leverage effect exponential instead of quadratic, and therefore the estimates of the conditional variance are guaranteed to be non-negative. If the asymmetric effect is present, $\xi_j < 0$, implying that negative shocks (bad news) increases volatility more than positive shocks (good news) of the same magnitude. While the model is symmetric if $\xi_j = 0$. The ARCH-type model also allows the inclusion of explanatory variables that can help explain volatility of a variable in the conditional variance equation. In the case of this study, factors such as oil demand, oil supply and oil production which have been assume to influence price of oil will be included to determine their nature of influence on the volatility of Nigerian oil (Bonny light) price. This is specified as thus;

$$\sigma^2 = \gamma_0 + \sum_{i=1}^{p} \lambda_i \mu_{t-i}^2 + \sum_{j=1}^{q} \gamma_j \mu_{t-j}^2 + \sum_{k=1}^{m} \eta_k OilPDET_k \qquad \textbf{(1.8)}$$

Although not all the variants of the ARCH-type models will perfectly explain the volatility of oil price in Nigeria, the Schwartz Information Criterion (SIC) will be used to guide the selection of the best model selection.

Empirically, examining the relationship between Balance of Payments (BOP) and Oil price volatility in Nigeria, a simple model can be state as;

$$BoP_t = \alpha_0 + \beta_1 OilPVol_t + \beta_2 OilExp_t + \beta_2 GDPr_t + \mu_t \qquad \textbf{(2.1)}$$

Where BoP_t denotes Balance of Payments (BOP); and $OilPVol_t$ is Oil Price Volatility. whileα_0, $\beta_1 - \beta_3$, μ and$t$denote intercept, slope coefficient of explanatory variables, error term and number of observations respectively. Equally, $OilExp_t$ and $GDPr_t$ which are the control variables denotes oil export inflow and economic growth rate respectively.

The Autoregressive Distributed Lagged (ARDL) bound testing technique for co-integration will be employed to examine the nature of co-integrating (long-run) relationship between oil price volatility and Nigeria's Balance of Payments (BOP), due to its ability to examine co-integrating relationships regardless of the order of integration of the series, and its use of single reduce form equation which simultaneously estimate the long run and short run parameters of the model and allow variables have different optimal lags which is not obtainable in other methods (Abu, 2017). The ARDL technique for co-integration (long-run) relationship requires the check of series/variables stationarity, due to the fact that series used are expected to be integrated of order not more than one

(I(1)), as the existence of a second order integration (i.e., I(2)) of any series (variable) invalidates the use of the ARDL technique, which will as well produce a nonsensical results. The ARDL bounds test is used to test the null hypothesis that no co-integration exists again the alternative hypothesis that co-integration exists, using the computed f-statistic obtained from the levels parameter of the conditional ECM to compare the critical values provided by Pesaran, Shin and Smith (2001) and/or Narayan (2005). As such, when the computed F-statistic is greater than the upper bound [I(1)], we reject the null hypothesis that no co-integration exists between the series. If the F-statistic is less than the lower bound [I(0)], we accept the null hypothesis that there is no co-integration between the series. Furthermore, if the F-statistic falls between I(0) and I(1), our inference would be inconclusive. The ARDL model to be estimated is specified as follows:

$$\Delta BoP_t = \alpha_0 + \sum_{i=0}^{n} \Delta\beta_i BoP_{t-i} + \sum_{i=0}^{n} \Delta\beta_i OilPVol_{t-i} + \sum_{i=0}^{n} \Delta\beta_i OilExp_{t-i} + \sum_{i=0}^{n} \Delta\beta_i GDPr_{t-i} + \partial_0 BoP_{t-1} + \partial_1 OilPVol_{t-1} + \partial_2 OilExp_{t-1} + \partial_3 GDPr_{t-1} + \mu_t \quad \textbf{(2.2)}$$

Where **Equation (2.2)** is the Conditional ECM; $\partial_0 - \partial_3$ are the parameters of the one period lag of level variables in the dynamic model, whose coefficient would be used to compute the f-statistics to compare against the critical values of the bound test (Pesaran, Shin & Smith, 2001).

4.0 Results and Discussions

Analysis of Volatility

The results of ARCH test (test for heteroscedasticity/variance) presented in **Table 1**, following the use of ARCH LM procedure indicates the presence of ARCH effect in Nigeria's oil price. This evident as the tests for different lags up to 10th lag still shows the presence of ARCH (volatility) effect in the simple AR model, hence necessitating the use of ARCH-type model to analyze oil price volatility and Balance of Payments (BOP). Correspondingly, haven established the presence of ARCH effect in Nigeria oil price, the ARCH(q), GARCH(p,q), GARCH-M(p,q), TGARCH(p,q) and EGARCH(p,q) models were estimated, with the Schwarz Information Criterion (SIC) serving are the navigator and guide for the selection of the appropriate model. This procedure however indicates the EGARCH-M(1,1) model as the best model, considering its low SIC values in relation to other models. Equally, the post-estimation test of ARCH LM test however indicates the capture of the ARCH effect in the model as shown by the nR^2 test and the F-test.

The result of the EGARCH-M(1,1) model estimated and presented in **Table 2** indicates that variance or volatility of oil price in the mean equation is statistically significant in explaining mean oil price. The negative sign indicates that with shocks in oil price, the mean price of oil is expected to be affected negatively. Accordingly, the ARCH coefficients (ARCH and log(GARCH)) are statistically significant, hence further confirming the presence of ARCH effects. The result shows that oil price volatility in Nigeria exhibits no mean reverting (i.e. the sum of their ARCH and GARCH coefficients is more than one), implying that the effects of shocks in oil price is permanent. Furthermore, with the coefficient of exponential asymmetry term being negative, it implies that the model for oil price is asymmetry, that is negative shocks or bad news in oil price generates more volatility than positive shocks or good news. Equally, the supply of oil and demand for oil are shown to be highly significant in determining oil price volatility. This is evident as changes in the demand for oil influences the volatility in oil price positively, in contrast to the negative influence on oil price volatility which emanates from changes in supply.

Table 1: Test for ARCH Effects

Test	ARCH(1)	ARCH(2)	ARCH(3)	ARCH(10)
F-test	229.9152 (0.0000)	117.0081 (0.0000)	76.88902 (0.0000)	23.69945 (0.0000)
nR^2	86.70943 (0.0000)	87.11633 (0.0000)	86.50006 (0.0000)	86.12046 (0.0000)

Source: Authors' computation Using E-views 10

Table 2: EGARCH-M(1,1) Result

Dependent: $OilPrice$

Variable	Coefficient	Z-Statistics	P-Value
Mean Equation			
$Constant$	0.971637	2.456488	0.0140
$OilPrice(-1)$	1.025189	159.6442	0.0000
$log(GARCH)$	−1.332133	−7.025216	0.0000
Variance Equation			
$Constant$	2.121524	4.467236	0.0000
$ARCH(1)$	0.635596	6.872013	0.0000
$Asymmentry\ (1)$	−0.081967	−1.685066	0.0920
$logGARCH(1)$	0.662465	12.61516	0.0000
$OilDD(-1)$	0.000828	6.958020	0.0000
$OilSS(-1)$	−0.000131	−6.619726	0.0000
Diagnostic			
SIC	4.823751		
LM Tests			
F-test	0.047233		0.8283
nR^2	0.047911		0.8267

Source: Authors' computation Using E-views 10

Stationarity (Unit Root) Test

The Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) were employed to conduct the unit root test for the series entering the model. The tests compare the null hypothesis, series "has a unit root" against the alternative hypothesis that the series "does not have a unit root". The result presented in Table 3 shows that the both test are in conformity in respect to the stationarity status or nature of the series. Accordingly, it indicates that the series (BoP, OilPVol, OilExp and GDPr) are mixture of I(0) and I(1), that is, while BOP and GDPr are stationary at levels (I(0)), OilPVol and OilExp are stationary after first differencing (I(1)). This therefore validates the use of the ARDL bound testing technique to estimate the relationship between the variables.

Table 3: Result of Unit Root Tests

Variables	ADF	P-P	Order of Integration
BoP	-2.606329*	-3.044759**	I(0)
$OilPVol$	-4.432504*	-4.008926*	I(1)
$OilExp$	-4.029614*	-4.210355*	I(1)
$GDPr$	-2.943862	-3.231731	I(0)

Note: ** and * denotes 5% and 1% level of significance respectively

Source: Authors' computation Using E-views 10

ARDL Bound Testing for Co-integration

As presented in **Table 4**, the result reveal that the computed f-statistics (5.185163) exceeds the upper bound (I(1)) at 1%, 5% and even 10% level. This therefore entails the rejection of the null hypothesis of no con-integrating relationship, and conclusion on the presence of a significant co-integrating (long-run) relationship between Balance of Payments (BoP) and oil price (and oil export).

Table 4: Result from Bound Test

Dependent Variable		Function		$k-1$	F-Statistics
BoP		$f(BoP/OilPVol, OilExp, GDPr)$		3	5.185163
Asymptotic critical values					
1%		5%		10%	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
3.65	4.66	2.79	3.67	2.37	3.2

Source: Authors' Computations Using E-Views 10

Long-Run and Short-Run Model

With the establishment of the presence of co-integrating (long-run) relationship between oil price volatility and BOP, the Autoregressive Distributed Lagged (ARDL) model was employed to examine the long term and short term behavior of the variables. The optimal lag selection was guided by the Schwarz Information Criterion (SIC) as ARDL(2,2,2,2).

The long-run result in **Table 5 (Pane A)** shows that oil price volatility exhibits a significant negative relationship with BOP in Nigeria. This implies that for a percent significant shock in Nigeria's oil price, it will result to ₦64.60 billion deficits in the BOP. This is in line with theoretical expectation and findings of Rammadhan (2000), and Elamin (2016). The impact is high (64.60) which establish the fact that Nigeria BOP is very sensitive to oil price fluctuations as a result of over depending and as the main source of financing budget.

Similarly, inflow from oil export being the major source of foreign receipt, exhibits a significant positive relationship with BOP. However, the result shows that significant positive changes in its value tend to influence the BOP positively (surplus BOP) by ₦41.62 million. Economic growth depicts a significant positive relationship with Nigerian BOP. Explicitly, a percent change (increase or decrease) in the Nigerian economic growth, the Balance of Payments will respond positively/negatively by ₦17.58 billion.

Table 5: Result of the ARDL Model

Panel A: Long-Run Estimates – Dependent Variable: BOP				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
$Constant$	1048.586	424.0942	2.472530	0.0147
$OilPVol$	-64.60231	21.11300	-3.059835	0.0027
$OilExp$	0.416224	0.132985	3.129869	0.0022
$GDPr$	17.58084	31.26968	0.562233	0.5750
Short-Run Estimates – Dependent Variable: ΔBOP				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
$\Delta BoP(-1)$	0.775980	0.049267	15.75036	0.0000
$\Delta OilPVol$	−19.76306	6.221006	−3.176827	0.0019
$\Delta OilPVol(-1)$	23.28817	251.04	3.582930	0.0005
$\Delta OilExp$	0.438788	0.065706	6.678048	0.0000
$\Delta OilExp(-1)$	−0.386618	0.069737	−5.543919	0.0000
$\Delta GDPr$	20.50987	5.830810	3.517499	0.0006
$\Delta GDPr(-1)$	−18.97002	5.902154	−3.214084	0.0017
ε_{t-1}	−0.360083	0.061617	−5.843891	0.0000
R^2	0.75056			
F-statistic	79.4354			0.0000
D-W stat	1.9601			

Note: Δ is the first difference operator
Source: Authors' Computations Using E-Views 10

Accordingly, the short-run result in **Table 5 (Panel B)** indicate that Nigeria's BOP in the previous period have a significant positive influence on current BOP. For a percent increase/decrease in the previous BOP, a surplus/deficit of ₦77.60 million in BOP will be recorded in the current period. Similarly, while oil price volatility in oil price in the current period poses a significant negative influence on the Nigeria's BOP, oil price volatility in the previous period shows a significant positive relationship with Nigeria's Balance of Payments. This entails that for a percent change in the volatility of oil price in current and previous period, Nigeria tend to record BOP deficit of ₦19.76 billion, and BOP surplus of ₦23.29 billion. In addition, the inflow of oil export exhibits a significant positive and negative relationship with BOP in the current and previous period respectively. This entails that for a percent change in the receipt for oil export in the current and previous period, surplus BOP relating to ₦438.79 million and BOP deficit of ₦386.62 million will be recorded respectively.

Similarly, economic growth depicts a significant positive and negative influence on Nigeria's BOP in the current and previous period. This implies that, for a percent change in Nigeria's economic growth, the BOP will respond positively (surplus) by ₦20.51 billion and negatively by ₦18.97 billion respectively. The coefficient of the error correction term lagged by one period (ε_{t-1}) is negative, less than 1 and statistically significant, and, therefore meets our expectation. The sign of the coefficient indicates a slow speed of adjustment to equilibrium after a shock and indicates that approximately 36% of the deviations or disequilibrium in BOP will be corrected within one quarter of a year.

Results of Diagnostics Tests

The results reported in **Table 6** reveal that the ARDL model employed passes the diagnostic tests including serial correlation (with 2-lags), functional form and heteroscedasticity. However, with the Jaque-Bera statistics indicating the non-normality of the model, it further confirms the presence of volatility or the asymmetry of Nigeria's BOP, due to the activities of oil price volatility. In addition, with the plots of the cumulative sum of recursive residuals (CUSUM) (Figure 2) and cumulative sum of squares of recursive residuals (CUSUMQ) (Figure 3) lying within the 5% significant lines/critical boundaries, and the result from the Ramsey RESET (Regression Specification Error Test), it thus confirms the stability of the model.

Table 6: Diagnostic Tests

Test Statistics	**Result**
Autocorrelation: $\chi^2(2)$	1.234803 (0.5393)
Heteroscedasticity: $\chi^2(1)$	0.417718 (0.5181)
Normality: Jaque-Bera	964.0689 (0.000000)
Functional Form: Ramsey RESET F-stat (1,125)	1.601328 (0.2081)

Source: Authors' Computations Using E-Views 10

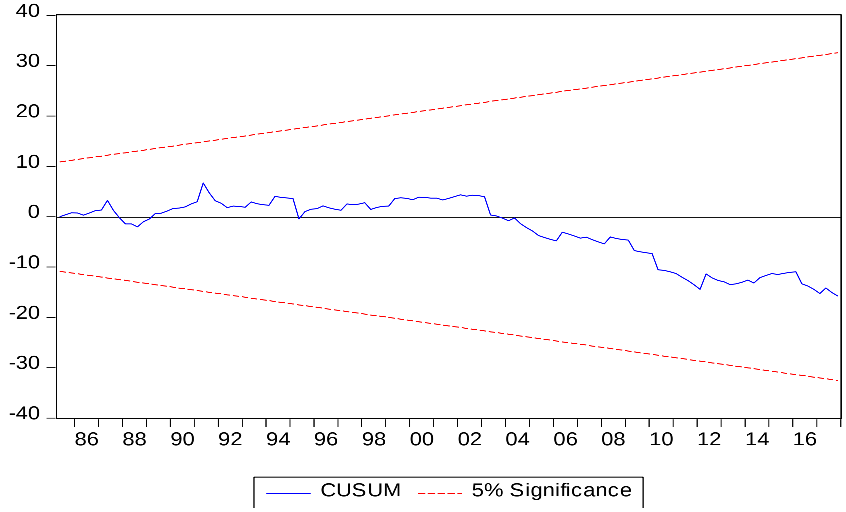

Fig. 2: *Plots of the Cumulative Sum (CUSUM) of Recursive Residuals*

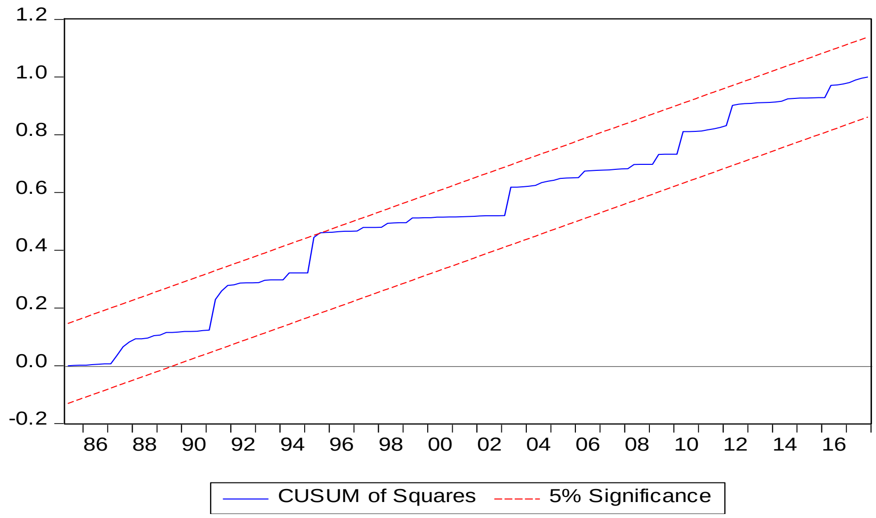

Fig. 3: *Plots of the Cumulative Sum (CUSUM) of squares of recursive residuals*

5.0 Conclusion and Recommendation

This study employed the Autoregressive Conditional Heteroscedasticity (ARCH)-type model (EGARCH-M) to examine the nature and behavior of Nigeria's oil (Bonny light) price volatility and the ARDL bound testing technique to examine the relationship between oil price volatility and BOP in Nigeria from 1980 to 2017. The results from the ARCH-type EGARCH-M(1,1) model indicates the absence of mean reverting process of the Nigeria's oil price volatility, with negative shocks generating more impact than positive shocks, and equally being determined negatively by global oil supply and positively by world oil demand. Accordingly, the ARDL bound test shows the presence of co-integrating (long-run) relationship between oil price volatility, BOP, oil export and economic growth. Oil price volatility is however shown to have a significant negative influence on Nigeria's BOP, while oil export and economic growth exhibits a significant and insignificant positive relationship with Nigeria's BOP in the long-run. In addition, in the short-run, while BOP and oil price volatility in previous periods, oil export in current period and economic growth in current period exhibits significant positive (surplus) influence on the current BOP, oil price volatility in current period, oil export and economic growth in previous periods influences BOP negatively (deficit) and significantly.

Therefore, it is recommended that, the Nigerian export basket be diversified, so as to reduce the dominance of oil export, and allow for the participation of non-oil products, whose prices are relatively stable over time, in other to maintain a favorable Balance of Payments (BOP). Similarly, it is also recommended of the central government to device new revenue sources of financing budget, so as to avoid unnecessarily expenditure cut down, as a result of shocks in oil prices.

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