Oil Price Asymmetry and Sectoral Output in Nigeria

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Joshua Adeyemi Ogunjimi

Department of Economics, University of Ibadan, Nigeria.
Email: joshuaogunjimi@gmail.com Tel: +2348064795124

ABSTRACT

Disaggregating the Nigerian economy into oil and non-oil sector, this study investigates the asymmetric effects of oil price on sectoral output in Nigeria using data spanning the period between 1981 and 2017. It adopts the novel Nonlinear Autoregressive Distributed Lag (NARDL) model developed by Shin *et al.* (2014) in which short-run and long-run nonlinearities are introduced via positive and negative partial sum decompositions of oil price. The Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root test results show that the variables used in this study are a combination of I(0) and I(1) series thus justifying the use of the Bounds test approach to cointegration whose result was in the affirmative. The results of the short-run and long-run NARDL models showed that oil price has asymmetric effects on the performance of the oil and non-oil sector of the Nigerian economy in the short-run but only have long-run asymmetric effects on the non-oil sector. In addition, the results revealed that oil price shocks (positive and negative) have positive effects on non-oil output while a positive and negative oil price shock have corresponding effects on oil output in the short run. Moreover, oil price shocks have more effects on the oil sector than the non-oil sector. Hence, this study recommends that the Nigerian economy be diversified to help cushion the effects of the uncertainties associated with the global oil market and to adopt structural reforms in the non-oil tradable sector to stimulate sustainable growth of the economy.

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Highlights of this paper

- This study evaluated the asymmetric effects of oil price on oil and non-oil sectoral output in Nigeria.
- The results showed that oil price has asymmetric effects on the performance of the oil and non-oil sector of the Nigerian economy in the short-run but only have long-run asymmetric effects on the non-oil sector.
- The result also showed that oil price shocks have more effects on the oil sector than the non-oil sector.

1. INTRODUCTION

The pivotal role natural resources, including crude-oil, plays in developed and developing economies alike cannot be overemphasized. However, it has been observed that the performance of countries with abundant endowment of natural resource falls short of those of resource poor economies (Karl, 2004). One of the foremost paradoxes in development discourse is the "Resource Curse" phenomenon which posits that natural resource abundant economies have a high tendency of experiencing adverse economic situations, such as dismal economic performance, less democracy, high corruption levels, greater political violence as well as ineffective governance, than countries with little or no natural resources (Sachs and Warner, 1995).

Similarly, the Dutch Disease syndrome, a variant of the resource curse phenomenon assumes the development of a certain (booming) sector at the expense of the other sectors (lagging and non-tradable sector). Consequently, the income of the booming sector increases markedly and attracts labour from the lagging sector thereby increasing production and exports of the booming sector. The booming sector continues to grow at the expense of the lagging sector thus making forward and backward linkages difficult as well as inhibiting the competitiveness of the lagging sectors. Summarily, the Dutch Disease Syndrome depicts a situation where a country's putative good fortunes (natural resource endowment) turn out to be detrimental to the economy.

The argument for the resource curse and Dutch Disease syndrome is that an increase in oil price for oil-exporting countries raises government revenue and makes financial resources available for investment to stimulate growth. However, this may as well inhibit growth through rent-seeking, appreciation of domestic currency and poor policy formulation and/or prescriptions (Moshiri and Banijasham, 2012). This indicates that it is not impossible for increase in oil price to adversely affect an oil-exporting economy. Put differently, the relationship between oil price and productivity may be non-linear indicating that the impact of changes in oil price may have asymmetric effects on an oil-exporting country's economic performance. Hence, it may be inappropriate to assume that oil price and other macroeconomic variables have a symmetric/linear relationship (Nusair, 2016).

Nigeria is a mono-cultural economy which exports primary products to the rest of the world. Before the discovery of crude oil in commercial quantities in the early 1970s, Nigeria exports agricultural products and has since neglected it in favour of crude-oil (another primary product) which yield a higher returns with which her teeming population is catered for. The discovery of crude oil in Nigeria can be said to have been a blessing as well as a curse to the economy as its positive and negative effects are greatly felt on the overall performance of the economy. On the negative effects, the problem of oil spillage has led to the death of fishes in the rivers of the community (Niger-Delta) from where crude-oil is extracted thus depriving them of their means of livelihood and worsening unemployment; difficulty in getting potable water for domestic use; increase in environmental degradation; surge in the incidence of militancy, bunkering and vandalism; among other social ills (Gummi *et al.*, 2017). On the positive side, crude-oil serves as a major source of government revenue, energy, foreign exchange as well as foreign direct investment inflows to Nigeria. Juxtaposing these positive and adverse impacts of crude oil on the Nigerian economy gives credence to the existence of Dutch Disease in Nigeria as crude oil discovery appears to have been more of a curse than blessings. It is worrisome that despite the huge revenue from domestic sales and

export of hydrocarbons, its contribution to stimulating growth of the Nigerian economy with regards to employment generation and productivity remains questionable.

It is noteworthy that Nigeria is a member of OPEC, the sixth largest oil producer in the world and exports crude-oil to other countries even though she imports petroleum products in refined form. This qualifies Nigeria as both an oil exporting and importing country. However, the import-dependent nature of the Nigerian economy places her at the mercy of developed countries, especially her trading partners, and international organizations thereby making her highly susceptible to external shocks. Furthermore, the renewed emphasis on the production of alternatives to fossil-fuel energy, such as solar, wind and bioenergy in the advanced economies, has reduced crude oil demand, and consequently caused its price to slump from about $120 per barrel to below $40 per barrel between mid-2014 and late 2015 thereby reducing Nigeria's foreign earnings and increasing her budget deficits. This and other factors like the declining external reserve, and political uncertainty, among others pushed the Dollar-Naira exchange rate to cross the 500 Naira mark in recent times for the first time in history of the nation (Akande, 2017).

It is evident from the fact that the falling oil price and economic slowdown have further revealed that Nigerian economy is excessively exposed to external shocks. Although various factors have been adduced to Nigeria's poor economic performance, the major problem has been the economy's continued excessive reliance on the fortunes of the ever unstable oil market for foreign exchange thereby causing frequent volatility in the country's exchange rate. Thus, in the absence of concerted efforts to shore-up and widen the revenue base, there will be reduction in crude oil revenue, excess crude oil receipts and foreign exchange earnings in the coming years. This will spell doom for the different sectors of the economy as Nigeria relies heavily on the importation of both consumer and capital goods for her productive activities. The fact that crude oil is an exhaustible asset makes it unreliable for sustainable development of the Nigerian economy (Utomi, 2004).

Nigeria has four refineries two of which are in Port Harcourt, and one each in Warri and Kaduna. They have a combined installed refining capacity of 445,000 barrels per day. However, the refineries operates below par as a result of their neglect during the military regime thus making importation of petroleum products inevitable (Odularu, 2008). Unfortunately, the price of oil in the international market is exogenously determined and quoted in foreign currency (USD) thus, a shock in the foreign economy affects domestic currency adversely. This is so because when Nigeria decides to import refined crude-oil products, she demands for foreign exchange in the foreign exchange market thereby increasing the value of the foreign currency at the expense of the domestic currency as economic theory posits that demand for a currency leads to an appreciation of the currency in relation to others while the converse is true for supply of currency.

The literature is resplendent with several studies relating oil price with economic growth in oil-exporting and oil-importing countries including Nigeria. One notable gap in the literature is that most of these studies on Nigeria (Odularu, 2008; Oyeyemi, 2013; Alley *et al*., 2014; Okoro, 2014; Mgbame *et al*., 2015; Nwanna and Eyedayi, 2016; Nweze and Edame, 2016; Offiong *et al*., 2016; Gummi *et al*., 2017; Ogboru *et al*., 2017) focused on the impact of oil price fluctuation on the aggregate Nigerian economy thus concealing some facts that could have been revealed if sectoral analysis were done. However, some studies towed the sectoral analysis path by examining the impact of oil price variation on just one sector of the economy at a time, the agricultural sector (Sekumade, 2009; Binuomote and Odeniyi, 2013; Oluwatayo and Ukpe, 2015) and the industrial sector (Okoye *et al*., 2018). Furthermore, most of the studies focused on the linear/symmetric relationship between oil price and productivity neglecting the asymmetric effect of oil price on output. This study seeks to fill this knowledge gap in the extant literature by investigating the asymmetric impact of oil price volatility on sectoral output (more than one sector).

The contributions of this study to the extant literature are in three major areas. Firstly, it examines the asymmetric effect of oil price fluctuation on sectoral output in Nigeria owing to the highly volatile nature of oil price. Secondly, it adopts the Non-linear Autoregressive Distributed Lag (NARDL) model developed by Shin *et al.* (2014) which introduced positive and negative partial sums of the explanatory variable to measure nonlinearities in the relationship of macroeconomic variables both in the short-run and long-run. Finally, this study will form a basis for further studies on this subject matter.

Following this introduction, the rest of this paper is organized as follows: review of relevant literature is the main thrust of Section 2 while Section 3 presents the methodological framework of this study. Whereas the concern of Section 4 is the presentation and interpretation of empirical results, Section 5 concludes this study with policy recommendations.

2. LITERATURE REVIEW

The link between oil price and economic growth has been a subject of debate, albeit with mixed results, since the end of World War II and has birthed a plethora of studies in the oil price-growth nexus literature. Put differently, there is no consensus in the extant literature on the relationship the oil prices and economic growth as different studies by different authors on different countries show varying results. Surprisingly, related studies on the same country have diverse findings owing to the different estimation techniques employed by different authors as well as the perspective from which the authors look at the subject matter.

Evidence abounds in the literature that oil-exporting and oil-importing countries are affected differently by oil price shocks. Whereas an increase in oil price is good news for oil-exporting economies as it indicates an improvement in their trade balance, it is a nightmare for oil-importing economies as they would have to pay more to maintain the quantity they purchase before the increase. Jayaraman and Lau (2011) found that a surge in oil and commodity prices stimulates economic growth in Papua, New Guinea. Asian Development Bank (2005;2005) revealed that small economies that lack oil resources are often badly hit by the surge in oil prices in the international market. Akpan (2009) and Olomola (2006) quipped that oil price increase raises the export earnings and income of net oil-exporting economies and also stimulates growth. On the other hand, Aliyu (2009) and Kurihara (2015) found that appreciation of domestic currency and oil prices have significant positive effects on economic growth. The increase in oil prices is more of a demand side effect than supply side effects (Darby, 1982; Cerralo, 2005; Bjørnland, 2009). Oriakhi and Iyoha (2003) and Bondzie *et al.* (2014) found that oil price variation influences government expenditure as well as economic growth in Nigeria and Ghana respectively.

On the other hand, Rentschler (2013) argued that oil price fluctuation has negative effects on all kinds of economies including net oil-exporting countries. His argument was premised on the fact that oil price fluctuations disrupts expectations and increases price uncertainties in all economies (including net exporting countries) thereby stalling investment decisions leading to the postponement of investment by firms and instigating resource reallocation. Whereas oil importing economies are confronted with uncertainties about cost of imports and levels of fuel subsidy, oil exporting countries are faced with precarious income. This obviously has a debilitating effect on economies that depend primarily on oil revenue and greatly subsidize petroleum products. Therefore, Rentschler (2013) concluded that both oil exporters and importers are hurt by oil price variation and that hedging against it can be beneficial to the economy in the long-run.

Interestingly, Nigeria is both an oil exporting and importing country thus, the effect of a surge in oil price depends on the volume of oil exports and imports, among others. All things being equal, if the volume of oil exports exceeds imports, oil price increase will stimulate economic growth and if oil imports outweigh exports, it inhibits

economic growth. However, if the volume of oil export is equal to import, oil price increase will have no effect on the economy. Odularu (2008); Alley *et al.* (2014); Nweze and Edame (2016) and Nwanna and Eyedayi (2016) found that there is a direct relationship between oil price and economic growth in Nigeria such that a surge in oil price contributes to the improvement of the performance of the Nigerian economy thus stimulating growth. However, Odularu (2008) bemoaned the lack of private sector participation in the downstream and upstream oil sector the Nigerian economy.

On the link sectoral output the oil price in Nigeria, Oluwatayo and Ukpe (2015) and Binuomote and Odeniyi (2013) employed the Ordinary Least Squares and error coreection model estimation techniques respectively to evaluate the impact premium motor spirit (PMS) pricing has on agricultural output and found that an increase in PMS pricing improves the performance of the Nigerian agricultural sector. Similarly, Sekumade (2009) explored the extent to which the agricultural sector depends on petroleum production and its effect on output. The finding revealed a direct relationship between agricultural output and oil exports and imports while oil production and agricultural output for export are inversely related. On the other hand, Okoye *et al.* (2018) evaluated the interrelationship between oil prices, the construction sector and Nigeria's GDP and found a significant positive correlation between the interrelationships even though these relationships did not translate to a causal relationship among the variables thus, indicating that neither oil price nor construction sector output stimulate GDP growth in Nigeria. However, in relation to oil price volatility and economic growth in Nigeria, whereas Oyeyemi (2013); Alley *et al.* (2014); Okoro (2014); Offiong *et al.* (2016) found that oil price volatility retards economic growth in Nigeria, Mgbame *et al.* (2015) argued that oil price variations stimulate growth while Olomola and Adejumo (2006) that oil price shocks plays no substantial role in influencing output movement in Nigeria.

Moreover, on direction of causality between oil price and economic growth, Gummi *et al.* (2017); Ogboru *et al.* (2017) and Ghalayini (2011) found a unidirectional causal relationship running from oil price to GDP growth indicating that oil price is a significant determinant of economic growth and that the rate of growth of an economy has no influence on the price of oil in the international market. This is particularly true because oil prices are subject to the forces of demand and supply as oil prices in the international market are set by a market-related pricing system linking oil prices to the market price of particular reference crude (Nkomo, 2006). However, Okoye *et al.* (2018) found no causal relationship between these two macroeconomic variables.

Using quarterly and annual time series data for the period 1960-2009, Farhani (2012) assessed the effect of oil price on the performance of the US economy and found that there is a very weak link between these macroeconomic variables due to asymmetric effects of oil price fluctuation and the existence of structural breaks. Similarly, from a long-term perspective, Gadea *et al.* (2016) discovered that the negative impact of oil price on the performance of the US economy is magnified when there is a huge increase in oil price and that the effect of oil price shock on US economic growth has been declining over time indicating that the US economy has alternative source of energy.

Analysing the impact of world oil prices on economic growth in Russia, Idrisov *et al.* (2015) suggested that based on classical models, a surge in oil price predetermines transitional trends in the short-run and cannot stimulate economic growth in the long run. On the other hand, Malik (2010) evaluated the effects of the rising oil prices and the changing macro conditions on Pakistan aggregate output and found the existence of a non-linear relationship between oil prices and aggregate output as well as a positive relationship between these macroeconomic variables. In the same vein, Nusair (2016) employed the NARDL framework to examine the dynamic effects of oil price shocks on the real GDP of the Gulf Cooperation Council (GCC) and found that rising oil price stimulate GDP growth while falling oil price stifles it. The results also suggest that rising oil prices considerably have more impact on real GDP than falling prices.

3. METHODOLOGY AND DATA ISSUES

The estimation technique employed to examine the short-run and long-run asymmetric effects of oil price dynamics on sectoral output in Nigeria is the novel Nonlinear Autoregressive Distributed Lag (NARDL) model developed by Shin *et al.* (2014). The NARDL model is an extension of the ARDL model developed by Pesaran *et al.* (2001). The choice of this framework is predicated on the fact that it yields valid results in as much as none of variables is integrated at order two, [I(2)]; it has an inherent technique (Bounds test) which checks for long-run cointegration among variables; it has the ability to incorporate the lags of both the dependent and independent variables in the same equation; and it allows for positive and negative partial sum decompositions of the explanatory variable. Furthermore, the NARDL framework is adopted in this study with the belief that positive and negative changes in oil price may have different impact on sectoral output in Nigeria. Moshiri and Banijasham (2012) alluded that while oil price increase may promote economic growth by making financial resources needed for investment available, they may also inhibit economic growth through poor policy-making, rent-seeking and currency appreciation.

In addition, to prevent spurious regression, this study will adopt the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests and the Bounds test for cointegration. The Wald test would be conducted to investigate the existence of asymmetry in oil price. Furthermore, the estimated models will also be subjected to post-estimation test to ensure that they conform to the assumptions of the Classical Linear Regression Model (CLRM). Specifically, this study will run the normality, serial correlation, heteroscedasticity as well as correct specification tests.

Following the law of demand and supply which state that output is a function of prices and the modelling framework of Ogboru *et al.* (2017) this study specifies the following models:

$$LOILY_t = \alpha_0 + \alpha_1^+ LOILP_t^+ + \alpha_2^- LOILP_t^- + \alpha_3 LEXR_t + \alpha_4 MPR_t + \alpha_5 INF_t + \varepsilon_{1t} \quad (1)$$

$$LNOILY_t = \beta_0 + \beta_1^+ LOILP_t^+ + \beta_2^- LOILP_t^- + \beta_3 LEXR_t + \beta_4 MPR_t + \beta_5 INF_t + \varepsilon_{2t} \quad (2)$$

Equation 1 shows that oil sector output is a function of positive and negative changes to oil price, exchange rate, monetary policy rate and inflation while Equation 2 shows that the non-oil sector output is also a function of positive and negative changes to oil price, exchange rate, monetary policy rate and inflation.

According Shin *et al.* (2014) the NARDL version of the asymmetric effect of oil price dynamics on sectoral (oil and non-oil) output is expressed as follow:

$$\Delta LOILY_t = \gamma LOILY_{t-1} + \alpha_1^+ LOILP_{t-1}^+ + \alpha_2^- LOILP_{t-1}^- + \alpha_3 LEXR_{t-1} + \alpha_4 MPR_{t-1} + \alpha_5 INF_t + \sum_{i=1}^{p-1} \emptyset_i \Delta LOILY_{t-i} + \sum_{j=0}^{q_1-1} \emptyset_j^+ \Delta LOILP_{t-j}^+ + \sum_{j=0}^{q_2-1} \emptyset_j^- \Delta LOILP_{t-j}^- + \sum_{j=0}^{q_3-1} \emptyset_j \Delta LEXR_{t-j} + \sum_{j=0}^{q_4-1} \emptyset_j \Delta MPR_{t-j} + \sum_{j=0}^{q_5-1} \emptyset_j \Delta INF_{t-j} + \varepsilon_{1t} \quad (3)$$

$$\Delta LNOILY_t = \Omega LNOILY_{t-1} + \beta_1^+ LOILP_{t-1}^+ + \beta_2^- LOILP_{t-1}^- + \beta_3 LEXR_{t-1} + \beta_4 MPR_{t-1} + \beta_5 INF_t + \sum_{i=1}^{p-1} \delta_i \Delta LNOILY_{t-i} + \sum_{j=0}^{q_1-1} \delta_j^+ \Delta LOILP_{t-j}^+ + \sum_{j=0}^{q_2-1} \delta_j^- \Delta LOILP_{t-j}^- + \sum_{j=0}^{q_3-1} \delta_j \Delta LEXR_{t-j} + \sum_{j=0}^{q_4-1} \delta_j \Delta MPR_{t-j} + \sum_{j=0}^{q_5-1} \delta_j \Delta INF_{t-j} + \varepsilon_{2t} \quad (4)$$

Equations 3 and 4 are extensions of Equation 1 and 2. Equations 3 and 4 can be re-parameterized to derive the unrestricted error correction version as follows in Equation 5 and 6:

$$\Delta LOILY_t = \gamma [LOILY_{t-1} - \left(-\frac{\alpha_1^+}{\gamma} LOILP_{t-1}^+ - \frac{\alpha_2^-}{\gamma} LOILP_{t-1}^- - \frac{\alpha_3}{\gamma} LEXR_{t-1} - \frac{\alpha_4}{\gamma} MPR_{t-1} - \frac{\alpha_5}{\gamma} INF_{t-1}\right) + + \sum_{i=1}^{p-1} \emptyset_i \Delta LOILY_{t-i} + \sum_{j=0}^{q_1-1} \emptyset_j^+ \Delta LOILP_{t-j}^+ + \sum_{j=0}^{q_2-1} \emptyset_j^- \Delta LOILP_{t-j}^- + \sum_{j=0}^{q_3-1} \emptyset_j \Delta LEXR_{t-j} + \sum_{j=0}^{q_4-1} \emptyset_j \Delta MPR_{t-j} + \varepsilon_{1t} \quad (5)$$

$$\Delta LNOILY_t = \Omega[LNOILY_{t-1} - \left(-\frac{\beta_1^+}{\Omega} LOILP_{t-1}^+ - \frac{\beta_2^-}{\Omega} LOILP_{t-1}^- - \frac{\beta_3}{\Omega} LEXR_{t-1} - \frac{\beta_4}{\Omega} MPR_{t-1} - \frac{\beta_5}{\Omega} INF_{t-1}\right) + \sum_{i=1}^{p-1} \delta_i \Delta LNOILY_{t-i} + \sum_{j=0}^{q_1-1} \delta_j^+ \Delta LOILP_{t-j}^+ + \sum_{j=0}^{q_2-1} \delta_j^- \Delta LOILP_{t-j}^- + \sum_{j=0}^{q_3-1} \delta_j \Delta LEXR_{t-j} + \sum_{j=0}^{q_4-1} \delta_j \Delta MPR_{t-j} + \varepsilon_{2t} \quad (6)$$

By letting,

$$\varepsilon_{1t-1} = LOILY_{t-1} - \infty_1^+ LOILP_{t-1}^+ - \infty_2^- LOILP_{t-1}^- - \infty_3 LEXR_{t-1} - \infty_4 MPR_{t-1} - \infty_5 INF_{t-1} \quad (7)$$

$$\varepsilon_{2t-1} = LNOILY_{t-1} - \emptyset_1^+ LOILP_{t-1}^+ - \emptyset_2^- LOILP_{t-1}^- - \emptyset_3 LEXR_{t-1} - \emptyset_4 MPR_{t-1} - \emptyset_5 INF_{t-1} \quad (8)$$

Equation 7 and 8 are the error correction terms of the oil sector output model and non-oil sector output model respectively.

Where,

$$\infty_1^+ = -\frac{\alpha_1^+}{\gamma}, \infty_1^- = -\frac{\alpha_1^-}{\gamma}, \infty_2 = -\frac{\alpha_2}{\gamma}, \infty_3 = -\frac{\alpha_3}{\gamma}, \infty_4 = -\frac{\alpha_4}{\gamma}, \infty_5 = -\frac{\alpha_5}{\gamma} \quad (9)$$

$$\emptyset_1^+ = -\frac{\beta_1^+}{\gamma}, \emptyset_1^- = -\frac{\beta_1^-}{\gamma}, \emptyset_2 = -\frac{\beta_2}{\gamma}, \emptyset_3 = -\frac{\beta_3}{\gamma}, \emptyset_4 = -\frac{\beta_4}{\gamma}, \emptyset_5 = -\frac{\beta_5}{\gamma} \quad (10)$$

Equation 9 and 10 defines the parameter of the error correction terms of the oil and non-oil output models respectively. Equations 5 and 6 can be rewritten as:

$$\Delta LOILY_t = \gamma \varepsilon_{1t-1} + \sum_{i=1}^{p-1} \emptyset_i \Delta LOILY_{t-i} + \sum_{j=0}^{q_1-1} \emptyset_j^+ \Delta LOILP_{t-j}^+ + \sum_{j=0}^{q_2-1} \emptyset_j^- \Delta LOILP_{t-j}^- + \sum_{j=0}^{q_3-1} \emptyset_j \Delta LEXR_{t-j} + \sum_{j=0}^{q_4-1} \emptyset_j \Delta MPR_{t-j} + \varepsilon_{1t} \quad (11)$$

$$\Delta LNOILY_t = \Omega \varepsilon_{2t-1} + \sum_{i=1}^{p-1} \delta_i \Delta LNOILY_{t-i} + \sum_{j=0}^{q_1-1} \delta_j^+ \Delta LOILP_{t-j}^+ + \sum_{j=0}^{q_2-1} \delta_j^- \Delta LOILP_{t-j}^- + \sum_{j=0}^{q_3-1} \delta_j \Delta LEXR_{t-j} + \sum_{j=0}^{q_4-1} \delta_j \Delta MPR_{t-j} + \varepsilon_{2t} \quad (12)$$

Equation 11 and 12 are the models to be oil and non-oil sector models to be estimated.

3.1. Data Sources and Description

This study made use of annual time-series secondary data for the period over 1981 to 2017, a period of 37 years. The data for oil output, non-oil output and monetary policy rate are sourced from Central of Nigeria (CBN) Statistical Bulletin (2017 edition), oil price data was sourced from United States Energy Information Administration (2017) while data for real effective exchange rate and inflation rate were sourced from World Development Indicator (2018). All the variables except monetary policy rate and inflation rate, which are already expressed in percentages, are expressed in their natural logarithm to allow for easy interpretation of results in proportionate term.

4. EMPIRICAL ANALYSIS

4.1. Preliminary Analysis

Pre-estimation analyses, such as descriptive statistics, unit root test and conitegration test, are run to determine the appropriate statistical technique for estimation as well as knowing the properties of each variable to avoid prevent spurious regression. Table 1 presents the summary of descriptive statistics of the variables employed in this study and it shows that the average positive and negative oil price changes are 1.79 and -1.76 respectively. It is also apparent that average volume of non-oil output is greater than that of oil output. In addition, the average inflation rate exceeds the average monetary policy rate; this has implications for the value for real interest rate. Furthermore, a cursory look shows that all the variables except log of real effective exchange rate, monetary policy rate and inflation rate are normally distributed as revealed by the probability values of the their respective Jarque-Bera statistic. The value of skewness shows that only positive change in oil price, monetary policy rate and inflation

are not statistically different from zero. Furthermore, it is also revealed that whereas positive and negative changes in oil price as well as log of oil and non-oil output are platykurtic, the log of real effective exchange rate, monetary policy rate and inflation rate are leptokurtic. In addition, the standard deviation is low for all variables except for inflation rate and monetary policy rate.

Table-1. Summary of descriptive statistics of the variables.

Statistics	$LOILP^{+}$	$LOILP^{-}$	LOILY	LNOILY	LREER	MPR	INF
Mean	1.79	-1.76	8.80	9.97	4.76	13.22	19.41
Median	1.57	-1.94	8.83	9.69	4.60	13.25	12.55
Maximum	3.99	0.00	9.14	11.04	6.28	26.00	72.84
Minimum	0.00	-3.48	8.31	9.13	3.89	6.00	5.38
Std. Dev.	1.41	0.90	0.23	0.65	0.61	4.03	17.71
Skewness	0.26	0.14	-0.43	0.45	1.04	0.79	1.69
Kurtosis	1.57	2.62	2.29	1.70	3.14	4.41	4.58
Jarque-Bera	3.50	0.33	1.86	3.75	6.48	6.68	20.85
Probability	0.17	0.85	0.40	0.15	0.04	0.04	0.00
Observations	37	37	37	37	37	37	37

Customarily, when a time-series analysis is to be carried out, it is expedient to carry out unit root test to check the time-series properties of the variables to be estimated so as to guard against spurious regression. For the purpose of this study, the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root test approach are employed to examine the order of integration of the each macroeconomic variable. To adjudge any variable stationary, its probability value must be less than 10 per cent or its ADF and PP test statistic must be greater than the test critical values in absolute term at all levels of significance.

Table 2 presents the result of the stationarity test. The results the ADF and PP unit root test are similar as they both show that inflation rate and monetary policy rate are stationary at level while log of oil and non-oil output, positive and negative changes in oil price and log of real effective exchange rate are stationary after been difference once. This result shows that none of the variables is stationary at second difference, I(2), thus giving credence to the use of the NARDL framework developed by Shin *et al.* (2014). Accordingly, this study proceeds to investigating the long-run relationship among the variables using the Bounds test cointegration approach.

Table-2. Unit root test results.

	Augmented Dickey Fuller (ADF)			Phillips-Perron (PP)		
Variables	**Level**	**First difference**	**I(d)**	**Level**	**First difference**	**I(d)**
INF	-3.90**b	-	I(0)	-2.72***a	-	I(0)
$LOILP^{+}$	-2.23b	-4.70*a	I(1)	-2.22b	-4.62a	I(1)
$LOILP^{-}$	-2.56b	-6.09*a	I(1)	-2.45b	-6.29*a	I(1)
LOILY	-1.42a	-6.44*b	I(1)	-1.42a	-5.97*b	I(1)
LNOILY	-1.73b	-3.83**b	I(1)	-2.25b	-3.92**b	I(1)
LREER	-2.13a	-4.50*a	I(1)	-2.32a	-4.41*a	I(1)
MPR	-3.24**a	-	I(0)	-3.19**a	-	I(0)

Note: *, ** and *** implies statistical significance at 1%, 5% and 10% level respectively; 'a' denotes model with constant and 'b' is for model with trend and constant and trend. I(0) and I(1) indicate stationarity at level and first difference respectively.

Following the results of unit root tests presented in Table 2 which shows that all the variables are either stationary at level or first difference, the Bounds test approach to cointegration is done. It tests the null hypothesis of no cointegration among the variables with the decision rule that the null hypothesis should be rejected if the value of the computed F-statistic exceeds the upper bound critical value, accepted if it fall below the lower bound critical value and adjudged inconclusive should it falls between the lower and upper bound critical value.

Accordingly, Table 3 shows that the existence of a long-run relationship among the variables in Model 1 is inconclusive because its computed F-statistic (2.97) falls between the critical value of the lower and upper bound at 5 per cent and 10 per cent level of significance. However, the long-run relationship among the variables of Model 1 can be ascertained through the error correction term to be derived when the model is estimated. On the other hand, there is a long run relationship among the variables of Model 2 as the value of its computed F-statistic (4.94) exceeds the upper bound critical value at all level of significance. Thus, the null hypothesis of no cointegration is rejected. Given the results of the Bound test, the short-run and long-run NARDL models will be estimated.

Table-3. Results of bounds test.

Significance Level	Critical value		Model 1[1]	Model 2[2]
	Lower (I0) Bound	*Upper (I1) Bound*	*Computed F-Statistic*	*Computed F-Statistic*
1%	3.41	4.68		
5%	2.62	3.79	2.97	4.94
10%	2.26	3.35		

4.2. Presentation and Interpretation of Results of the Estimated NARDL Models

The results of the estimated NARDL oil and non-oil output models are presented in Table 4. It depicts that the coefficients of the error correction term for model 1 (-0.47) and Model 2 (-0.21) follows a priori expectation in that they are both less than one, negative and statistically significant at 5 per cent and 1 per cent significance level respectively. This implies that the speed of adjustment of oil output and non-oil output from a short-run shock to their long-run equilibrium is moderate and slow respectively as approximately 47 per cent and 21 per cent of the shock to their determinants in the previous period is accounted for in the present period. The results also shows that positive oil price changes has positive effects on oil output as well as non-oil output in Nigeria. Specifically, a positive change in oil price by one per cent will, on the average, lead to 0.26 per cent and 0.04 per cent change in oil output and non-oil output respectively. This indicates that the oil sector benefits more from an increase in oil price than the non-oil sectors. This result parallels the findings of Malik (2010); Alley *et al.* (2014); Kurihara (2015) and Nwanna and Eyedayi (2016) and is in line with a priori expectation in that proceeds from crude oil is the main source of foreign exchange for Nigeria (an oil-exporting country). Specifically, Alley *et al.* (2014) averred that the positive effect of oil price on output confirms the fact that a positive change in oil price is beneficial to an oil-exporting country. However, it was found that whereas the relationship between positive change in oil price and oil output is significant its relationship with non-oil output is not significant but is negative and significant with its first period lag.

On the other hand, a negative change in oil price has an insignificant inverse and direct relationship with oil output and non-oil output respectively. Specifically, an increase in negative oil price shock by 1 percent will reduce oil output by approximately 0.02 per cent and increase non-oil output by 0.002 per cent. Again, it is obvious that the degree of responsiveness of oil output to a negative change in oil price outweighs that of non-oil output. This finding is in line with the (Mgbame *et al.*, 2015) and contrasts the findings of Elmi and Jahadi (2011); Oyeyemi (2013); Okoro (2014); Gadea *et al.* (2016). Looking at output from the supply side, the negative effects of a negative change in oil price on oil output is in consonance with the law of supply which states that a low price discourages producers thereby reducing their output. On the other hand, the positive relation between negative oil price change and non-oil output implies a fall in the oil price relative to other products' prices thus, non-oil firms are encouraged

[1] Nonlinear relationship between Oil Output Model and oil price changes.

[2] Nonlinear relationship between Non-Oil Output Model and oil price changes.

to produce more of the their products because it yields more returns than the oil sector. In sum, oil price shocks (positive and negative) have positive effects on non-oil output while a positive and negative oil price shock have corresponding effects on oil output. Moreover, oil price shocks have more effects on the oil sector than the non-oil sector.

In addition, real effective exchange rate has significant positive and negative effects on oil output and non-oil output respectively such that a 1 per cent real effective exchange rate depreciation will, on the average, lead to an expansion in oil output by 0.11 per cent and a contraction in non-oil output by approximately 0.03 per cent. Economic theory posits that exchange rate movement triggers two effects – price and volume effects. Specifically, exchange rate depreciation makes a domestic economy's exports cheaper and import dearer while the converse is true for exchange rate appreciation. Accordingly, since oil prices are exogenously determined and denominated in foreign currency, a depreciation of the domestic currency in relation to a basket of foreign currencies will increase oil revenue, oil rents and oil output and could possibly lead to the neglect of the non-oil sector, a situation that is prevalent in Nigeria. Hence, this result is plausible as it correctly depicts the economic situation of Nigeria as well as the channel through which exchange rate movement affects output in the country.

Moreover, the results show that whereas monetary policy rate has an insignificant positive relationship with oil output, it has a significant inverse relationship with non-oil output. Specifically, if monetary policy rate increases by 1 per cent, oil and non-oil output will increase and decrease respectively by 0.004 percent. Here, the magnitude of impact of monetary policy rate on oil and non-oil output is the same but their direction of relationship is different. Economic theory postulates that interest rate affects output through investment in that an increase in interest rate will dissuade investors from borrowing thus reducing investment and subsequently, output. Hence, economic theory suggests an inverse relationship between interest rate and output. Therefore, while the result of the non-oil output parallels economic theory, the result of the oil output model refutes it.

In contrast to the coefficients of MPR, the coefficient of inflation rate is negative for the oil output model and positive for the non-oil model indicating that inflation rate has a negative effect on oil output and a positive impact on non-oil output. Specifically, if inflation rate increases by 1 per cent, there will be approximately 0.002 per cent fall and increase in oil output and non-oil output respectively. This implies that the degree of responsive of oil and non-oil output to a change inflation rate is the same even though they respond in opposite directions. Economic theory posits that an increase in inflation rate implies a fall in the purchasing power of money as well as a fall in real income and profit of an economic agent. For a firm, an increase in inflation rate implies a fall in price of its products which discourages and retards production (output) indicating that inflation rate and output are inversely related. Accordingly, the result of the oil output is in line with theoretical postulations while that of non-oil output is not.

Likewise, the values of the Adjusted R-squared show that about 90 per cent and 99 per cent of the variation in oil output and non-oil output respectively are explained by positive and oil price changes, real effective exchange rate, monetary policy rate and inflation rate. This indicates that each model has a viable goodness of fit and their explanatory powers are very high. Furthermore, the probability values of the F-statistic of Model 1 and 2 show that positive and negative oil price changes, real effective exchange rate, monetary policy rate and inflation rate jointly influence the performance of the oil and non-oil sector of the Nigerian economy.

In bringing to bear one of the innovations (test for asymmetric effect of oil price on sectoral output) of this study, Table 4 also presents the results of the tests for short-run and long-run asymmetry in oil prices. The null hypothesis of no short-run asymmetry will be rejected for both Model 1 and 2 while that of long-run asymmetry will be accepted for Model 1 (Oil-output model) and rejected for Model 2 (Non-oil-output model). This implies that positive and negative oil price changes have asymmetric effects on the performance of the oil and non-oil sector of

the Nigerian economy in the short-run but only have asymmetric effects on the non-oil sector and not the oil sector in the long-run. Intuitively, this suggests that oil price dynamics have different impacts on oil output in Nigeria both in the short-run and long-run but have the same and different impact on non-oil output in the short-run and long-run respectively. This result supports the empirical findings of Malik (2010) and Nusair (2016) who found that the relationship between oil price change and output is non-linear.

Worthy of note is the results of the post-estimation test which was carried out to check whether the oil and non-oil output models conform to the assumptions of the Classical Linear Regression Models (CLRM). Specifically, this study tests if the models are correctly specified and if error terms are normally distributed (iid), homoscedastic and does not suffer from serial correlation. The results show that Model 1 and 2 pass all the tests thus making their results acceptable and eligible for policy prescriptions. Specifically, the results show the models are correctly specified and their error are normally distributed as well as the absence of serial correlation and heteroscedasticity.

Table-4. NARDL short-run estimates.

Variables	Model 1	Model 2
D(LOILP^{+})	0.263 (0.0132)	0.043 (0.3936)
D(LOILP^{+}(-1))	-	-0.158 (0.0109)
D(LOILP^{-})	-0.015 (0.7253)	0.002 (0.9214)
D(LREER)	0.111 (0.0169)	-0.027 (0.0844)
D(MPR)	0.004 (0.4187)	-0.004 (0.0666)
D(INF)	-0.002 (0.0668)	0.002 (0.6944)
ECT(-1)	-0.208 (0.0298)	-0.467 (0.0001)
Adj. R2	0.898	0.997
F-Statistic	38.60 (0.0000)	1573.24 (0.0000)
Post-Estimation Tests		
Jarque-Bera Normality Test	2.696 (0.2598)	0.007 (0.9963)
Breusch-Godfrey Serial Correlation LM Test	3.775 (0.1514)	0.084 (0.9588)
Heteroscedasticity Test (ARCH)	0.113 (0.7371)	1.652 (0.1987)
Ramsey RESET Linearity Test	0.454 (0.5067)	0.085 (0.7735)
Wald Test for Short-Run Asymmetry	8.09 (0.0175)	9.52 (0.0231)
Wald Test for Long-Run Asymmetry	3.51 (0.1728)	22.67 (0.0000)

Note: The values in parentheses represent probability values.

Table 5 presents the results of the long run estimated NARDL model. It shows that positive and negative oil price changes have an insignificant negative relationship with oil output in Nigeria in the long run. Specifically, an increase in positive and negative change in oil price by 1 per cent will, on the average, lead to a fall in oil output by 0.12 and 0.07 per cent respectively. This gives credence to the earlier assertion that oil price changes have no long-run asymmetric effect on oil output in Nigeria. These results imply that the degree of responsiveness of oil output to a positive oil price change is more than that of a negative oil price change. However, the insignificance of these relationships suggests that positive and negative oil price changes do not exert influence on oil output in Nigeria in the long run.

In contrast, both positive and negative oil price changes have positive impacts on non-oil output such that an increase in positive and negative oil price changes by 1 per cent will increase non-oil output by approximately 0.48 and 0.005 per cent respectively. As is the case in the oil output model, the magnitude of impact of positive change in oil price is more than that of a negative change. However, whereas positive change in oil price influences non-oil output, negative oil price change does not. This indicates that the performance of the Nigerian non-oil sector is hinged on oil price dynamics which is the major source of government revenue. It also suggests that there is a low rate of private sector participation in the non-oil sector of the Nigerian economy as government dominates its activities.

Furthermore, real effective exchange rate has an insignificant inverse relationship with both oil output and non-oil output in the long run. Specifically, a real effective exchange rate depreciation by 1 per cent will lead, on the average, to 0.19 per cent and 0.06 per cent fall in oil and non-oil output respectively. This implies that a depreciation of the domestic currency in relation to a basket of foreign currencies will reduce the output as well as exports of the oil and non-oil sector of Nigeria thus worsening Nigeria's current account balance. This result negates the assertion of the J-curve that exchange rate depreciation does not improve the current account in the short run but in the long run due to time lags.

In addition, monetary policy rate has an insignificant positive effect on oil output but a significant negative impact on non-oil output in the long run. Specifically, increasing monetary policy rate by 1 per cent will lead to approximately 0.02 per cent increase in oil output and 0.01 per cent fall in non-oil output. On the other hand, the coefficient of inflation rate is in line with a priori expectation in that it is negative indicating that inflation rate affects the performance of the oil and non-oil sector in the long run such that an increase in inflation rate by 1 per cent will reduce oil and non-oil output by approximately 0.01 and 0.0003 respectively.

Summarily, positive and negative oil price shocks, real effective exchange rate and monetary policy are not long-run determinants of oil output in Nigeria but inflation rate is. On the other hand, only positive oil price shock and monetary policy rate stimulate oil and non-oil output growth in the long run in Nigeria.

Table-5. NARDL long-run estimates.

Variables	Model 1	Model 2
$LOILP^{+}$	-0.123 (0.4542)	0.475 (0.0000)
$LOILP^{-}$	-0.074 (0.7256)	0.005 (0.9218)
LREER	-0.189 (0.2191)	-0.058 (0.1229)
MPR	0.017 (0.4557)	-0.009 (0.0677)
INF	-0.010 (0.0851)	-0.0003 (0.7008)
C	9.654 (0.0000)	9.659 (0.0000)

Note: The values in parentheses represent probability values.

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study investigated the asymmetric effects of oil price dynamics on sectoral output in Nigeria. Disaggregating the Nigerian economy into oil and non-oil sector and using annual time-series data spanning the period between 1981 and 2017, this study specified and estimated two equations using the novel NARDL framework. The Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root test results showed that the variables used in the study are a combination of I(0) and I(I) series thus, supporting the employment of Bounds test approach to cointegration whose result was in the affirmative. The results of the short-run and long-run NARDL models showed that oil price has asymmetric effects on the performance of the oil and non-oil sector of the Nigerian economy in the short-run but only have long-run asymmetric effects on the non-oil sector. In addition, the results revealed that oil price shocks (positive and negative) have positive effects on non-oil output while a positive and negative oil price shock have corresponding effects on oil output in the short run. Moreover, oil price shocks have more effects on the oil sector than the non-oil sector. Also, oil price shocks are not long-run determinants of oil output but a positive oil price shock drives non-oil output in the long run. In addition, whereas real effective exchange rate and monetary policy rate are determinants of non-oil output in the short-run, inflation rate influences oil output in the short-run.

These finding have policy implications. In particular, the heavy dependence of Nigeria on oil as the main driver of economic activity makes her susceptible to oil price volatility. For instance, the sharp decline in oil price in the international market in 2014 plunged the Nigerian economy into inevitable recession which makes it extremely

difficult for state governments to pay the salaries of civil servants. Hence, diversifying the Nigerian economy is imperative to help cushion the effects of the uncertainties associated with the global oil market and to generate employment opportunities for her teeming labour force, increase output and facilitate sustainable growth. In addition, structural reforms should be adopted in the non-oil tradable sector and a conducive investment environment be created for both the private sector and foreign investors through the effective management of interest rate, exchange rate and inflation rate. Moreover, the proceeds from oil sales should be used for infrastructural development that could stimulate sustainable growth of the Nigerian economy.

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