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Dynamic Nexus between Oil Revenues and Economic Growth in Nigeria

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Abstract

This study examines the dynamic asymmetric relationship between oil revenues and economic growth in Nigeria. Employing a Non-Linear Autoregressive Distributed Lag (NARDL) method in conjunction with an Autoregressive Distributed Lag (ARDL) method and a Threshold Autoregressive Error Correction Model (TAR-ECM) on Nigerian data, spanning the period from 1981 to 2016, the study finds that there is co-integration between oil revenues and economic growth. When the ARDL estimation method is used, we find that oil revenues have significant positive effects on economic growth in both the short-run and long-run. The results from NARDL show the existence of short-run and long-run asymmetric relationships between oil revenues and economic growth with the exception of the case in which an industrial production index is used as a proxy for economic growth. Also, the NARDL results further show that positive oil revenues are beneficial to the economy. However, the positive impact of oil revenues on the economy is gradual as shown by the results obtained from the TAR-ECM estimation method. This calls for a better management of oil revenues so as to guard against the negative impacts of oil price volatility and shortage of revenue during periods of negative developments in the oil market.

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1. Introduction

Resource-endowed countries usually face a daunting challenge whenever the prices of their resources fluctuate in the international market. This is particularly common in the crude oil-endowed countries such as the countries in the Organisation of Petroleum Exporting Countries (OPEC) and non-OPEC countries that are producing and supplying crude oil for sale in the international market. The rationale for the anxiety in these countries stems from the fact that government financing activity is closely connected with the revenues realised from the sales of crude oil. Thus, when oil price fluctuates, particularly when it declines, it constrains government in terms of its spending on critical infrastructures such as roads, hospitals, pipe-borne water, electricity and lots more. This is what has been the story over the years in Nigeria which is a member of OPEC since 1971.

Baffes, Kose, Ohnsorge, and Stocker (2015) reveal that since the 1980s, the world had had five periods of oil price declines, namely: 1985-1986, 1990-1991, 1997-1998, 2008-2009 and 2014. In most of these periods, it is observed that in Nigeria, when oil price declined, oil revenues, government expenditure and economic growth also declined. For instance, between the years 1985 and 1986 when oil price fell from $27.33 per barrel to $14.97 per barrel (46%), oil revenues fell from ₦10.92 billion to ₦8.11 billion (26%), and economic growth declined by 1.89 %.[1] When oil price fell from $23.68 per barrel in the year 1990 to $20.07 per barrel in 1991, oil revenues, government expenditure and economic growth declined by 14.99%, 10.48% and 0.5% respectively. Similarly, in the second quarter of 2014 when oil price suddenly declined from about $140 per barrel to about $62 per barrel, oil revenues fell from ₦6,793.82 billion to ₦2,693.91 billion, representing about 60.35% decline. Consequently, in the second quarter of 2016, the Nigerian economy experienced recession for the first time in 25 years after the 1991 economic downturn, having contracted by 1.58% at the end of the year 2016 (CBN, 2016).

Over the years, economists and policymakers have been interested in investigating the relationships between oil price changes and other macroeconomic variables both in the developed and the developing countries as well as the oil-producing countries with the objective of determining the consequences of oil price changes on the economy (see Rasche and Tatom, 1981; Hamilton, 1983; Burbidge and Harrison, 1984; Santini, 1985; Gisser and Goodwin, 1986; Mork, 1989; Mory, 1993; Mork et al., 1994; Lee et al., 1995; Hooker, 1996; Daniel, 1997; Carruth et al., 1998; Sadorsky, 1999; Davis and Haltiwanger, 2001, Muellbauer and Nunziata, 2001; Cunado and De Garcia, 2003; and Huang et al., 2005 for developed countries; Brown and Yucel, 2000; Aleisa and Diboogle, 2002; Ayadi, 2005; Mehrara and Oskoui, 2007; Mehrara, 2008; Farzanegan and Markwardt, 2009; Berument, Ceylan and Dogan, 2010; Iwayemi and Fowowe, 2011; and Farzanegan, 2011 for developing and oil-producing countries).

Apart from this, researchers, particularly in the oil-producing countries, are also interested in carrying out studies on the nature of the relationship between oil revenues and economic growth. The rationale for this interest stems from the fact that when oil price fluctuates, it first has a negative effect on oil revenues before it is diffused into the rest of the economy. As a result, several empirical studies have been carried out. Extant studies have sort of assumed a linear relationship between oil revenues and economic growth, using different econometric techniques (Mashayekhi, 1998; Oechslin, 2010; Farzanegan, 2011; Ibeh, 2013; Dreger and

[1] Between 1985 and 1986 when the oil price declined, the total government expenditure in value terms actually increased from ₦13.04 billion to ₦16.22 billion. However, its growth rate declined from 31.36% in 1985 to 24.40% in 1986. The increase in the value of government expenditure can be attributed to the increase in external borrowing which soared from ₦17.30 billion in 1985 to ₦41.45 billion in 1986.

Rahmani, 2014; Ijirshar, 2015; Kabir, 2016; Laourari and Gasmi, 2016; Raifu and Raheem, 2018). However, the development in economies across the world and the sophistication of econometric techniques have increased interest in the modelling of oil revenues-growth nexus in a non-linear framework. Specifically, researchers and policymakers are interested in the nature of the behaviour of the relationship between oil revenues and economic growth over time, that is, whether the relationship is symmetric or asymmetric as in the case of the relationship between oil price and economic growth. In support of the research on the non-linear relationship between oil revenues and economic growth, Mehrara (2008) argues that the budget associated with or dependent on oil revenues behaves asymmetrically because the oil price upon which oil revenues depend also behaves asymmetrically. For this reason, government spending from the budget is likely to increase significantly when the positive oil price shocks occur and reduce drastically in the case of the negative oil price shocks. Thus, government development projects through government spending suffer when oil price falls. The asymmetric nexus between oil revenues and economic growth has been examined using threshold regression technique (Mehrara, Maki and Tavakolian, 2010).

This study is, therefore, set out with the objective to examine the asymmetric relationship between oil revenues and economic growth in Nigeria. Our study is similar to the one conducted by Mehrara, Maki and Tavakolian (2010) in the sense that we first employ Threshold Autoregressive Error Correction Model (TAR- ECM) as used by Mehrara et al. (2010). However, it is different in several ways. First, apart from using the TAR- ECM, for robustness, we also use both Linear Autoregressive Distributed Lag (ARDL) and Non-linear Autoregressive Distributed Lag (NARDL) methods developed by Pesaran, Shin and Smith, (2001) and Shin, Yu and Greenwood-Nimmo, (2014) respectively. Contrary to threshold regression which is used to determine the turning point above which oil revenues can have either a negative or a positive effect on the economy, NARDL is capable of capturing both the positive and negative effects of changes in oil revenues on the economy. Second, we consider the effects of real oil revenues on three measures of economic growth, namely: real gross domestic product (GDP), real GDP per capita and industrial production index (IPI). All these variables are used to provide robustness for the study. For instance, the use of real GDP per capita and real oil revenues enables us to know the extent to which oil revenues, not subject to inflation volatility, affect the share of national income that accrues to each citizen. Furthermore, the inclusion of industrial production index enables us to know how oil revenue variability affects the production base of the economy and the nature of the relationship between oil revenues and industrial production activity.

The rest of the study is organised as follows: section two presents the methodological approach. Section three describes the data and shows the trend of the relationship between oil revenues and economic growth over time. Section four discusses the empirical findings while Section five concludes.

2. Methodological Approach

The objective of this study is to investigate the asymmetric relationship between oil revenues and economic growth in Nigeria using a Nonlinear ARDL developed by Shin et al. (2014). However, for robustness, two other estimation methods are used. These methods include: the Linear Autoregressive Distributed Lag (ARDL) and the Threshold Autoregressive Error Correction methods. Only the ARDL and NARDL frameworks are presented here.[2] The two models (ARDL and NARDL) are improvements on the existing models used to determine whether the variables are co-integrated or not. They are also used to investigate economic relationship among variables irrespective of the order of integration of variables (order 0, order 1 or mixture of order 0 and 1) except order 2. The only difference between ARDL and NARDL is that the ARDL captures the symmetric effect of one variable on the other while the NARDL captures the asymmetric effect. In other words, NARDL is capable of capturing

[2] Since TAR-ECM method is a complementary method, its framework is not presented in this study

the negative and positive effects of a change in oil revenues on economic growth simultaneously. We begin with the specification of ARDL following Pesaran et al. (2001) as follows:

$$\Delta y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 oilrev_{t-1} + \beta_3 se_{t-1} + \beta_4 inv_{t-1} + \sum_{t=1}^{n} \alpha_i \Delta y_{t-1} + \sum_{t=0}^{n1} \delta_i \Delta oilrev_{t-1} + \sum_{t=0}^{n2} \phi_i \Delta se_{t-1} + \sum_{t=0}^{n3} \varphi_i \Delta inv_{t-1} + \varepsilon_t \qquad (1)$$

Where y_t represents economic growth variables (real GDP, real GDP per capita and industrial production index), *oil rev, se* and *inv* denote oil revenues, secondary school enrolment and investment respectively. β_0 is a constant representing a drift component of the model, β_1 to β_4 are the long-run coefficient parameters for each of the variables, while $\alpha_i, \delta_i, \phi_i$ and φ_i are the short-run dynamic parameters and ε_t is the error term, which is assumed to be independent and identically distributed with zero mean and constant variance.

The long-run null hypothesis (H_0) based on ARDL is specified as:

$$\beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$$

The alternative hypothesis (H_1) is:

$$\beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$$

The null hypothesis is tested against the alternative hypothesis and if co-integration exists, the error correction model (ECM) which captures the speed of adjustment from the short-run disequilibrium towards the long-run equilibrium is specified as:

$$\Delta y_t = \beta_0 + \sum_{t=1}^{n} \alpha_i \Delta y_{t-1} + \sum_{t=0}^{n1} \delta_i \Delta oilrev_{t-1} + \sum_{t=0}^{n2} \phi_i \Delta se_{t-1} + \sum_{t=0}^{n3} \varphi_i \Delta inv_{t-1} + \lambda ect_{t-1} + \varepsilon_t \qquad (2)$$

Where ect_{t-1} is the error correction term. The co-efficient of the error correction term must be negatively signed, less than zero and significant before it can be said that there is an adjustment from the short-run disequilibrium towards the long-run equilibrium.

The linear ARDL model presented above only shows a symmetric relationship between oil revenues and economic growth and thereby fails to account for the effect of a decrease and an increase in oil revenues on economic growth (Borenstein, Cameron and Gilbert, 1997). In Nigeria, oil revenues respond to cyclical movement of oil prices in the international market. When oil prices increase, oil revenues also increase and vice versa for a decline in oil price. Hence, failure to account for the effect of this cyclical movement in oil revenues will result in a biased analysis. To account for the effect, therefore, we apply the Non-linear Autoregressive Distributed Lag Method. The specification of NARDL model begins with a long-run form model as follows:

$$y_t = \eta_0 + \eta_1 oilrev_t^{+} + \eta_2 oilrev_t^{-} + \eta_3 se_t + \eta_4 inv_t + \mu_t \qquad (3)$$

Following Shin et al, (2014), oil revenues can be decomposed into partial sum of positive and negative components as follows:

$$oilrev_t^{+} = \sum_{j=1}^{t} \Delta oilrev_j^{+} = \sum_{j=1}^{t} \max(\Delta oilrev_j, 0), oilrev_t^{-} = \sum_{j=1}^{t} \Delta oilrev_j^{-} = \sum_{j=1}^{t} \min(\Delta oilrev_j, 0), \qquad (4)$$

Given equations (3) and (4), the NARDL model that incorporates the long-run model into the short-run model is specified as:

$$\Delta y_t = \eta_0 + \eta_1 y_{t-1} + \eta_2^+ oilrev_{t-1}^+ + \eta_3^- oilrev_{t-1}^- + \eta_4 se_{t-1} + \eta_5 inv_{t-1} +$$
$$\sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{q-1} (\theta_j^+ \Delta oilrev_{i=j}^+ + \theta_j^- \Delta oilrev_{i=j}^-) + \sum_{j=1}^{r-1} \lambda_j \Delta se_{t-1} + \sum_{j=1}^{s-1} \gamma \Delta_j inv_{t-1} + \varepsilon_t \quad (5)$$

Where y_t remains as defined; p, q, r and s are lag orders and, $\eta_0, \eta_1, \eta_2^+, \eta_3^+, \eta_4$ and η_5 are the long run coefficients; $\sum_{j=0}^{q-1} \theta_j^+$ and $\sum_{j=0}^{q-1} \theta_j^-$ denote the asymmetrically distributed lag parameters which indicate the short-run impact of oil revenues on output. $oilrev_{t-j}^+$ and $oilrev_{t-j}^-$ are the partial sums of positive and negative changes in oil revenues. The long-run positive and negative effects of oil revenues on economic growth can be computed by $\beta_1 = -\frac{\eta_2^+}{\eta_1}$ and $\beta_2 = -\frac{\eta_3^-}{\eta_1}$ which show the directions and the magnitudes of oil revenues increase and decrease on the economy.

Although our focus is to examine, asymmetrically, the relationship between oil revenues and economic growth, the inclusion of control variables is justified on the following ground. In economic parlance, it is believed that economic relation is not usually bivariate but rather multivariate in nature. Thus, it would be implausible that only the oil revenues would serve as determinant of economic growth in an oil-producing country like Nigeria. It has been proved theoretically and empirically that there are other variables that can serve as determinants of economic growth among which are secondary school enrolment and investment (See Becker, 1994, Barro, 1996, 2001, 2003; Chen and Feng, 2000; Bakari, 2017a, b). A priori, it is expected that oil revenues will be positively related to economic growth. Similarly, secondary school enrolment and gross fixed capital formation (investment) are expected to positively influence economic growth.

3. Data Sources, Description and Trend Analysis

In order to examine the nonlinear relationship between oil revenues and economic growth in Nigeria, this study employs annual data covering the period from 1981 to 2016.[3] The variables used include: real GDP, real GDP per capita, industrial production index, oil revenues, gross fixed capital formation and secondary school enrolment. The real GDP and real GDP per capita are output and output produced per person respectively in the economy and they are expressed in constant 2010 local currency unit (Naira), while oil revenues are the revenues that accrue to the government from the sales of crude oil in the international market. The investment and human capital are captured by gross fixed capital formation (GFCF) and secondary school enrolment respectively. While oil revenue data are obtained from the database of the Central Bank of Nigeria, real GDP, real GDP per capita, gross fixed capital formation and secondary school enrolment are sourced from the World Development Indicators (WDI). The Industrial Production Index (IPI) is obtained from the International Financial Statistics (IFS) and the Central Bank of Nigeria’s database. All the variables are in natural logarithm form. Table I summarises the descriptive statistics of the variables and Figure 1 provides an evolution of the relationship between oil revenues and economic growth over time.

From Table I, it can be observed that during the period under consideration, Nigeria has an average value of real GDP of 32,700 billion naira ($217.25 billion) which ranges from a minimum of 15,200 billion naira ($101.42 billion) to a maximum of 69,800 billion naira ($464.28 billion). The real GDP per capita has a mean value of 0.25 million naira ($1669.64).

[3] For the estimation of TAR-ECM, the annual data were converted to quarterly data in EVIEWS 9 using the Quadratic-Match Average. The Quadratic-Match Average performs a proprietary local quadratic interpolation of the low-frequency data to fill in the high observations.

The lowest and the highest values of the real GDP per capita are 0.17 million naira ($1151.13) and 0.39 million naira ($2563.09) respectively. In the case of the industrial production index, the mean value is 93.71 per cent with the minimum and maximum values of 49.95 per cent and 146.67 per cent respectively. The average value of real oil revenues is 35.46 billion naira. The minimum and maximum values of oil revenues are 9.25 billion naira and 82.83 billion naira respectively. The secondary school enrolment has an average of 32.27 per cent with the lowest and highest values of 17.10 per cent and 56.18 per cent respectively. With regard to gross fixed capital formation, its mean value is 4,620 billion naira ($30.72 billion). The minimum and maximum values of gross fixed capital formation are 1,800 billion naira ($11.97 billion) and 10,600 billion naira ($70.34 billion) respectively. The wide gap between the lowest and highest values of the variables is an indication of the presence of large variance in the variables. This is confirmed by the high values of the standard deviation of most of the variables, which indicate that the variables exhibit a high degree of dispersion from their means. As regards the results of skewness, it is noted that most of the variables are moderately and positively skewed to the right. This implies that they are asymmetrically distributed with a long right tail. With regard to Kurtosis, most of the variables are platykurtic because their values are less than the benchmark of 3 considered to be a mesokurtic or a normal distribution. Jarque-Bera results show that only the real oil revenues are normally distributed.

From Figure 1, we observe that the movement in oil revenues influences economic growth measured by real GDP and real GDP per capita. Specifically, around 1985 when the oil revenues slumped as a result of falling oil price, the economy proxied by real GDP and real GDP per capita also declined. Similarly, during the 2014 global oil price crisis, which led to a decline in oil revenues, it can be observed that real GDP and real GDP per capita also declined. This shows that oil revenues, which accrued from the sales of crude oil, dictated the dynamics of the economy. In the case of the evolution of the relationship between oil revenues and industrial production index, it appears that there is no predictable pattern between them.[4]

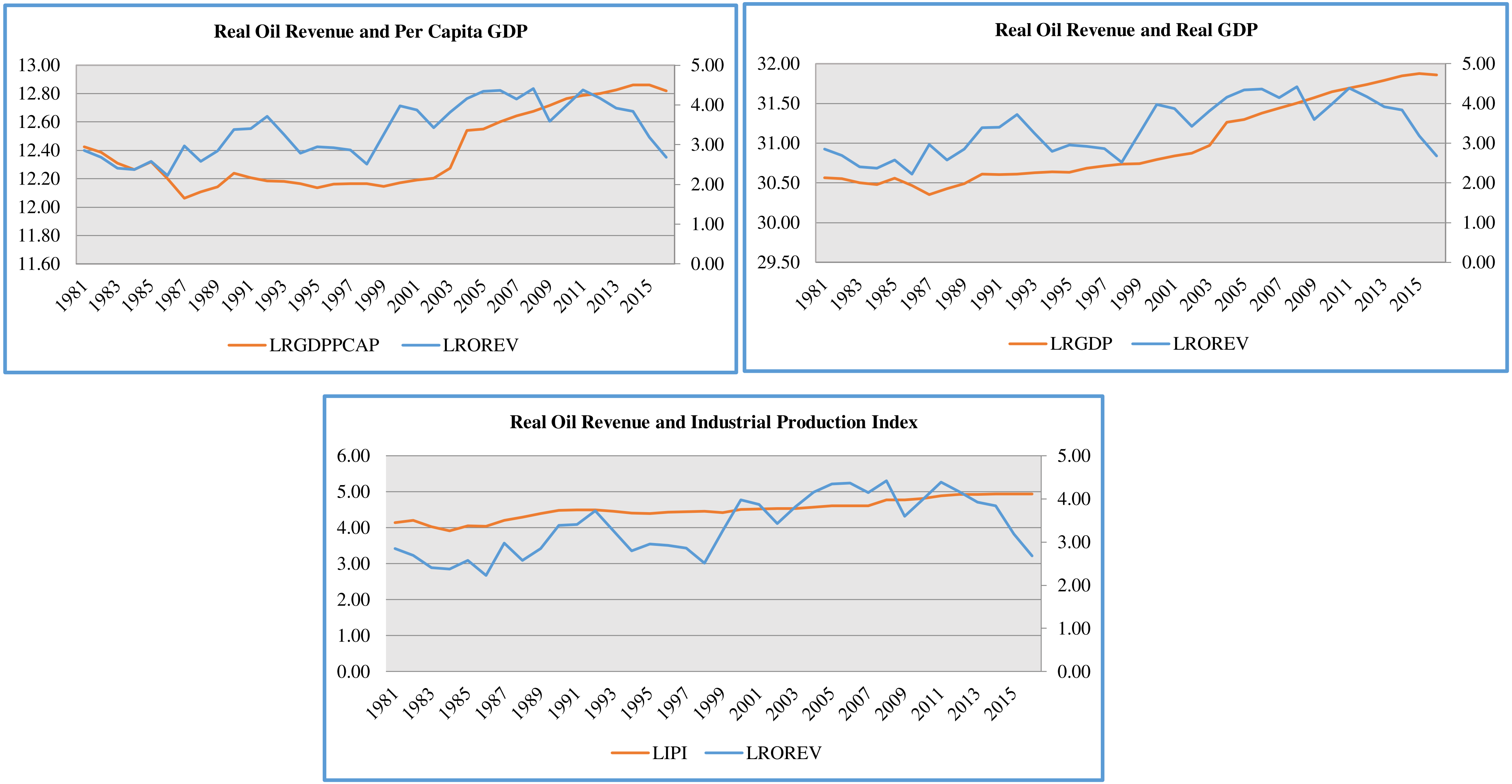
Table I: Descriptive Statistics of Variables

	RGDP	RGDPPCAP	IPI	ROILREV	SE	INV
Mean	32700.00	*250943.70*	93.71	35.46	32.27	4620.00
Median	22400.00	*213241.50*	89.52	27.72	28.22	2800.00
Maximum	69800.00	*385227.60*	146.67	82.83	56.18	10600.00
Minimum	15200.00	*173011.90*	49.95	9.25	17.10	1800.00
Std. Dev.	18100.00	*71864.64*	26.56	22.93	9.77	2970.00
Skewness	0.90	*0.73*	0.47	0.71	1.04	0.86
Kurtosis	2.27	*1.93*	2.38	2.22	3.05	2.10
Jarque-Bera	5.68	*4.90*	1.91	3.94	6.48	5.61
Probability	0.06	*0.09*	0.39	0.14	0.04	0.06
Observations	36	*36*	36	36	36	36

Source: Computed by the Authors
RGDP, RGDPPCAP, IPI, ROREV, LSE, INV indicate real GDP, real GDP per capita, industrial production index, real oil revenues, secondary school enrolment and investment respectively.

[4] *All the variables are logged before they are plotted.*

Figure 1: Trend of Oil Revenues and Measures of the Economy



4.0. Results and Discussion

4.1. Correlation Analysis

Table II presents the results of the correlation analysis of the variables used. The results show that the variables are positively correlated. Specifically, oil revenues have positive correlation with real GDP with a correlation coefficient of 0.644. This indicates the degree of association between oil revenues and the Nigerian economy. Also, oil revenues are correlated with real GDP per capita with a correlation coefficient of 0.532. The same positive correlation is obtained in the case of industrial production index. For other variables such as the secondary school enrolment and investment, they are equally positively correlated with real GDP, real GDP per capita and industrial production index.

Table II: Correlation Results

Variable	LRGDP	LRGDPPCAP	LIPI	LROREV	LSE	LINV
LRGDP	1.000					
LRGDPPCAP	0.941*** (0.0000)	1.000				
LIPI	0.898*** (0.0000)	0.746*** (0.0000)	1.000			
LROREV	0.644*** (0.0000)	0.532*** (0.0008)	0.696*** (0.0000)	1.000		
LSE	0.884*** (0.0000)	0.818*** (0.0000)	0.785*** (0.0000)	0.336** (0.0450)	1.000	
LINV	0.793*** (0.0000)	0.904 *** (0.0000)	0.609*** (0.0001)	0.332*** (0.0000)	0.663*** (0.0000)	1.000

Source: Computed by the Authors using EVIEWS 9
Note: ***, ** and * denote 1, 5 and 10 percent level of significance respectively
LRGDP, LRGDPPCAP, LIPI, LROREV, LSE and LINV represent logarithms of real GDP, real GDP per capita, industrial production index, real oil revenues, secondary school enrolment and investment respectively

4.2. Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests

Table III presents the results of the Augmented Dickey-Fuller and Phillips-Perron unit root tests carried out to determine the properties of the variables used in this study with the objective to avoid spurious analysis. The results show that the variables are a mixture of integration of order 0 and 1 which is the prerequisite for using ARDL and NARDL.

Table III: Augmented Dickey-Fuller and Phillips-Perron Unit Root Test Results

Variable	ADF		P-P	
	Level	**FD**	**Level**	**FD**
LRGP	-2.722* (0.0703)	-5.377*** (0.0000)	-3.199** (0.0201)	-7.385*** (0.0000)
LRGDPPCAP	-0.296 (0.9260)	-3.604*** (0.0057)	-0.006 (0.9581)	-4.333*** (0.0004)
LIPI	-0.445 (0.9024)	-4.055*** (0.0011)	-0.496 (0.8928)	-5.056*** (0.0000)
LROREV	-1.735 (0.4134)	-3.935*** (0.0018)	-1.522 (0.5228)	-5.654*** (0.0000)
LSE	0.905 (0.9932)	-3.417 (0.0104)	0.568 (0.9868)	-3.674 (0.0045)
LINV	-0.990 (0.7569)	-4.476*** (0.0002)	-1.069 (0.7274)	-4.561*** (0.0002)

Source: Computed by the Authors using EVIEWS 9
Note: ***, ** and * denote 1, 5 and 10 percent level of significance respectively
FD denotes first difference

4.3. Estimation Results

This Section presents the main results of the empirical analysis. Although TAR-ECM is estimated, its Tables of results are presented in the Appendix. The main findings are briefly explained here before presenting the results of ARDL and NARDL. The criteria used to select the optimal lag length for oil revenue threshold include: SSR, AIC, BIC and HQIC.[5] Based on these criteria, 3 optimal lag lengths were selected (see Table VI in the Appendix). The results, as reported in Table VII in the Appendix, show that below the 0.084 threshold level in the real GDP model, oil revenues exhibit an insignificant positive effect on real GDP, while above the threshold, oil revenues have a significant positive effect on real GDP. Below the threshold of 0.092, the impact of oil revenues on GDP per capita is negatively insignificant while above the threshold oil revenues exhibit a significant positive effect on GDP per capita. However, below the threshold of -0.027, oil revenues have a significant positive impact on industrial production index while above the threshold; there is an insignificant negative effect of oil revenues on industrial production index (IPI). The results, particularly from the IPI model, can explain the phenomenon of Dutch Disease. Dutch Disease occurs when the development in one sector of the economy has a negative effect on the other sectors of the economy, particularly in the resource-rich countries such as oil-producing countries. The channel of transmission to other sectors is the appreciation of exchange rate which arises from excessive spending of revenues realised from the sales of the natural resources (crude oil). Given our results therefore, it can be submitted that above a certain threshold, spending of oil revenues can lead to Dutch Disease syndrome with negative effect on the economy, most importantly the industrial sector of the economy.

To estimate the ARDL, one maximum lag length is selected using AIC. The results are shown in Table IV. The results show that in all the models, oil revenues have positive and significant effects on the economic growth in the short-run and in the long-run. From the Table, it is also observed that the sizes of the coefficients of the effects of oil revenues on the economy in the long-run are higher than those in the short-run. This implies that the contributions of oil revenues to the Nigerian economy increase over time. To be precise, the coefficients of the effects of oil revenues on real GDP, industrial production index and real GDP per capita are 0.097 per cent, 0.056 per cent and 0.067 percent in the short-run while those in the long-run are 0.482 per cent, 0.229 per cent and 0.167 percent respectively. We also observe that there is an adjustment from the short-run disequilibrium towards the long-run equilibrium as shown by the results of error correction terms which are negative, less than one and statistically significant. Specifically, the coefficients of error correction terms for oil revenues-real GDP model, oil revenues-IPI model and oil-revenues-real GDP per capita are -0.200, -0.245 and -399 respectively. This implies that when the shocks occur in the economy (the shocks can be internal or external), about 20.0 per cent, 24.5 per cent and 39.9 per cent of such shocks/disequilibria are corrected for in the current period.

The results of NARDL are also presented in Table IV. The Table combines different results ranging from co-integration test, short-run/long-run asymmetric tests, short-run/long-run estimated parameters to post-estimation results. Having decomposed oil revenues into positive and negative components, Stepwise Least Squares method with backward unidirectional iteration is used to estimate nonlinear ARDL. Three maximum lag lengths are chosen based on AIC, estimated at 10 percent level of significance. The co-integration tests are carried out using a Wald test based on the assumption that there is no co-integration between the variables, particularly oil revenues and economic growth. The results show that oil revenues and economic growth are cointegrated. In other words, there is a long-run relationship between the variables.[6] The short-run and long-run asymmetric tests are carried out using the Wald test restrictions. The null hypothesis of the Wald test (WLRA) long-run

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[5] *SSR, AIC, BIC and HQIC denote Sum of Squared Residuals, Akaike Information Criterion, Bayesian Information Criterion and Hannan-Quinn Information Criterion respectively*

[6] *The co-integration results are in line with the co-integration results reported in the ECM estimation based on OLS method presented in Table 6 in the appendix to this study.*

asymmetric states that the coefficients of positive and negative oil revenues are equal, that is, symmetrically related ($\eta^{+} = \eta^{-}$) while the short-run counterpart with the similar assumption is specified as $\sum_{j=0}^{q-1}\theta^{+} = \sum_{j=0}^{q-1}\theta^{-}$. As shown in the Table, the null hypothesis of long-run symmetrical relation can only be rejected at 5 per cent level when real GDP per capita is used to proxy economic growth. However, in all the models, the null hypothesis of a short-run symmetric relation can be rejected at 5 per cent level of significance. Thus, in the models of real GDP per capita, only the short-run asymmetric relationship between the real oil revenues and economic growth exists while in the models of real GDP and industrial production index, both short-run and long-run asymmetric relationships exist.

In the Table, it can be seen that positive oil revenues have a positive effect on economic growth, irrespective of the proxies of economic growth. Specifically, an increase in oil revenues by 1 per cent results in an increase in the real GDP, the industrial production index and the real GDP per capita by 0.360 per cent, 0.071 per cent and 0.208 per cent respectively. The findings are plausible because when the oil price increases in the international market, it brings more revenues to the government, which can be invested in the critical sectors of the economy that are capable of impacting the overall economy. Besides, our results are, to a certain extent, close to the one reported by Mehrara (2008). Mehrara (2008) reported 0.38 per cent as the coefficient of impact of oil revenues on economic growth for some oil-producing countries. The negative oil revenues, however, yield mixed results. While the negative oil revenues have positive effects on economic growth when real GDP and real GDP per capita are used to proxy economic growth, the negative oil revenues, however, have an insignificant negative impact on the economy when the industrial production index is used to proxy economic growth. These findings, particularly with reference to the industrial production index model, are in line with those of Mehrara, Maki, and Tavakolian (2010) who find that there is a threshold level above which oil revenues will have a negative effect on economic growth. Such a scenario has been attributed to the Dutch Disease syndrome by Mehrara et al. (2010) in which development in the oil sector affects negatively the development of other sector, particularly industrial sector.

The control variables included in the model yield mixed impact on the measures of economic growth. Irrespective of the measures of economic growth and the estimation techniques (ARDL or NARDL), secondary school enrolment has a positive and significant effect on economic growth. On the other hand, investment only has a positive and significant effect on economic growth when real GDP per capita is used to proxy economic growth (See Table IV).

The post-estimation results based on the ARDL and NARDL are mixed. For instance, in the ARDL estimation method, only the oil revenues-IPI model passes the Jarque-Bera normality test while in the NARDL, it is only the oil revenues-real GDP model that fails Jarque-Bera normality test. In the case of Breusch-Godfrey serial correlation LM test, ARCH LM heteroskedasticity test and Ramsey Reset test, all the models pass the tests irrespective of the method of estimation. Also, CUSUM and CUSUM squares tests show that the models are stable and can be used for policy formulation.[7]

[7] *CUSUM test for oil revenues-growth model appears to be unstable, albeit, its CUSUM square is stable.*

Table IV: ARDL and NARDL Results: Dynamic Effects of the Oil Revenues on Economic Growth

Variable	ARDL	NARDL	ARDL	NARDL	ARDL	NARDL
	RGGDP	RGGDP	LIPI	LIPI	RGDPPCAP	RGDPPCAP
Constant	21.762*** (6.2317)	12.200*** (3.4278)	4.974 (1.4423)	1.229** (2.5575)	4.081** (2.6311)	3.054** (2.4755)
RGGDP(-1)		-0.513*** (-3.0650)				
LIPI(-1)				-0.618*** (-10.105)		
RGDPPCAP(-1)						-0.701*** (-3.8305)
LROREV	0.482*** (3.2149)		0.229*** (3.5492)		0.167*** (3.1955)	
LROREV_P(-1)		0.185*** (4.6207)		0.044*** (3.7982)		0.146*** (3.9752)
LROREV_N(-1)		0.120*** (2.9567)		-0.0001 (-0.0090)		0.173* (3.3253)
LSE	0.956*** (3.8625)		1.042*** (3.7833)		0.322*** (2.9136)	
LSE(-1)		0.232* (1.9082)		0.128** (2.9761)		0.357** (2.700)
LINV	0.153 (1.0293)		-0.163 (-1.0921)		0.230*** (3.5234)	
LINV(-1)		0.094 (1.4043)		0.034 (1.8427)		0.154** (2.3170)
DRGGDP(-1)	-0.200** (-2.0595)					
DRGGDP(-2)		-0.331* (1.7457)				
DRGGDP(-3)		-0.358* (-1.9787)				
DLIPI(-1)*			-0.245*** (-3.5977)			
DLIPI(-1)			0.180 (1.3999)			
DLIPI(-2)				0.358*** (4.9508)		
DLIPI(-3)				0.378*** (4.7626)		
DRGDPPCAP(-1)					-0.399*** (-3.4124)	
DRGDPPCAP(-3)						-0.366* (-1.9140)
LROREV	0.097*** (3.6980)				0.067*** (4.5921)	
LROREV **			0.056*** (3.1737)			
LINV**			-0.040 (-1.2331)			
DLINV	0.031 (0.8083)	0.197** (2.7301)			0.092** (2.1809)	0.207** (2.7358)
DLINV(-2)				0.053** (2.3913)		
LSE*			0.256*** (4.3269)			
DLSE	0.191** (2.0644)			0.262*** (3.8321)	0.128** (2.4466)	
DLSE(-1)			-0.509***	-0.383***		

			(-4.0857)	(-5.3607)		
DLSE(-2)		0.254 (1.7038)		-0.184** (-2.4557)		
DLROREV_N		0.157*** (3.1646)				0.174*** (3.2544)
DLROREV _P(-1)				-0.066** (-2.5148)		
DLROREV _P(-3)		-0.149** (-2.4333)				-0.129* (-2.018)
DLROREV _N(-2)				-0.076** (-2.7774)		
DLROREV _N(-3)		0.163** (2.6515)		-0.121*** (-4.9217)		0.116* (1.8625)
ECT(-1)	-0.200*** (0.0000)		-0.245*** (0.0000)		-0.399*** (0.0000)	
F-Stats of Bounds Testing /$W_{cointegration}$	6.501	14.157*** (0.0013)	7.786	24.754*** (0.0000)	5.787	4.591*** (0.0055)
W_{SRA}		4.447** (0.0158)		12.968*** (0.0000)		2.936** (0.0366)
W_{LRA}		5.840*** (0.0020)		103.213*** (0.0000)		2.463 (0.1315)
LOR^+		0.360*** (4.6207)		0.071*** (3.7982)		0.208*** (3.9753)
LOR^-		0.234*** (2.9567)		-0.0002 (-0.0090)		0.247*** (3.3253)
R^2	0.9893 (98.93%)	0.6614 (66.14%)	0.9777 (97.77%)	0.9151 (91.51%)	0.9695 (96.95%)	0.5786 (57.86%)
Adj. R^2	0.9879 (98.79%)	0.4476 (44.76%)	0.9717 (97.17%)	0.8452 (84.52%)	0.9655 (96.95%)	0.3779 (37.79%)
F-stat Prob(F-stat)	696.026*** (0.0000)	3.093 (00137)	163.061*** (0.0000)	13.090 (0.0000)	238.602*** (0.0000)	2.883 (0.0196)
DW	1.934	2.179	1.905	2.215	1.770	1.859
JB_{NMT}	16.868 (0.0002)	6.901 (0.0317)	0.060 (0.9704)	0.3798 (0.8271)	26.116 (0.0000)	5.238 (0.0729)
B-G SC LMT	0.973 (0.3903)	0.938 (0.4107)	0.036 (0.9642)	2.333 (0.1312)	0.726 (0.4927)	0.217 (0.8071)
ARCH LMT	0.039 (0.8442)	0.568 (0.4572)	2.0281 (0.1336)	0.754 (0.3923)	0.077 (0.7825)	0.477 (0.4952)
Ramsey Reset Test	1.786 (0.0846)	0.353 (0.5601)	0.519 (0.4779)	1.190 (0.2916)	1.473 (0.2347)	0.301 (0.5893)
CUSUM	Unstable	Stable	Stable	Stable	Stable	Stable
$CUSUM^2$	Stable	Stable	Stable	Stable	Stable	Stable

Source: Computed by the Authors
Note: ***, ** and * denote 1, 5 and 10 percent level of significance respectively

5. Conclusion

This study applies NARDL approach in conjunction with ARDL and TAR-ECM to examine the asymmetric nexus between oil revenues and economic growth in Nigeria during the period from 1981 to 2016. These approaches are used to provide robustness and prove the consistency of our findings. Specifically, ARDL and NARDL are used to investigate the existence of symmetric and asymmetric co-integration between oil revenues and economic growth. Besides, the NARDL is used in conjunction with a Wald test to test for the existence of short-run and long-run asymmetric relationships between the two variables and to determine the effects of positive and negative changes in oil revenues on economic growth. For robustness, we also consider the effects of real oil revenues on three measures of economic growth, real GDP, real GDP per capita and industrial production index. Control variables such as gross fixed capital formation (a proxy for investment) and secondary school enrolment (a proxy for human capital) are included in the model. These two variables serve as determinants of economic growth, apart from oil revenues. The co-integration results show that oil revenues and economic growth are co-integrated linearly and nonlinearly, which suggest that there is a long-run relationship between oil revenues and economic growth. The study also shows that both the short-run and long-run asymmetric relationships exist between oil revenues and economic growth, except in the case of real GDP per capita where the existence of only the short-run asymmetric relationship is established. Using ARDL, oil revenues have positive impacts on economic growth in the short-run and in the long-run. However, using NARDL, we discover that positive real oil revenues have a positive effect on the economy across all the measures of economic growth while the negative oil revenues yield mixed effects. The point is that the negative oil revenues can have either a positive or a negative impact on the economy depending on the variables used to represent economic growth. Above all, oil revenues have significant positive effects on the economy above a certain threshold level. In the light of this, it is advisable for government to fashion out an effective way of managing oil revenues to minimise any oil revenue volatility or shortfall occasioned by the unstable international price of crude oil. Oil is the main export of the country and it is also the main source of government revenues in Nigeria.

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Appendix

Table V: Ordinary Least Squares Error Correction Method

Variable	Real GDP	Per Capita GDP	Industrial Production Index
Constant	0.003* (0.073)	-0.0001 (0.939)	0.0018 (0.269)
Dlrorev	0.025** (0.026)	0.021* (0.054)	0.080*** (0.000)
Dlse	0.146 ** (0.021)	0.122** (0.049)	0.120** (0.044)
Dlinv	0.087 *** (0.000)	0.078*** (0.000)	0.058*** (0.007)
dlrgdp(-2)	0.456 *** (0.000)		
dlrgdppcap(-2)		0.474*** (0.000)	
dlipi(-2)			0.397*** (0.000)
ect(-1)	-0.035** (0.033)	-0.076*** (0.001)	-0.029** (0.017)

Source: Computed by Authors
Note: ***,** and * represent 1%, 5% and 10% level of significance respectively

Table VI: Selection of Optimal Lag Length for Threshold (Real Oil Revenues)

Variable	SSR	AIC	BIC	HQIC
Dlrorev	61.364	-116.980	-111.055	-114.573
dlrorev(-1)	57.522	-124.319	-118.408	-121.917
dlrorev(-2)	54.121	-131.012	-125.115	-128.615
dlrorev(-3)	52.430	-133.503	-127.619	-131.112
dlrorev(-4)	53.226	-129.431	-123.562	-127.046
dlrorev(-5)	54.145	-125.111	-119.256	-122.732

Source: Computed by Authors
Note: SSR, Sum of Squared Error, AIC, Alkaike Information Criterion, BIC, Bayesian Information Criterion, HQIC, Hannan-Quinn Information Criterion

Table VII: Results of the Error Correction Model using the Threshold Non-Linear Model

	Real GDP		Per Capita GDP		Industrial Production Index	
	dlrorev(-3) ≥0.084	dlrorev(-3) <0.084	dlrorev(-3) ≥ 0.092	dlrorev(-3) <0.092	dlrore(-3) ≥-0.027	dlrorev(-3) <-0.027
constant	0.002 (0.100)	-0.005 (0.226)	-0.001 (0.390)	-0.006 (0.265)	0.005** (0.037)	0.003* (0.069)
dlrorev	0.019** (0.042)	0.013 (0.587)	0.019** (0.042)	-0.009 (0.681)	-0.004 (0.819)	0.087*** (0.000)
dlse	0.110**	0.492**	0.106**	0.278	-0.213**	0.382***

	(0.032)	(0.012)	(0.036)	(0.224)	(0.010)	(0.000)
dlinv	0.119*** (0.000)	-0.071* (0.081)	0.115*** (0.000)	-0.058 (0.149)	0.085*** (0.003)	0.042** (0.050)
dlrgdp(-1)	0.426*** (0.000)	0.976*** (0.000)				
dlrgdppcap(-1)			0.429*** (0.000)	1.053*** (0.000)		
dlipi(-1)					0.614*** (0.000)	0.271*** (0.000)
ect(-1)	-0.011 (0.476)	-0.033 (0.288)	-0.022 (0.290)	-0.084* (0.058)	-0.034* (0.087)	-0.040*** (0.001)
SSR	0.0227		0.0222		0.0206	

Source: Computed by Authors

Note: ***, ** and * represent 1%, 5% and 10% level of significance respectively