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Accounting for the Effects of Oil Prices on Exchange Rate in Nigeria: Empirical Evidence from Linear and Non-Linear ARDL Models

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Abstract

This study empirically examines the impact oil prices on the exchange rate in Nigeria. Time series annual dataset spanning 1980 to 2018 was estimated using the linear and nonlinear ARDL model developed by Pesaran and Shin, (1998) & Pesaran, et al. (2001) and Shin, et al. (2014); where oil prices, nominal exchange rate, interest rate, and oil revenue serves as the variables for analysis. From the result of the linear-ARDL models both the long run and short-run revealed that oil price has positive and significant impact on exchange rate. Similarly, the nonlinear model also revealed that, both in the long run and short-run, the depreciating effect of a fall in oil price is stronger than an appreciating effect of a arise in oil price of an equal magnitude. This, we argue, reflects the dependency of the economy on oil. One policy implication of this finding is that stability of oil prices and oil revenue is critical for the stability of the domestic currency and, hence, prices. It is, therefore, recommended that authorities should focus on resolving the production difficulties in the Nigeria's oil industry as a means of reducing the current revenue volatility.

Keywords: linear and nonlinear ARDL, oil prices, exchange rate and oil revenue

Introduction

Oil is one of the most significant natural resources in the modern economy and also it is fetching more and more relevance for oil exporting developing countries, which already records more than a half of world total oil consumption (Narayan et al, 2015). Similarly, for oil exporting countries, since early 1970s, oil has been accounting for a substantial part of their gross domestic product and exports earnings. The importance of oil arises from two broad dimensions; first, at international levels, oil products are the largest traded single commodity in the world whether measured in value or volume. Furthermore, market for crude oil is a truly international market. Secondly, at national level oil matters whether a country is an importer or exporter; for oil importing country, oil is often a major drain on the balance of payments. It also raises important concerns over import dependence and supply security. For the oil exporter like Nigeria, oil exports bring large-scale revenue and foreign exchange to the economy. However, it may also cause problems. The country can become dependent upon oil revenues and therefore vulnerable to fluctuations in oil prices.

Arguably, movement in oil prices in the international market may impose a significant pressure on oil dependent economies like Nigeria because, oil is the backbone of the economy and it contributes largely to economic activities in the country. From the beginning of 1970s global oil shock, oil prices remain unpredictable with high consequences on economic performance of Nigeria that solely depends on oil proceeds as a main source of revenue and foreign exchange.

Studies, including, Hamilton (1983); Hamilton et al (2003); Alimi & Fatukasi (2014); Oluwatosin, Omisakin, Yaqub & Oyinlola (2012); Ogun (1998); Mordi & Adebiyi (2010); Shaari, Hussain & AbdulRahim (2013); Farzanegan & Markwardt (2007) have shown that there exists a firm empirical linkage between oil price changes and exchange rate fluctuation in oil exporting countries. For example, the link between prices of oil and exchange rate is likely to be a strong cause for fluctuations and instability in the value of the Nigerian Naira in response of the fluctuations in the international oil prices. This factor necessitated successive governments in Nigeria to introduce various exchange rate regimes as policy strategies to complement or reduce

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the influence of the volatility of oil prices on the Nigerian Naira and the economy as a whole.

To better buttress, this argument, in 1970 when oil price was $2.4/barrel, the real exchange rate was for Nigeria was ₦0.71 against the US dollar. By October 1973, the international oil market saw one of the significant increase in oil price where the price of oil rose by more than four hundred percent, the real exchange rate in Nigeria appreciated by ₦0.66 against the US dollar. The inflow of oil rents during the two global oil shocks led to large inflows of revenues into Nigerian economy. However, expecting that the oil revenues would be sustained; the Nigerian government completely neglected the tradable sectors such as agriculture and manufacturing in favor of the oil sector.

More recently, the movements in the Nigeria's exchange rate have empirically proven to reflect fluctuations in the price of oil throughout periods beyond those earlier aforementioned, these oil price fluctuations that caused a glut in the international oil market affected the exchange rate of Nigeria negatively. For instance, in 2015 when the oil price of decline to as low as $41.85/ barrel, the Nigerian exchange rate further depreciated to ₦192 against US dollar and ₦253.5 against US dollar in 2016 when the oil price further fell to $36.34. Since then, the exchange rate has continued to depreciate to as high as ₦305.8 against the US dollar in 2017 and 2018 following the continuous happenings in the international oil market.

Knowing the relationships between oil prices and exchange rates in a highly oil dependent economy like Nigeria will may help policymakers to formulate accurate assessment of exchange rate misalignment due to fluctuations in the international oil prices. The paper adds to the existing literature in developing countries by investigating the oil price pass-through effects on exchange rates in Nigeria, as well as the impact of (A) symmetric oil price deviations on domestic exchange rates using non-linear Autoregressive Distributed Lags Models. Second section of this paper examines the theoretical literature on movements of the exchange rate and global oil prices. Section three examines the existing studies on the linkage between global oil prices and exchange rates. The empirical methodology in Section four, while section five is the empirical findings and discussions. The sixth section is conclusion and policy implication of the findings.

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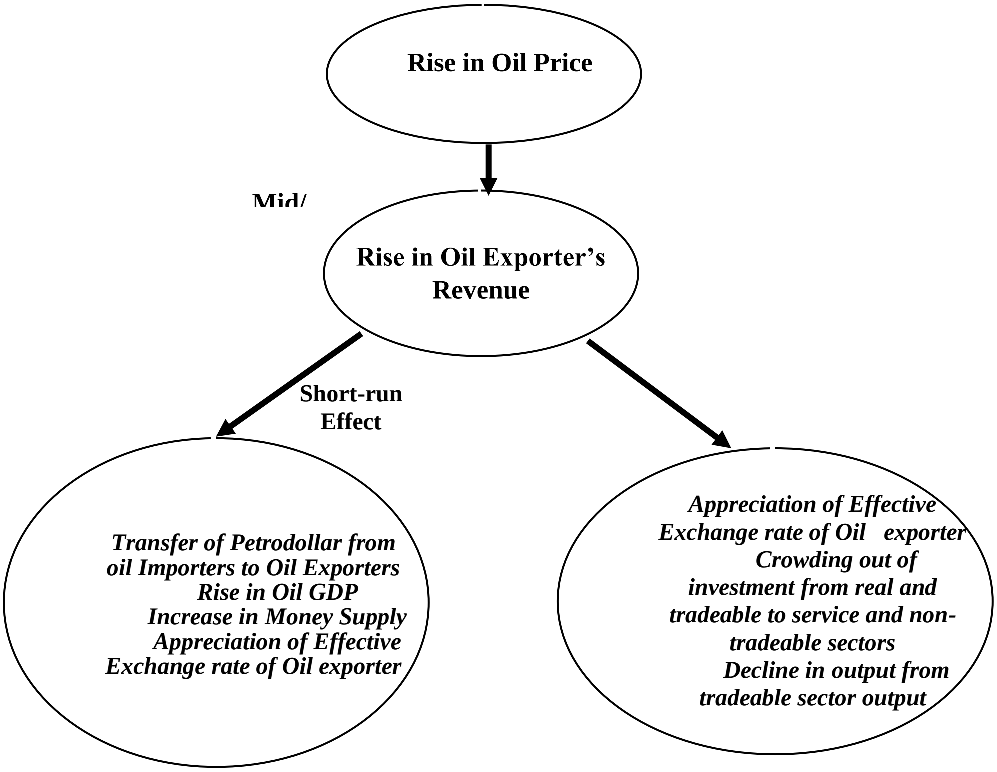
2.0 Literature Review:

2.1: Theoretical Literature and Conceptual Framework

Figure 1.0 *Theoretical transmission channels from oil price to exchange rate.*



Arguably, the literature on oil prices and exchange rates considers three direct transmission channels of oil prices to exchange rates: the terms of trade channel, the wealth effect channel and the portfolio reallocation channel (Buetzer et al., 2016). Figure 1 above shows two significant direct transmission channels of rise in oil prices to exchange rates through short term wealth effects and long-term portfolio effects.

The booms in oil sector that is accompanied by unprecedented rise in oil prices that brought about influx of foreign revenues to the oil exporting countries are traditionally analyzed in terms of "spending" and "resource movements or portfolio effects". Arguably, oil sector can be considered as a separate enclave with its own capital, labor, and technology; it does not compete with the nonoil economy for resources.

The "spending" effect operates as follows; rise in international oil prices will lead to an influx of petrodollar revenues to the oil exporting counties. This will lead to increase domestic money supply, this in turn; the real exchange rates will tend to appreciate as the relative price of nontraded sectors rises. This will lead to shift of the productive resources from tradeable

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to non-tradeable toward the nontraded sectors, which will result to greater dependence on oil for foreign exchange. The shift will in the short run will lead to movement of both labor and capital and investable resources towards oil sector, leading to a decline in tradeable sector investment and output.

However, if tradeable sectors can respond strongly to investments financed by oil revenues, product, market pulls toward the nontraded sectors may be counterbalanced in the medium to long run. On the other hand, if the tradeable sector cannot response to the phenomenon, there will be shortage of output with a consequence of rise in prices of tradeable goods; hence the country has to depend on imported goods, leading to domestic inflation with attendant BOP crises.

E~~r~~mpirical Literature

The first strand focused on the connection between exchange rate and oil prices among OPEC member countries and some selected developed countries. Studies in this strand include (Chen and Chen, (2007); Yousefi and Wirjanto,(2004); Isse, (2010); Turhan, Hacıhasanoğlu and Soytas, (2012); Jouko Rautava, (2004); Pershin, Molero and Gracia, (2015); Farzanegan and Markwardt, (2007); Shafi and Hua, (2014). Thus, much of the literature in this strand have empirically established that fluctuations in oil prices are the most significant factor that determines exchange rate fluctuations in the long term for particularly the developed economies.

However, studies such as Ferraro et al. (2015) suggests a systematic connection between changes in consumer prices and changes in exchange rate changes at the monthly and quarterly frequencies. Similarly, Sascha et al. (2012) recorded that the exchange rate of oil-producing countries systematically appreciate~~s~~ against those of oil-consuming countries aftershocks raising real oil prices. Apparently, while there is wide country variation, there is existence of considerable prove of a significant connection between oil prices and exchange rate for many countries that either import or export oil as a major commodity. Particularly, for oil-producing countries such as Iran, Farzanegan and Markwardt, (2007) dissected the dynamic connection between asymmetric oil price shocks and main macroeconomic variables in Iran. In divergence to the preceding empirical findings for net oil-consuming economies, oil price increase (decrease) has a significant positive (negative) influence on industrial output; suddenly, they could not detect a significant effect of oil prices fluctuation on real government expenditure, but the reaction of real imports and exchange rate to asymmetric oil price shocks were statistically significant.

The second strand of literature supports the suggestion that causality runs from oil prices to exchange rates, literature in this strand include; Amano and Van Norden, (1998); Zalduendo, (2006); Sadorsky, (2016); Schmidbauer

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and Rosch, (2008); Bashar and Kabir, (2013); Narayan, Narayan and Prasad, (2008); Şahbaz, Adıgüzel, Bayat and Kayhan, (2013). Basically, most studies in this strand of literature found evidence of causal relationship between oil price to exchange rate for both importers and exporters of crude oil. Apparently, studies that support one-way causality from oil prices to exchange rate are basically supported by both theoretical and empirical results, particular for exporters of crude oil and most (oil) importers other than the USA with whose currency (the US dollar) is used to trade the commodity. However, Amano and Van Norden, (1998) found non-causal ~~r~~effect from exchange rate to oil prices even for the US economy. Whereas, Joscha Beckmann, Robert Czudaj and Vipin Arora, (2017) established that the theoretical underpinning for causality from exchange rates to oil prices is based on the fact that the oil price is expressed in the US dollar.

Hence, increase in the value in the US dollar increases the value of oil measured in terms of the domestic currency, and this reduces demand for oil outside the US, leading to a drop in the oil price, all else equal (Bloomberg and Harris, 1995; Akram, 2009) as cited by Joscha et al., (2017). Furthermore, Sabhaz et al. (2013) found the existence of causal effect from real exchange rate to oil prices on medium and long term for the case of the Romanian economy. Conclusively, despite few empirical findings establishing the presence of causality running from both real oil prices and real exchange rate, there is strong conviction in both theory and practice that the exchange rate of a single country (except the US dollar in many cases) cannot significantly affect the international price of oil. Sa'ad et al(2023), found , the oil price fluctuations showed a significant and incomplete pass-through to both exchange rates and inflation in Nigeria.

The third strand of literature found the presence of negative connection between exchange rate and oil prices, literature are; Grisse, (2010); Akram, (2004); Sari, Hammoudeh and Soytas (2009); Doğan, Ustaoğlub and Demez, (2012); Elder and Serletis, (2008) [38]; Lippi and Nobili, (2008) [39]; Benassy-Quere et al. (2007); Huang and Guo, (2007). Basically, literature in this strand implies that an increase (decrease) in oil price brings about a decline (rise) in the exchange rate for either oil importers or exporters. The kind of the negative connection between oil prices and domestic exchange rate for both importers and exporters of crude is on both sides of the same coin: in that, a unit rise in the price of oil only depreciates the exchange rate of oil importers (not exporters), while a fall in oil prices only depreciates exchange rates of oil-producers (such as Nigeria). Empirically, Adeniyi et al. (2012), using two volatility models (GARCH and EGARCH) discovered that a rise in oil prices ends in the Nigerian exchange rate appreciation against the US dollar. However, Sascha et al. (2012) recorded that no evidence of exchange rates of

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oil-producers systematically appreciates against that of oil-consumers aftershocks increasing the real oil price.

Empirically, the literature to which this study directly contributes to are those that assess the effect of oil prices on exchange rate on developing (oil-producing) countries in general and Nigeria in particular which is very much limited to a few studies: Farzanegan and Markwardt, (2007); Aliyu, (2009) and Adeniyi et al. (2012). Although a wealth of literature exists relating oil prices and exchange rate to rate growth in Nigeria, and assessing the influence of oil price changes on exchange rate in Nigeria using several tools of analysis. Thus, from the literature reviewed or accessed none them employed the symmetric and asymmetric ARDL model for the purpose of assessing the impact of oil prices on exchange rate for the developing countries (particularly Nigeria) covering the scope of this study as at the time this study was conducted. Hence, this study seeks to fill in the gap by focusing on the impact of prices of oil on exchange rate in Nigeria using the symmetric and asymmetric ARDL models.

Methods

The empirical model of this study is based on the theoretical framework of Beckmann, Czudaj and Arora (2017) in order to form the connection between oil price and Nigerian exchange rate. Moreover, four variables are employed as the functional model, which are: exchange rate serves as the dependent variable while oil price, oil revenue and interest rate serves as independent variables

$$NEXR = f(OILP, OILR \text{ and } INTR) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

Where: NEXR - Exchange rate; OILP - Oil price and OILR – stands for oil revenue; INTR – stands for interest rate. However, our regression model is specified below:

$$NEXR_t = \beta_0 + \beta_1 OILP_t + \beta_2 OILR_t + \beta_3 INTR + \mu \quad \ldots\ldots(3.2)$$

Where the forecasting variables is the oil prices (OILP) and the outcome variable is the exchange rate (NEXR), all at time ***t***, β_0 is the intercept of the model, β_1, β_2 and β_3 are the model parameters and μ is the Error component of the model. Taking natural log of equation 3.2 will yield the following estimable model:

$$lnNEXR_t = \beta_0 + \beta_1 lnOILP_t + \beta_2 lnOILR_t + \beta_3 lnINTR_t + \mu \quad (3.3)$$

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3.2 Model 2: Nonlinear ARDL (NARDL) Model

The model was developed by Shin, et al. (2014), this model permits the incorporation of the possibility of nonlinear effects of positive and negative changes in the regressors on the regress and, while the case of ARDL, wherein the possible impact regressors remains same. On the other hand, in case of the impact of segregated components of regressors is found to be the same, then NARDL model boils down to the standard symmetric ARDL model. In addition, NARDL method presents graphs of cumulative dynamic multipliers used to tinge out the adjustment patterns after the positive and negative shocks. Most importantly, the model is simple and complete enough to permit any asymmetric switching from short-run to long-run or vice versa.

In comparison to the classical co-integration tests, NARDL models give some other advantages. Firstly, they are robust in determining cointegration in small sample sizes (Romilly, Song, & Liu, 2001). Secondly, they can be employed irrespective of whether the regressors are stationary at level or at the first difference (i.e. I(0) or I(1)). They will be discarded, however, if the regressors are I(2). The other advantages of NARDL are the asymmetric NARDL framework of Shin et al. (2014) is mainly fit for analysis as it allows us not only to gauge the short- and long-run asymmetries but also to detect hidden co-integration. For example, a positive shock in oil prices may have a serious effect in the short-run while a negative shock has a weak effect in the long-run (or vice-versa).

$$\Delta NEXR = \alpha + \sum_{k=1}^{n1} \beta_k \Delta NEXR_{t-k} + \sum_{k=0}^{n2} \delta_k \Delta OILP_{t-k} + \sum_{k=0}^{n3} \sigma_k \Delta INTR_{t-k} + NEXR_{t-1} + OILP_{t-1} + \Delta INTR_{t-1} + \mu \quad ..3.4$$

Where: ***NEXR*** = first difference of Exchange rate; ***OILP*** = first difference of oil price and ***OILR*** = first difference of oil revenue; ***INTR*** **=** first difference of interest rate, μ = error term

3.2.3 The symmetric and asymmetric models:

Following the works of Hatemi –J (2012) and Rafiq et al. (2016) the model shall be decomposed into partial sum of positive and negative oil shocks in order to reflect the rising and falling in the prices of oil as well as how the maximal and minimal shocks affect the exchange rate. Going by this objective and pioneering works of earlier researchers, this study explored the impacts of oil price shocks on the Nigerian exchange rate quoted against the US dollar in respect of a symmetric framework in model 1 and an asymmetric framework in model 2 in the following:

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Model 1: The symmetric model

$$NEXR_{1it} = \alpha_{1it} + \beta_{1it}OILP_{1it} + \delta_{1it}OILR_{it} + \phi_{1it}INT_{it} + \mu_{1it} \qquad (3.5)$$

Model 2: The asymmetric model

$$NEXR_{2it} = \alpha_{2it} + \beta_{2it}OILP_{2it}^{+} + \gamma_{2it}OILP_{2it}^{-} + \delta_{2it}OILR_{it} + \phi_{2it}INT_{it} + \mu_{2it} \quad ..... (3.6)$$

From the models above, NER stands for exchange rate, O represents oil prices, O^{+} represents positive or rising oil prices, O^{-} represents negative or falling oil prices, OR represents oil revenue and INT represents interest rate. t = 1980, 1981, 1982,1983,1984,1985 ………., 2018.

At the beginning, OILPt (oil prices at time t) can be written as the following:

$$OILP_{t} = OILP_{t-1} + \varepsilon_{1t} = OILP_{0} + \Sigma_{i=1}^{t} \varepsilon_{1i} , \quad ...., (3.7)$$

Where t =1980, 1981, 1982,1983,1984,1985 ………., 2018, the constant O_0 is the first constant and the slopes ε_{1i} represents the disturbance term. Hence, the positive term is defined as: ε_{1i}^{+} = max (ε_{1i} , O), while the negative term is defined as: ε_{1i}^{-} = min(ε_{1i}, O). Thus, ε_{1i} can be written as:

$$\varepsilon_{1i} = \varepsilon_{1i}^{+} + \varepsilon_{1i}^{-} \quad .... (3.8)$$

Therefore;

$$OILP_{t} = OILP_{t-1} + \varepsilon_{2t} = OILP_{0} + \Sigma_{i=1}^{t} \varepsilon_{2i}^{+} + \Sigma_{i=1}^{t} \varepsilon_{2i}^{-} \quad .... (3.9)$$

Conclusively, both the higher and lower oil shocks can be defined cumulatively as:

$$OILP_{t}^{+} = \Sigma_{i=1}^{t} \varepsilon_{2i}^{+} \text{ and } OILP_{t}^{-} = \Sigma_{i=1}^{t} \varepsilon_{2i}^{-} \quad .... (3.10)$$

As regards the above specified relations among the aforementioned defined variables, the study employed both the linear and non-linear ARDL technique in order to ascertain the association between oil price shocks and exchange rate in Nigeria.

We employed both the linear and nonlinear ARDL model in order to detect the effect of rising and falling oil prices on exchange rate in Nigeria. Thus, in order to check for the stationarity of the data are tested using the *KPSS* test because it is more efficient than ADF and PP. however, the KPSS null hypothesis states that the process is stationary, while the ADF and PP where the null hypotheses states that the series is non-stationary. Thus, the unit root result is presented in Table 1.

Table 1. Unit Root Result; H0: Series is Stationary

Variables	**KPSS at Levels**	**KPSS at First Difference**	**Remarks**
NEXR	0.736[2]	0.249[ ]**	**I (1)**
OILP	0.412[1]**	-----------	**I (0)**
OILR	0.632[1]	0.113[ ]**	**I (1)**
INTR	0.191[1]**	----------	**I (0)**
KPSS Critical Value at 5% = 0.463			

** indicates significant at 5%
[*] Indicates that no lag length was included in the tests.

The KPSS test used the "general to specific" method, which does not require a lag length to be included in the lag selection option. The estimation option used for the KPSS test was the Newey-West Bandwidth without intercept and trend. The KPSS results, at 5%, indicate that the variables of the study are integrated of different orders. OILP and INTR are stationary at levels, that is integrated of zero order [I (0)], while NEXR and OILR are stationary at first difference, that is integrated of order one [I (1)]. Therefore, at levels, the KPSS values for OILP and INTR are greater than 5 per cent, indicating that the null hypotheses of stationarity at levels cannot be rejected. For NEXR and OILR however, the KPSS values are greater than the critical at 5 per cent at level, but less than 5 per cent at first difference. Hence, NEXR and OILR have no unit root at first difference which means that they are integrated of order one (I(1)). Therefore, since the regressors are integrated of different orders, the data set has met necessary condition for NARDL model.

Table 2. Linear ARDL Model: Long-run Impact

Dependent Variable: NEXR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OILP	0.338	0.074	4.580	0.0050
OILR	0.005	0.039	0.117	0.9074
INTR	-0.675	0.089	-7.512	0.0000
C	-67.99	189.1	-0.359	0.7217

Table 2 shows the result of long-run impact of oil prices, oil revenue and interest rate on the exchange rate on. The result indicates that oil price (OILP) has a positive long-run impact on the nominal exchange rate (NEXR). The estimate is highly statistically significant and satisfies the *a priori* expectation. The positive and significant association between oil price and NEXR in Nigeria suggests that an oil price increase is likely to increase the exchange rate of Naira against the US dollar. This is expected as it strengthens the Nigerian balance of payment position and add to her foreign reserve. This

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finding is consistent with Basher et al. (2012), Paresh et al. (2008), Hacihasanoglu et al. (2013).

Furthermore, oil revenue (OILR) is also found to have a positive long-run impact on NEXR. The finding suggests that the value of Nigerian Naira appreciates by about 0.5% following a 1% rise in oil revenue (OILR). However, the coefficient of oil revenue is statistically insignificant. The positive association between oil revenue and NEXR satisfied the a priori expectation, however, because the estimated coefficient of oil revenue is insignificant, it suggests that oil revenue is yet to have appreciable long-run impact on the Nigerian economy. Rather than re-investing the oil revenue on capital projects to further boost the long-term potential of the economy, a very significant proportion of the revenue goes to the recurrent expenditure component of the Nigerian budget, election spending, and welfare of the political class in the country. Hence, oil, which is supposed to be a blessing to the country, becomes rather, a curse. This result contradicts Macdonald (1998) but conforms to the findings of Sannassee *et al*, (2012).

However, unlike oil price and oil revenue, interest rate (INTR) has a negative effect on exchange rate in the long-run. The result suggests that the long-run value of Nigerian naira depreciates following a rise in interest rate (INTR). In addition, the estimated coefficient of oil revenue is highly statistically significant as expected. INTR is the cost of borrowing capital for investment. Therefore, an increase in the cost of borrowing will discourage the foreign and the local investors to take loan from financial institutions for investment purposes. The result agrees with Muhammad and Muhammed (2012) study for Pakistan

Table 3. Linear ARDL Model: Short-run Impact

Dependent Variable: NEXR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OILP)	0.1687	0.0541	3.1152	0.0039
D(OILR)	0.0072	0.0029	2.4305	0.0211
D(INTR)	-0.0453	0.5993	-0.0757	0.9402
ECMt (-1)	-0.6721	0.0626	10.738	0.0000

Table 3 shows the result of short-run impact of oil prices, oil revenue and interest rate on exchange rate. As expected, the coefficient of the error correction mechanism (ECMt) is negative (-0.67) and highly statistically significant. This means that about 67 per cent of the disequilibrium error, which occurs in the short period, is corrected in one year, indicating a fairly fast adjustment.

The result also indicates that, in the short-run, oil prices (OILP) have a positive impact on nominal exchange rate (NEXR), and the estimate is highly statistically significant and satisfies the *a priori* expectation. However, in

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terms of the magnitude of the impact, the short-run impact is less than the long-run. The finding corroborates Salim and Rafiq (2013), Cong and Shen (2013), Ng (2012), Bouchaout and Al-Zeaud (2012) and Farzanegan and Markwardt (2009).

Oil revenue (OILR) also exerts a positive impact on NEXR in the short-run. The result suggests that the value of Nigerian naira appreciates following a rise in oil revenue (OILR). The positive association between oil revenue and NEXR satisfied the *a priori* expectation; however, the estimated coefficient is smaller than that of the long-run estimate when compared. This is as expected because an increase in oil revenue increases foreign reserves and this increases forex supply and liquidity in the foreign exchange market. The findings of this study is consistent with Benhard (2013).

However, interest rate (INTR) posits a negative but insignificant impact on nominal exchange rate in the short-run. The result suggests that the value of Nigerian naira depreciates following a rise in interest rate (INTR). In addition, the estimated coefficient of interest rate is highly statistically significant. This is as expected since an increase in the cost of borrowing will discourage investors from taking loan from financial institutions for investment purposes. Furthermore, the positive sign suggests that, unlike the uncovered interest parity suggests, foreign investors do not appear to regard naira-denominated and foreign currency-denominated assets as substitutes, so that rise in domestic interest rates (hence, yield on naira-denominated assets) do not raise capital inflows to appreciate the naira.

Table 4. Nonlinear ARDL Model: Asymmetric Response of Exchange Rate to Oil Price

Long Run Asymmetric Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob
OILP_POSITIVE	0.631	0.114	5.552	0.001
OILP_NEGATIVE	-0.706	0.132	-5.331	0.001
OILR_POSITIVE	0.019	0.007	2.860	0.019
OILR_NEGATIVE	-0.006	0.005	-1.311	0.209
INTR_POSITIVE	0.302	0.159	1.897	0.077
INTR_NEGATIVE	0.988	0.247	3.997	0.001
C	-28.20	8.909	-3.165	0.006
Short Run Asymmetric Coefficients				
D(NEXR(-1))	0.230	0.172	1.343	0.199
D(OILP_POSITIVE)	0.348	0.084	4.132	0.009
D(OILP_POSITIVE(-1))	0.662	0.092	7.176	0.000
D(OILP_POSITIVE(-2))	0.107	0.007	14.82	0.000
D(OILP_NEGATIVE)	-0.045	0.109	-0.418	0.682
D(OILP_NEGATIVE(-1))	-0.034	0.012	-2.747	0.038
D(OILP_NEGATIVE(-2))	-0.457	0.125	-3.659	0.002

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D(OILR_POSIVITE)	-0.007	0.003	-2.248	0.040
D(OILR_POSITIVE(-1))	0.011	0.004	2.697	0.016
D(OILR_NEGATIVE)	-0.005	0.003	-1.465	0.163
D(INTR_POSITIVE)	1.446	2.175	0.665	0.516
D(INTR_POSITIVE(-1))	-7.026	2.518	-2.789	0.013
D(INTR_NEGATIVE)	2.133	2.742	0.778	0.448
ECMt(-1)	-0.786	0.144	-5.472	0.000

Table 4 shows the result of non-linear ARDL model of asymmetric relationship between NEXR, oil price (OILP), oil revenue (OILR) and interest rate (INTR), in both the long-run and in the short-run. The nonlinear ARDL model allows determining whether the dependent variable responds symmetrically or asymmetrically (positively or negatively) to changes in the independent variables. If the exchange rate responds positively or negatively to positive and negative changes in oil price with the same magnitude, then the relationship between exchange rate and oil price is symmetric, if otherwise, it is asymmetric.

The long-run result shows that the reaction of NEXR to rising oil price is (+0.63) while the response of NEXR to falling oil prices is (-0.706). This implies that when OILP increases, NEXR appreciates, but when OILP decreases, NEXR depreciates with different magnitudes, suggesting that the response of NEXR to rising OILP is different from its response to negative changes in OILP. Therefore, the association between oil prices and exchange rate is asymmetric and, in addition, nominal exchange rate reaction to a fall in oil prices is more than its response to the rise in oil prices. That means that appreciation of the nominal exchange rate in response to a rise in oil price is larger than the depreciation resulting from a fall in oil price of the same magnitude. This finding conforms to the results of studies by Bashir and Sadorsky (2016), Schmidbauer and Rosch (2008), Chen and Chen (2007) and Zalduendo (2006).

Furthermore, the reaction of NEXR to rising oil revenue (OILR) is positive while the reaction of NEXR to falling oil revenue (OILR) is negative. The result shows that NEXR appreciates when OILR increases, but depreciates following a decrease in OILR. This conforms to the *apriori* expectation. For interest rate however, the reaction of NEXR to both rising and falling changes in interest rate is indifference. Is implies that NEXR appreciates irrespective of whether interest rate rises or falls. It appreciates by about 30 per cent when interest rate increases but appreciates by about 98 per cent when interest rate falls.

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From the Table, the short-run results showed nominal exchange rate respond positively to rising oil prices at different lags and negatively to falling oil prices. The response is, however, stronger to a rise than to a similar fall in oil prices. This conforms to the a priori expectation. For oil revenue, however, only OILR (-1) conforms to the a priori expectation, with 1.1 per cent appreciation in nominal exchange rate following a 1 per cent rise in OILR (-1). However, NEXR depreciates by about 0.5 per cent when OILR decreases by 1 per cent.

Similarly, the long-run result, the response of NEXR to both rising and falling interest rate is indifference. Is implies that NEXR appreciates irrespective of whether interest rate rises or falls. The error correction mechanism (ECMt) is negative (-0.786) and highly significant. This means that about 79 per cent of the disequilibrium error, which occurs in the short-run, is corrected in one year.

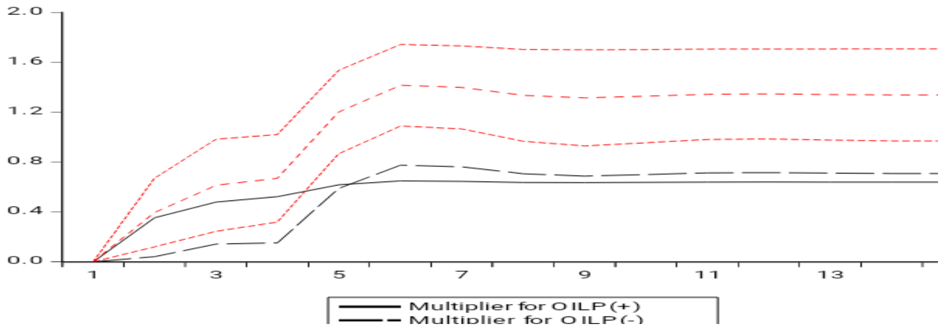

Figure 1. Non-Linear Asymmetric Plots for Oil prices

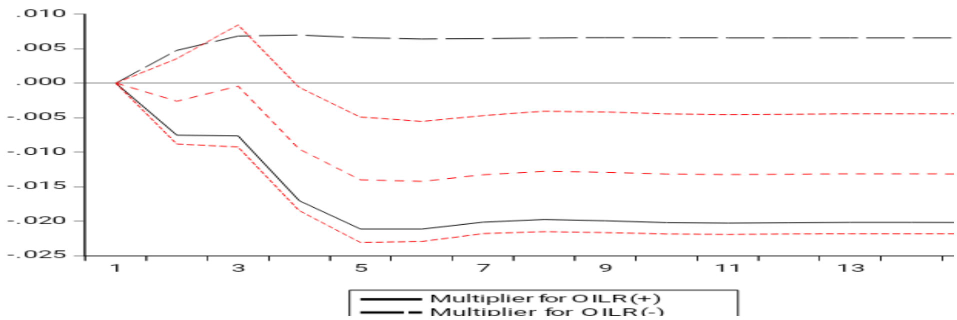

Figure 2. Non-Linear Asymmetric Plots for Oil revenue

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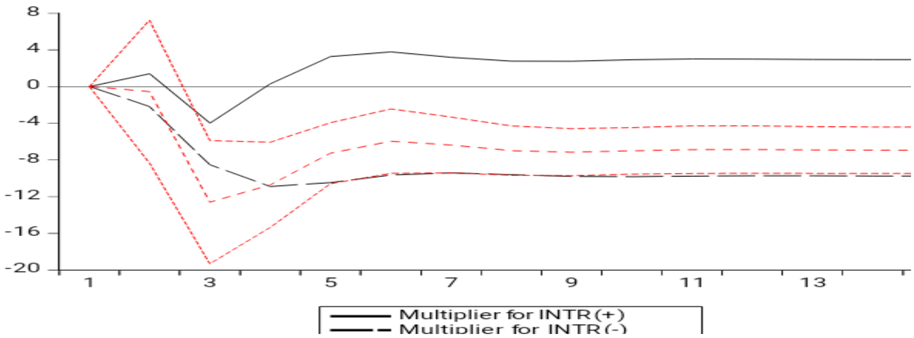

Figure 3. Non-Linear Asymmetric Plots for Interest rate.

Figure 1, 2 and 3 further confirms that oil prices (OILP) and oil revenue (OILR) exhibit asymmetric behaviors while interest rate (INTR) is symmetric. This is because the asymmetric plot for oil prices (OILP) and oil revenue (OILR), represented by red dotted lines, neither coincide with the positive nor with the negative multipliers for each of the variables, whereas, asymmetric plot for interest rate (INTR) coincide with the negative multiplier. The implication of the findings is that, nominal exchange rate responds to increases in oil prices and oil revenue is different from its response to decrease in oil price and oil revenue, which is as expected.

Table 5. Post Estimation Tests *Serial Correlation; H_0: No autocorrelation*

-statistic	0.606999	Prob. F(2,13)	0.5597
Obs*R-squared	2.989303	Prob. Chi-Square(2)	0.2243
Heteroskedasticity			
F-statistic	0.000922	Prob. F(1,32)	0.9760
Obs*R-squared	0.000979	Prob. Chi-Square(1)	0.9750

Source: E-views 9 Output

Table 5 indicates the post estimations test results. The serial correlation test has a probability value of 0.559 which is greater than 0.05 which summits that the null hypothesis of no-serial correlation fail to be rejected. Similarly, the probability value of heteroskedasticity is 0.976 submitting that the null hypothesis of no-heteroscedasticity is failed to be rejected. ,

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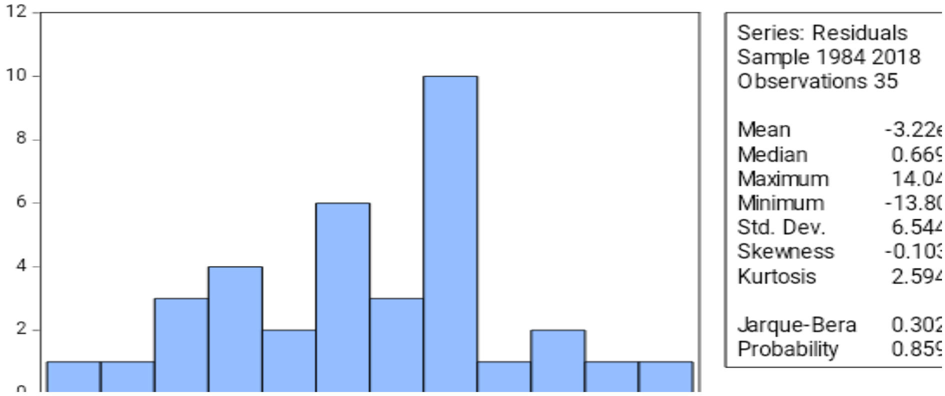
Figure 4. Normality plot



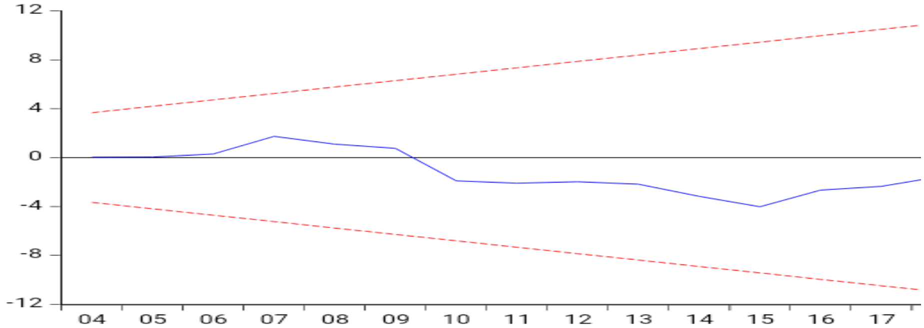


Figure 5. CUSUM Plot of Stability

Furthermore, the normality plot by Jacque-Bera is presented in figure 2 with the value and the probability which are 0.303 and 0.8595 respectively. Hence, the null hypothesis of the residuals is normally distributed is accepted. Also, the result passed the test of stability of CUSUM and CUSUM of squares tests which is presented in Figure 4 and 5. Therefore, it can be concluded that the residuals in the model are stable.

Conclusion

This study uses linear and non-linear ARDL models to determine the impact of oil prices on the exchange rate in Nigeria for the period 1980 to 2018. The empirical results indicate that the effects of oil price and oil revenue are asymmetric with respect to nominal exchange rate because the responses of nominal exchange rate to increases in oil price and oil revenue are different from its response to decreases in oil price and oil revenue. It was found that, in the long term, when oil prices fall nominal exchange rate falls (depreciates). The long-run result indicates that the response of NEXR to positive changes in OILP is positive while the response of NEXR to negative changes in OILP

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is negative. This implies that when OILP increases, NEXR appreciates but when OILP decreases, NEXR depreciates. Furthermore, the exchange rate responds more strongly to a fall in oil price (-0.71) of a given magnitude than for a rise in oil price (0.63) of the same magnitude. This suggests that the response of NEXR to positive changes in OILP is different from its response to negative changes in OILP. Therefore, the association between oil prices and exchange rates is asymmetric. The larger depreciating effect of a fall in oil price relative to the appreciating effect of a rise of the same magnitude reflects, in part, the dependence of the Nigerian economy on oil.

Like oil price, the reaction of NEXR to rising oil revenue (OILR) is positive while the reaction of NEXR to falling oil revenue (OILR) is negative. The result shows that NEXR appreciates by about 19% when OILR increases and depreciates by about 0.6 per cent following a decrease in OILR. The implication of rising oil revenue for an oil dependent economy like Nigeria is that the number of barrels sold is expected to increase and generate substantial revenue and then translate to the growth of the economy. For interest rate however, the reaction of NEXR to both rising and falling interest rate is indifferent. This implies that NEXR appreciates irrespective of whether interest rate rises or falls. It appreciates by about 30 per cent when interest rate increases but appreciates by about 98 per cent when interest rate falls.

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