Investigating Oil Prices and Exchange Rates Nexus in Nigeria: ARDL Approach

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Abstract: This paper examined the long-run association of real exchange rates, real oil prices, interest rate, inflation and external debt in Nigeria. It used monthly data for the period, 1980-2017. The model employed in the study started with testing for the existence of unit roots which were found to be a combination of orders I(0) and I(1), fulfilling the ARDL condition. Also, using various cointegration tests, the study reveals that cointegration exists among the selected variables. The granger causality test found that oil price positively and significantly impacted exchange rates in Nigeria, suggesting that a rise in global oil prices resulted in exchange rate appreciation. In a similar way, increases in oil prices triggered inflation. In view of this, it is suggested that appropriate policy measures be considered during oil price increases to mitigate unfavourable movement in exchange rates.

Keywords: ARDL; External Debt; Oil Prices; Granger Causality; Exchange Rates

JEL Classification: E0; E1 O0; O13; Q3

1. Introduction

Despite previous studies have observed the significance of oil price variations on exchange rates behaviour especially among the oil exporting economies, the explanation to exchange rates behaviour have remained equivocal (see Babatunde 2015; Aziz, Dahalan, Hakim, 2013) and Golub, 1983). Although, these studies have a strong consensus that real exchange rates and real oil prices may cointegrate. They also hold that variations in oil prices dominantly account for persistent shocks and the volatility of US dollar real exchange rates over the period of post-Bretton (see

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Amano and van Norden, 1998; Chaudhuri and Daniel, 1998). Notwithstanding, while interest further emerges and grows at investigating the oil price-exchange rate association among the developed economies like the OECD (Organisation for Economic Co-operation and Development), and Middle Eastern nations (MECs) (see Chaudhuri and Daniel, 1998; Korhonen and Juurikkala, 2009), study on developing Africa's oil exporting countries are meagre. Similarly, studies on nominal exchange rates determination employing monetary techniques are far more extensive than researches on real exchange rates determination. Furthermore, despite the fact researches on the real exchange rates determination in the developing economies are budding, researches carried out on real exchange rates determination in the context of oil-producing countries is somewhat infrequent. Undeniably, very few authors have examined the role of real oil prices on the determination of real exchange rates. Study like Habib and Kalamova (2007) examines whether the real oil price has any effect on the real exchange rates of a few major crude oil exporting countries comprising Saudi Arabia, Russia, and Norway. Their result shows the existence of a positive, long-run relationship association amid the real oil prices and real exchange rates for Russia. However, it is otherwise in Saudi Arabia and Norway. Notwithstanding, few attempts have been made, engaging wide-ranging empirical and conceptual researches to understand the behavior of exchange rates in the developing oil exporting countries, yet have met with only inadequate accomplishments (see Aziz, Dahalan and Hakim, 2013; Babatunde, 2015).

As noted in Brignall and Modell (2000), Arize, Malindretos and Kasibhatla (2003), Hodge (2005), Hausmann (2008), Musonda (2008) and Demir (2010), variations in real exchange rates can cause distortions in the economy, impedes trade flows and creates uncertainty in investment decisions; causes uncertainty in macroeconomic policy formulation. Higher real exchange rates may lead to cheaper domestic production and consequently, results in cheaper exports and expensive imports.

However, to determine the policy option suitable to limit the fluctuations in the values of the domestic currency; understanding the forces associated with the fluctuations in the value of the domestic currency and determine the behavior of exchange rates, this study seeks to address the issue for Nigeria economy, characterized a monocultural economy.

2. Theoretical Background

Basically, various theories like purchasing power parity (PPP) model, monetary model, traditional flow model, and portfolio balance model are found in the literature explaining the exchange rates movement and its relationship with external shocks. Nonetheless, the structural model advanced in Meese and Rogoff (1988) is found suitable in this empirical study to consider the role of real oil price shocks and inclusion of interest rate differential to be accountable for the long-run equilibrium real exchange rates and external debt/GDP (debt GDP). This theory examines the co-movements of real exchange rates and long-term real interest rates over the experience of modern flexible exchange rates.

However, the real exchange rates (Q_{t}) is expressed in the logarithm term below is premised on three assumptions detailed below. Nonetheless, supposing the real exchange rates are defined as:

$$Q_{\mathrm{t}} = \vartheta_{\mathrm{t}} - (p_{\mathrm{t}} - p_{\mathrm{t}}^{*}) \qquad 1$$

Where ϑ denotes the logarithm form of nominal exchange rates (domestic currency per unit of foreign currency); p and p^{*} are respectively the logarithm forms of domestic and foreign prices of goods and services; t is the time.

Rearrange and simplified (1):

$$Q_{\mathrm{t}} = \vartheta_{\mathrm{t}} - p_{\mathrm{t}} + p_{\mathrm{t}}^{*} \qquad 2$$

The assumptions are:

i) it is assumed that the long-run real exchange rates are nonstationary variables; therefore, ii) occurrence of shocks cause real exchange rates to its equilibrium value and at a constant rate; and lastly, iii) revealed real interest rate parity is satisfied given that:

$$\forall_{\mathrm{t}}(Q_{\mathrm{t+\alpha}} - Q_{\mathrm{t}}) = (\delta_{\mathrm{t}} - \delta_{\mathrm{t}}^{*}) \qquad 3$$

where δ^{*} and δ respectively are the real foreign and domestic interest rates for an asset of maturity α.

Converging the above three assumptions to interact, the real exchange rates can, therefore, be stated as (4):

$$Q_{\mathrm{t}} = -\tau(\delta_{\mathrm{t}} - \delta_{\mathrm{t}}^{*}) + \widehat{Q_{\mathrm{t}}} \qquad 4$$

Accordingly, τ is a parametre and > 0[1].

[1] τ relatively leaves the question open, what are the determinants of $\widehat{\mathrm{Q}}$ that are nonstationary variables?

3. Methodology

Majorly, this study establishes the long-run relationship amidst exchange rates and oil prices. This is carried out by examining the factors determining exchange rates in Nigeria. The study relies on monthly data comprising exchange rates, interest rate, inflation, oil price, exchange rates, and debt/GDP for the period covering 1980 to 2017. Data availability dictates the choice of cut-off. Primarily, the data for this study is sourced from the Central Bank of Nigeria (CBN) statistical bulletin, National Bureau Statistic (NBS) and World Development Indicators (WDI). Data were sampled at different frequencies: annually and quarterly. Therefore, to overcome the dilemma confronting forecasters where data are a sample at varied frequency. Following Ghysels and Wright (2009); Tay (2006), the study adopts the time averaging techniques used in Ghysels, Santa-Clara, and Valkanov (2004 and 2006), Clements and Armesto, Engemann and Owyang (2010), Clements and Galvao (2008), Xu, Zhuo, Jiang, Sun and Huang (2019) to convert those variables employed into monthly data. This approach is favorably supported in the literature and considered standard (See Davoodi *et al.*, 2013; Xu, Zhuo, Jiang, Sun, Huang, 2019).

Real exchange rates are computed, using the domestic level of price and level of price in the US[1]. It is done through a simple mathematical operation[2]. The real oil prices are expressed[3]. The Brent Blend/Brent Crude is considered as a measure for the crude oil because it accounts for the largest oil exports in Nigeria among several major arrangements of oil entailing of Brent Sweet Light Crude, Forties crude, Brent Crude and Oseberg crude (OPEC, 2016). In addition, the real exchange rates and real oil prices are expressed in their natural logarithm forms. We derive the real interest rate, using Fisher's equation. The real interest rate solved from the Fisher equation[4]. For the real interest rate differentials (RDR), It is expressed[5]. The Hodrick Prescott filter is employed into the RDR monthly data series. The external debt to the GDP captures the openness of Nigeria with her trading partners (see Kia 2006; Eslamloueyan and Kia, 2015). Consequently, the model to be estimated is expressed as:

The model to estimate is given as:

[1] The US is selected to be the numeraire country, based on its wide acceptability and been the country with the most traded currency and a major importer of the Nigeria crude oil.

[2] Real exchange rates equal nominal exchange rates X (foreign price level /domestic price level). (i.e. $Q = E * {P_d}/{P_f}$). Where, E is the nominal exchange rates, P_d and P_f respectively are foreign price level and domestic price level.

[3] Monthly average prices of crude oil defined in relations to the US dollars and deflated by domestic CPI (consumer price index).

[4] (1 + Interest) / (1+Inflation) -1.

[5] $RDR_t = r_t - r_t^*$; Accordingly, r_t symbolise the real interest rate of Nigeria; r^* denotes the real foreign interest rate.

$Q_{\mathrm{t}} = \varphi_{1\mathrm{t}} + \varphi_{2\mathrm{t}} I_{\mathrm{t}} + \varphi_{3\mathrm{t}} rop_{\mathrm{t}} + \varphi_{3\mathrm{t}} rinf_{\mathrm{t}} + \varphi_{4\mathrm{t}} dbtgdp_{\mathrm{t}} + \xi_{\mathrm{t}}$ 4

Given that $I_{1\mathrm{t}} = rdr_{\mathrm{t}}$ 4.1

Where: Q is the real exchange rates; $\varphi_1 - \varphi_4$ are the parametres of various determinants; I is differential in real interest rate; rop is the real price of oil; $rinf$ is real inflation; $dbtgdp$ is the stock of external and ξ is the disturbance terms.

Following Chudik and Pesaran (2013), given that the ARDL regression model is expressed as:

$\Delta q_t = \varphi_0 + \varphi_1 \Delta\vartheta_{t-1} + \varphi_2 \Delta\vartheta_{t-2} + \cdots + \varphi_p \Delta\vartheta_{t-p} + \Pi_1 \Delta q_{t-1} + \Pi_2 \Delta q_{t-2} + \cdots + \Pi_z \Delta q_{t-z} + v_t$ (5)

Where q_t is an endogenous variable that captures the exchange rates; φ_0 is a constant term or intercept; Δ is the first difference operator; ϑ and q are lagged independent variables both in long and short runs respectively. $\varphi_1 - \varphi_p$ represent the model short-run dynamics; $\Pi_1 - \Pi_p$ is the long-run relationships; and u_1 is random walk/white noise. The ARDL technique has the following advantages when it is compared with other earlier and traditional cointegration methods (see Harris and Sollis, 2003): It is not necessary that variables of the models are integrated of the same order. Therefore, the ARDL technique is applicable if the underlying variables are integrated of order zero, order one or fractionally integrated. The ARDL test is comparatively more effectual when the study involves data with finite and small sample size; and finally, Harris and Sollis (2003) observes that the ARDL technique offers unbiased estimates for the long-run model; the ARDL technique holds that, only a reduced single form equation association exists amidst the dependent and exogenous variables (see Pesaran, Smith, and Shin, 2001); through the ARDL technique, the Error Correction Model (ECM) is obtainable through a simple direct transformation, that integrates long-run adjustments with short-run equilibrium, not having to lose long run information.

The corresponding error correction model is expressed as:

$\Delta q_t = \varphi_0 + \varphi_1 \Delta\vartheta_{t-1} + \varphi_2 \Delta\vartheta_{t-2} + \cdots + \varphi_p \Delta\vartheta_{t-p} + \theta(q_{t-1} - \mu_0 - \mu_0 rop_t - \mu_2 I_t - \mu_3 rinf_t) + z_t$ (6)

Where θ is the coefficient measuring the speediness of adjustment of disequilibrium in short-run, $\mu_0 rop_t, \mu_2 I_t$ and $\mu_3 rinf_t$ denote the long run parametres of real oil prices and real interest rate differential respectively, $\varphi_1 \Delta\vartheta_{t-1}$, $\varphi_2 \Delta\vartheta_{t-2}$ and $\varphi_p \Delta\vartheta_{t-p}$ are respectively the short-run parameters for real oil price, real interest rate differential and inflation rate and z_t accounts for the error term.

4. Empirical Results

4.1. ARDL Unit Root Results

As a starting point, the study conducts a stationarity test presented in tables 1a to 1c, to confirm the existence of unit root. For this reason, the research employs the conventional Augmented Dickey-Fuller (ADF), Dickey-Fuller (DF) and the Phillips-Perron tests, consequent to the Ng and Peron (2001) and the Dickey-Fuller Generalized least square (DF-GLS) de-trending test, following Elliot et al. (1996). The three-standard unit root test techniques are applied to all the variables consisting of exchange rates, inflation, oil price, interest rate, and dbtGDP to test for the existence of unit-roots. The finding reveals that the order of integration is a blend of I(1) and I(0), and none is I(2). These outcomes satisfy the condition for testing and using Autoregressive Distributed Lags (ARDL) (see Paseran, Shin and Smith, 2001).

Table 1a. Augmented Dickey-Fuller (ADF) Unit Root Tests

Variable	(AIC) (Intercept)			(AIC) (Trend and Intercept)		
	Integration Order	t^* Statistic	P-Value	Integration Order	t^* Statistic	P-Value
Oil Price	I(1)	-3.487428	0.0088***	I(1)	-3.455175	0.0457**
Exchange Rate	I(0)	-3.136107	0.0247**	I(0)	-3.441469	0.0473**
Inflation	I(0)	-3.160896	0.0041***	I(0)	-3.599463	0.0310**
Interest Rate	I(0)	-4.217767	0.0007***	I(1)	-4.322131	0.0002***
Dbtgdp	I(1)	-3.519563	0.0079***	I(1)	-3.507899	0.0397**

Source: Authors' computation, 2019

"***", "**" and "*" symbolize statistical significance respectively at 1%, 5%, and 10%.

Table 1b. Philip-Peron (PP) Unit Root Tests

Variable	Newey-West Bandwidth (Intercept)			Newey-West Bandwidth (Trend and Intercept)		
	Integration Order	t^* Statistic	P-Value	Integration Order	t^* Statistic	P-Value
Oil Price	I(0)	-4.918487	0.0000***	I(0)	-4.926509	0.0003***
Exchange Rate	I(1)	-3.763481	0.0036***	I(1)	-3.786368	0.0181***
Inflation	I(1)	-4.688687	0.0001***	I(1)	-4.684901	0.0008***
Interest Rate	I(0)	-3.498766	0.0085***	I(0)	-3.887323	0.0133***
Dbtgdp	I(1)	-3.724325	0.0041***	I(1)	-3.712643	0.0224**

Source: Authors' computation, 2019

"***", "**" and "*" symbolize statistical significance respectively at 1%, 5%, and 10%.

Table 1c. Dickey-Fuller (DF) Unit Root Tests

Variable	Akaike Information Criterion (Intercept)			Akaike Information Criterion (Trend and Intercept)		
	Order of Integration	t* Statistic	P-Value	Order of Integration	t* Statistic	P-Value
Oil Price	I(1)	-2.172899	0.0485**	I(1)	-3.400088	0.0007***
Exchange Rate	I(0)	-1.978300	0.0196***	I(1)	-2.741747	0.0070***
Inflation	I(1)	-2.694012	0.0073***	I(1)	-2.842340	0.0047***
Interest Rate	I(0)	-3.972935	0.0001***	I(0)	-4.830498	0.0000***
Dbtgdp	I(1)	-3.339199	0.0009***	I(1)	-3.461080	0.0006**

Source: Authors' computation, 2019

"***", "**" and "*" symbolize statistical significance respectively at 1%, 5%, and 10%.

4.2. ARDL Optimal Lag Selection

Ideal lag length is obtained as displayed in table 2, estimating the regressions separately, following consecutive modified LR t-statistic (each test at 5% significant level). This is achieved using various lag order selection criteria comprising, the Hannan-Quinn Information criterion (HQ), Akaike Information Criterion (AIC), Final Prediction Error (FPE) and Schwarz Information Criterion (SIC) which are basically considered when ARDL estimating technique is employed (see Raza *et al.*, 2015). However, lag length 2 is considered suitable for the variables. This lag gives the least criteria for the value of FPE, AIC, SIC, and HQ.

Table 2. The ARDL Optimum Lag Selection Criteria

Lag Length	FPE	AIC	SIC	HQ
0	7.05e+23	69.10203	69.14879	69.12048
1	1.13e+14	46.55100	46.83158	46.66173
2	1.20e+11*	39.69917*	40.21355*	39.90217*
3	1.33e+11	39.80241	40.55060	40.09768
4	1.48e+11	39.90642	40.88842	40.29396

Source: Authors' Computation, 2019

4.3. Measurement of the Strength of the Model Selection Criteria

The study uses the criteria graph approach as shown in figure 1, to identify and determine the various top twenty models, premised on benchmark analysis.

Basically, this technique helps us to determine the superiority of the (AIC) compared with other estimating criteria like the Hannan-Quinn (HQ) criterion and Schwarz Information Criterion (SIC) for selection of model in the regression, the short and long runs association. The decision rule for this approach is that the better the model, when the amount of AIC is low, implying that, the best ARDL model is considered adequate with the lowest AIC value. However, figure 1 presents ARDL (2, 2, 2, 1, 0) as the model with the minimum negative value of AIC and hence, the most preferred over other criteria for this study.

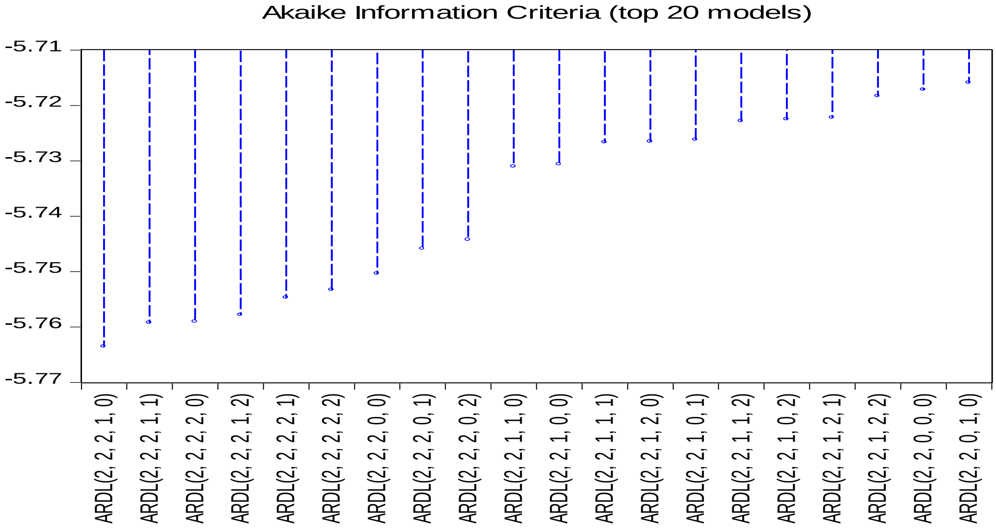

Figure 1. Summary of the Strength of the Model Selection

Source: Authors' computation, 2019

Supporting the criteria graph in fig 2, the result in the criterial table shown in table 3 offers supports for the appropriateness of lag 2 as the most suitable lag for the model. This confirms that, among the several models, the appropriate specification satisfying the AIC, LR, SIC, and HQ is ARDL (2, 2, 2, 1, 0). This also buttresses the results from the result for maximum lag length selection shown in table 2.

Table 3. Criteria Table

Model Selection Criteria Table						
Dep. Var.: REXR						
Sample: 1980M01 2017M12						
Model	LogL	AIC*	BIC	HQ	Adj. R-Sq	Specification
6	1285.738534	-5.763523	-5.652446	-5.719711	0.999531	ARDL(2, 2, 2, 1, 0)
5	1285.781124	-5.759191	-5.638858	-5.711728	0.999530	ARDL(2, 2, 2, 1, 1)
3	1285.742897	-5.759018	-5.638685	-5.711555	0.999530	ARDL(2, 2, 2, 2, 0)
4	1286.474776	-5.757804	-5.628215	-5.706691	0.999530	ARDL(2, 2, 2, 1, 2)
2	1285.783892	-5.754678	-5.625089	-5.703565	0.999529	ARDL(2, 2, 2, 2, 1)
1	1286.477959	-5.753294	-5.614449	-5.698529	0.999529	ARDL(2, 2, 2, 2, 2)
9	1281.825826	-5.750343	-5.648523	-5.710182	0.999523	ARDL(2, 2, 2, 0, 0)
8	1281.836441	-5.745866	-5.634790	-5.702055	0.999522	ARDL(2, 2, 2, 0, 1)
7	1282.476099	-5.744236	-5.623903	-5.696773	0.999523	ARDL(2, 2, 2, 0, 2)
15	1277.549514	-5.730993	-5.629173	-5.690833	0.999514	ARDL(2, 2, 1, 1, 0)

Source: Authors' computation, 2019

Figure 2: CUSUM Stability test

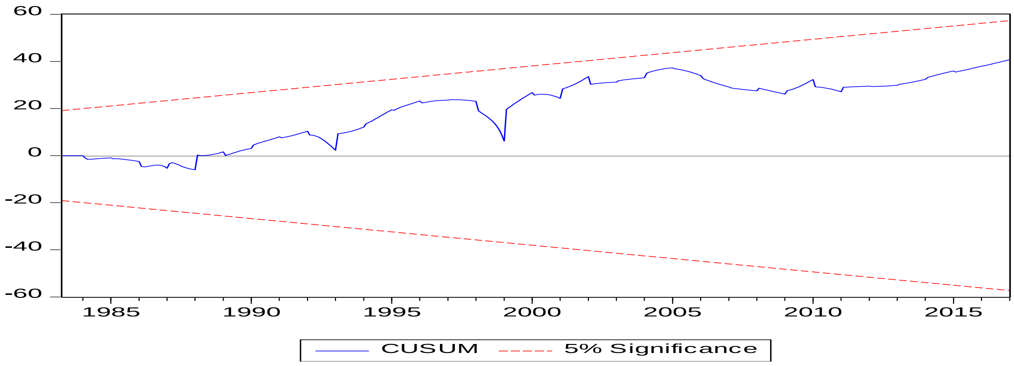

Figure 2. CUSUM Stability test

Source: Authors' computation, 2019.

Table 4. Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.481308	Prob. F(2,429)	0.6183
Obs*R-squared	0.991804	Prob. Chi-Square(2)	0.6090

Source: Authors' computation, 2019.

4.4. The ARDL Regression Model

The regression model that underlies the ARDL equation, shown in (5) fits well and appropriately. The model is statistically significant at 1% level.

Various diagnostic test supports the fitness of the model. These tests include the serial correlation (Breusch-Godfrey and Durbin Watson tests), Normality of errors/Jarque-Bera and Heteroskedasticity tests. In addition, following Pesaran and Pesaran (1997), the study tests for model stability as displayed in figure 2. It depicts that, the model is non-instable because the plotted trend of the CUSUM is captured within the critical bounds of a 5% confidence interval of parameter stability. The covariance test conducted shows that oil price correlates with real exchange rates at a 1% level of significance. In addition, the serial correlation test conducted, using the Breusch-Godfrey Serial Correlation LM Test procedure reveals that the model is not serially correlated (see table 4).

Table 5 presents the results of the ARDL estimation, showing that in the long run, aside from the interest rate, all other variables considered are statistically significant in explaining the exchange rates movement in Nigeria. While interest rate and oil prices have a negative impact on exchange rates, offering robust evidence that, higher real oil prices and interest rates result in an appreciation of real exchange rates and vice versa. This relationship is consistent with empirical evidence and economic theory. Therefore, it validates the studies carried out on a few oil exporting countries (see Koranchelian et al., 2005; Zalduendo, 2006; Korhonen and Juurikkala, 2009). Inversely, inflation rate and debtGDP positively relate with exchange rates, implying that, increase in inflation rate or debtGDP will result in depreciation in the exchange rate. This relationship also satisfies economic theory and empirical studies that, investment is impeded during inflation and hence, growth is distorted. This claim validates Aziz, Dahalan, and Hakim (2013).

Table 5. ARDL Regression for Long and Short Run Estimates

Dep. Var.: LREXR				
Method: ARDL				
Sample: 1994M01-2013M12				
Method for Selecting Model: (AIC)				
Regressor (2 Lag Selected Automatically): LREXR, RINF, RINT, DROP, DBTGDP				
Selected Model: ARDL (2, 2, 2, 1,0)				
Var	Coefficient	Standard Error	test-Statistic	Probability*
Longrun Equation				
RINF	0.086059	0.057426	1.498625	0.0347
RINT	-0.054403	0.045271	-1.201713	0.2301
DROP	-0.130966	0.311571	-0.420342	0.0464
DBTGDP	8.60E-11	5.14E-11	1.673917	0.0499
Short-run Equation				
LREXR(-1)	-0.002305	0.001276	-1.807028	0.0715
RINF(-1)	0.000198	6.29E-05	3.154558	0.0017
RINT(-1)	-0.000125	7.00E-05	-1.790809	0.0740
DROP(-1)	-0.000302	0.000635	-0.475604	0.0346
DBTGDP	1.98E-13	9.50E-14	2.086727	0.0375
D(LREXR(-1))	0.864512	0.024238	35.66701	0.0000
D(RINF)	0.007494	0.001380	5.432040	0.0000
D(RINF(-1))	0.006785	0.001368	4.960139	0.0000
D(RINT)	-0.004038	0.000811	-4.978444	0.0000
D(RINT(-1))	-0.003220	0.000798	-4.033246	0.0001
D(DROP)	-0.004203	0.001406	-2.989148	0.0030
C	0.012096	0.007363	1.642910	0.1011

Source: Authors' computation, 2019.

In the short run, apart from the lagged value of the interest rate, all the coefficients of the independent variables are found to be statistically significant at the five percent level of significance. The result shows the lagged value of exchange rates to have the largest influence on itself. Overall, aside from the lagged value of interest rate, all the variables in the model are statistically significant and affect exchange rates.

4.5. The ARDL Cointegration Results

The study determines where the variables co-integrate using the Wald test technique. The result is presented in table 6, having the p-value as 0.0000, indicating that variables are statistically significant at 1% level. Following Pesaran and Pesaran (1997), the hypotheses to test for the Wald co-integration test are expressed as:

$$Null\ Hypothesis\ (H_0): C(1) = C(2) = C(3) = C(4) = 0: No\ cointegration\ among\ variables$$

$$Null\ Hypothesis\ (H_1): C(1) = C(2) = C(3) = C(4) \neq 0: Cointegration\ exists\ \text{among variables}$$

Following the result in table 6 that, the F-Statistic that the $\text{p} - \text{value} < 5\ \text{percent}$, the decision rule suggests that the H_0 be rejected while H_1 is accepted, indicating that long-run cointegration association exists among variables in the model. In addition, the F-statistic computed as 13.4578, is greater than the upper bound critical value of 4.23 at 5 percent significant level (see Pesaran and Pesaran, 1997). The result declares supports that, cointegration exists among real exchange rates and other selected variables for this study.

Table 6. The ARDL Cointegration Results

Wald Test			
Equation: ARDL			
test-Statistic	Value	DF	Probability
F-Statistic	13.4578	(4.1471)	0.0000****
Chi-Square	53.8312	4	0.0000****

Source: Authors' computation, 2019

"****" symbolize statistical significance at 1 percent

4.5. The Error Correction Model (ECM)

Basically, this study is set to examine both the long-run and short-run association amidst real exchange rates and real oil prices in Nigeria using the error correction model approach. Therefore, following various studies in literature like Pesaran (2001), the study introduced the ECT coefficient to determine the speed of adjustment at which the model returns to equilibrium. Expectedly, the ECT is suitable when its value is negative and less than one (ECT<1); and statistically significant. Else, there is no evidence of long-run adjustment (see Chudik and Pesaran, 2013). In other word, a significant and negative parameter of the error ECT reveals that the parametres cointegrate. That is, the statistically significant value of the ECT at 5 percent indicates that the determinants of exchange rates in Nigeria co-move to a long-run equilibrium (see Boutabba, 2014; and Sebri and Ben-Salha, 2014). Also, this result is consistent with Bannerjee *et al*. (2008), Waliullah and Rabbi (2011), arguing that a highly significant ECT confirms that, stable long-run relationship exists among the parametres. As shown in the short-run, a few variables have a negative impact on exchange rates, which according to Dritsakis (2011) expresses the dynamic adjustment of the variables. Consequently, Engle and Granger (1987) establish that an error correction mechanism holds where a cointegration relationship exists.

Table 5. Error Correction Coefficient

Variable	Coefficient	Std. Error	t-Statistic	Prob*
ECT(-1)	-0.320745	0.074859	-2.664155	0.00030

Source: Authors' computation, 2019.

However, table 5 below presents the results, which fulfill these conditions, having its coefficient as -0.320745 and highly significant at one percent. The minus sign preceding the ECT coefficients indicates the presence of disequilibrium in the earlier short-run period of the ARDL system and the speediness of adjustment from the short-run divergence on the path to long-run equilibrium is at the rate of 32 percent. This suggests that an average of 32 percent of the divergence from long-run equilibrium in the short-run period of the determinants of exchange rates are periodically corrected.

Table 6. Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
RINF does not Granger Cause LREXR	443	21.31400	0.0269
LREXR does not Granger Cause RINF		2.17675	0.0346
RINT does not Granger Cause LREXR	443	1.20831	0.2997
LREXR does not Granger Cause RINT		0.09537	0.9091
DROP does not Granger Cause LREXR	442	0.12425	0.0320
LREXR does not Granger Cause DROP		15.3727	0.2545
DBTGDP does not Granger Cause LREXR	443	12.42756	0.0452
LREXR does not Granger Cause DBTGDP		0.38010	0.6840

Source: Authors' computation, 2019.

Table 6 presents the granger causality results, revealing that oil price granger causes exchange rates. The result establishes that there is a unilateral causality between exchange rates and oil prices. By implications, this validates the long-run result that variation in exchange rates can be accounted for by changes in oil prices but not vice versa. Similarly, external debt reports a unilateral relationship with exchange rates. Thus, external debt granger causes exchange rates. This suggests that change in exchange rates can be explained by changes in the external debt and not in a reversal order. The inflation rate is shown to have a bilateral relationship with exchanges, implying that while inflation granger causes exchange rates, exchange rates also granger causes inflation. Finally, the interest rate does not report any evidence of causality, either moving from interest rate to exchange rate or exchange rate to interest rate.

5. Conclusion

This study investigates whether there an association existing between the real exchange rates and crude oil prices in Nigeria. Five quarterly variables are tested and found stationary at either level or I(0) and first difference or I(1) but not at second difference or I(2). Consequently, the study employs the ARDL estimating technique covering 1980 to 2017, to examine the impact of the real oil price shocks on the real exchange rates. The results reveal a significant effect of real oil price shocks on real exchange rates. Specifically, the results reveal a significantly proportional relationship between real oil prices and exchange rates, implying that exchange rates respond negatively to positive change in oil prices and vice versa. The study reveals the presence of a long-run relation (i.e. cointegration relation) among variables. Also, it reveals that the model is stable and there is covariance in the oil prices and exchange rates. For policy relevance, this finding suggests that policymakers should be cognizant of oil prices in determining an appropriate exchange rate equilibrium. Thus, when oil price shocks occur, relevant monetary policy measures should be employed to stabilize the unanticipated shocks to exchange rates that may distort the economy. The necessary measure is recommended to be put in place to prudently manage the country's debt portfolio to minimize probable shocks that may be associated with a debt burden.

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