



Crude Oil Price and Exchange Rate on Economic Growth: ARDL Approach

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Abstract

This study investigated the impact of crude oil price and exchange rate on economic growth in Nigeria using an autoregressive distributed lag model covering the period from 1982-2018. The results indicated that crude oil price and exchange rate have significant positive impact on economic growth in both the long-run and the short-run periods. The findings suggested that crude oil price and exchange rate which are the focal points of the study, could affect economic growth in both the long-run and the short-run. Therefore government should diversify its earnings in agriculture, industrialization and investment in order to reduce the heavy reliance on crude oil and income fluctuation resulting from the fluctuation in crude oil prices.

Subject Areas

Environmental Economics

Keywords

Crude Oil Price, Exchange Rate, GDP per Capita, ARDL Approach, Granger Causality

1. Introduction

One of the most important driving forces of the global economy is the crude oil and changes in the price of this oil will have significant effects on economic growth and the well being of the population around the world [1]. Crude oil prices are highly unstable and it has a great impact on economic growth and it arouses many controversies among the policy makers and researchers. Some economic researchers like [2] [3] and [4] among others argue that it will pro-

mote economic growth. It was observed in oil exporting countries that increase in oil prices will increase national income of exporting countries.

The OPEC Reference Basket rebounded in September from low levels registered last month, mainly supported by supply disruptions and heightened geopolitical tensions in the Middle East, which helped to push all crude oil benchmarks higher. The ORB value rose by \$2.74, or 4.6% in September to settle at \$62.36/b. All basket component values increased following the attacks on Saudi Arabia's oil processing facilities at Abqaiq and Khurais, which caused a supply disruption of about 5.7 mb/d, raising concerns on the tightening physical crude market. However, oil prices came down and the risk premium faded after Saudi Arabia restored production and fulfilled all scheduled shipments to customers [5].

Crude oil is a major source of foreign exchange earnings and the dominant source of revenue for the Nigerian economy. The Nigerian economy has been completely reliant on oil and the basis upon which government budgeting, revenue distribution and capital allocations are determined. Volatility in oil price is an upward and downward movement of oil prices globally. This assertion thus translates that these oil prices are exogenous because it's determined by external influences that somewhat stagnate the Naira and Nigeria cannot moderate the causes of these oil price slides. Nigeria's exports of oil at a time of peak prices have enabled the country to post merchandise trade and current account surpluses in recent years. Reportedly, 80% of Nigeria's energy revenues flow to the government; 16% cover operational costs, and the remaining 4% go to investors Atukeren, (2003) as cited in [6].

According to [7], after recording economic growth due to major reforms and improved political system, demonstrated by successful democratic dispensation, the economy plummeted due to the drastic fall in oil and political disorder originating from insurgence attack and regional agitation for emancipation. The fall in oil prices have sent the Nigerian currency plunging, advancing long-standing widespread and abject poverty together with infrastructural decay. This has affected both the cost and standard of living of the vulnerable poor which constitute the larger part of the population. Nigeria is endowed with abundant assets, most notably vast natural resources with arable land and entrepreneurial population. However, 82% of the Nigerian populations are poor and lives on less than USD 2 per day, when compared with 26% in South Africa. As such, there has been increasing suffering exacerbated by high level of unemployment caused by little or no job creation due to over dependency on oil [8].

The recent shock in crude oil prices has adversely affected Nigeria, especially in the areas of foreign exchange earnings, foreign reserves, decline in government revenue and threat in terms of ability to meet financial obligations as at when due. The average crude oil price further dropped in a row by USD 8.26 or 13.10% month to month to USD 54.77/b in December 2018; the lowest since

October 2017. This decrease is due to concerns over unforeseen rise in global oil supply with decreased demand amidst ambiguity about worldwide economic growth [9]. For oil exporting countries, falling oil prices may cause hardship through the depleting effect on revenue caused by either less in profits or even losses. The significance of the study cannot be overemphasized. First, it should help to inform decision makers on the economic impact of crude oil price fluctuation and exchange rate on economic growth for oil exporting countries like Nigeria. Second, the research study will serve as a contribution to the literature as well as the methodology. Third, the empirical finding of the paper will be beneficial to the government, the private sector of the economy and the academia as a whole.

The objective of this study was to look at the impact of crude oil price and exchange rate on the economic growth of Nigeria. Many studies conducted in Nigeria only looked at the impact of crude oil price alone on economic growth or impact of foreign exchange rate alone on economic growth. Therefore, this is the gap that the study intended to fill in the literature. In accordance with the literature, crude oil price is supposed to have a direct relationship with economic growth because an increase in the price of crude oil means an increase in the level of economic growth. Whereas foreign exchange rate can have direct and also indirect relationship with the level of economic growth, but only empirical tests could validate this. Accordingly, this research work sought to empirically test the effects of crude oil price and exchange rate on economic growth of Nigeria by employing an autoregressive distributed lag (ARDL) model advanced by Pesaran, Shin and Smith (2001).

This paper is organized in sections. The first section contains introduction, research problem, significance of the study, objective of the study and the organization of the paper. The second section consists of review of related literature, which provides some snapshots of similar empirical literature. The third section presents methodology and data. The fourth section presents results and discussion of the paper. Finally, the fifth section discusses the conclusions and policy recommendations.

2. Review of Related Literature

Many research studies have been conducted in areas related to this. However, a major part of the researches conducted were on crude oil price and economic growth nexus or on exchange rate economic growth nexus. Review of literature shows that there is no many existing studies that specifically examine the impact of crude oil price and exchange rate on economic growth, especially in Nigeria. Though there is a bunch of literature that investigated the relationship between crude oil price and economic growth nexus and exchange rate and economic growth nexus. The literature here will give an overview of the existing literature on the related topic from general perspective and later narrow it down to focus on Nigeria.

[10] examines the effects of crude oil price movement and exchange rate policy on the Nigerian stock market over the period spanning 2012 to 2015. After applying ARDL the results shows that oil prices are positively and significantly related to the performance of the Nigerian stock market and exchange rate is found to be effective in cushioning the effect of crude oil price decline on the stock market. The result from the granger causality test suggested that the policy measure may not be potent as expected.

[11] evaluated the effect of crude oil price volatility on Nigeria economy and the national income over a period covering 1995 to 2017. Using descriptive and inferential (regression) statistics revealed that oil price volatility has a negative and insignificant combined effect on gross domestic product, gross national product and per capita income. They recommended that Nigeria should adopt policies that will address negative oil price shocks so that the budgetary system and national income will not be affected.

[12] investigates the impact of crude oil price volatility on the levels of economic activity in Iraq over the periods of 2003 to 2015. Using multivariate autoregressive regression (VAR) model, the results revealed a highly significant impact of volatility of crude oil price on the level of gross domestic product in Iraq.

Using generalized autoregressive conditional heteroscedasticity (GARCH), component generalized autoregressive conditional heteroscedasticity (CGARCH) and exponential generalized autoregressive conditional heteroscedasticity (EGARCH) to examines the macroeconomic effects of exogenous oil price shock in Nigeria, [13] showed that oil price volatility has significant positive effect on exchange rate, foreign external reserves, government revenue, capital importation and, symmetric and persistent of oil price shock in Nigeria.

Using the simple ordinary least square (OLS) method and Granger causality test, [14] investigates the causal relationship between oil price and key macroeconomic variables in Nigeria. The findings of the study that covers the 1980 to 2010 periods revealed that there was a positive and insignificant relationship between oil price and the gross domestic product and exchange rate in Nigeria. There was no evidence of evidence of causal relationship running from gross domestic product to oil price and from oil price to gross domestic product.

[15] examines the relationship between crude oil price and economic growth of Nigeria over the 1981 to 2013 periods. Using vector autoregressive (VAR) model and ordinary least square (OLS), the results from the VAR model showed that the oil price changes in oil price has a significant impact on the economic growth of Nigeria. While the result from OLS method showed oil prices have positive relationship with GDP, decrease in oil prices have a negative impact on GDP and also fluctuation in exchange rate has both negative and positive impact on crude oil price and the GDP. They recommended the need for the diversification of the economy so as to strengthen the economy even without oil.

[16] examines the impact of oil prices on economic growth in Nigeria covering the 1980-2016 periods. After applying ordinary least squares (OLS) method, the study revealed a long-run relationship among the variables and that there is a

positive and significant relationship between oil price changes and economic growth. They authors suggested a combination of strict fiscal policy, diversification and industrialization in order to protect the country's economy.

[17] analyzed the effect of oil price on the macroeconomic variables from 1990-2015 in Nigeria. Using multiple regression technique, the results showed that unemployment rate contribute positively and significantly to crude oil price. While interest rate impacted negatively and significantly on crude oil price. The result further revealed that inflation rate, exchange rate and real gross domestic product do not have any effect on crude oil price.

[18] explored the impact of oil price movements on real output growth in Nigeria during the period 1970-2011. Using dynamic VAR analytical framework, the findings indicate that the oil price shocks are therefore not found to directly contribute to output, exchange rate or inflation in the short run. They however, manifest significant and positive relationship with output growth in the long run. The generalized impulse responses reaffirm the direct link between the oil price shock and growth, as well as the indirect linkages.

[19] investigated the impact of premium motor spirit, gross domestic investment, labour employment and lending interest rate on economic growth over the period of 1970-2013 in Nigeria. Using error correction model the result showed that premium motor spirit and the lags of interest rate indicated negative and significant impact on economic growth, while gross domestic investment and the lags of labour employment indicate positive and significant impact on economic growth. They recommend that government should reduce the premium motor spirit pump price by deregulation and allowing private sector participation.

[20] investigated the nexus between oil price volatility and infrastructural growth in Nigeria using co-integration and error correction modeling approach for the periods 1981-2016. The results suggest that both the oil price volatility and inflation rate tend to exert negative impact on infrastructural growth, while the appreciation of real exchange rate tends to trigger investment in infrastructure. They recommended the need for the design and implement effective diversification of policies with a view to raising nation's revenue trajectory. Conclusively, all the relevant literature on Nigeria in this area generally focused on relating crude oil price volatility or shocks with economic growth or exchange rate and economic growth or GDP. In line with this, the study seeks to fill this gap by testing the impact of crude oil price and exchange rate on economic growth of Nigeria.

[21] studied the degree of interdependence between oil price and economic growth activity for four major countries (United Arab Emirate, Kuwait, Saudi Arabia, and Venezuela) in the organization of petroleum exporting countries (OPEC) over the periods of 2000 to 2010. Using frequency approach of Priestley and Ton and Engle Granger test for co-integration. The results show that oil price shocks in the periods during period of fluctuations in the global financial

turmoil affect the relationship between oil and economic growth in the OPEC countries.

3. Methodology and Data

The Nigeria's annual data employed in this study spans from 1982 to 2018. The data were sourced from [22] [23] [24] and [25]. Economic Growth, *GDPC* (GDP per capita Constant US\$ 2010) is modeled as a dependent variable, Crude Oil Price, *COP* (USD per barrel) and Official Exchange Rate, *EXC* (US dollar per LCU) are the independent variables.

To derive the model, it is known that based on the Quantity theory of money equation (particularly income approach equation) where demand for money is equated to the supply of money. Therefore, the equation can be denoted as follow: $MV = PY$

$$Y = \frac{MV}{P} = f(MVP^{-1})$$

where: Y is the economic growth, M will be dropped, V will be replaced with EXC and P^{-1} will be replaced with COP . Therefore, the model can be written as: $GDPC = f(EXC, COP)$.

Following the above model of the study, the econometric form of the model can be written in a simple log-linear form and augmented it with the crude oil price and exchange rate variables as follows:

$$\ln GDPC_t + \beta_0 + \beta_1 \ln EXC_t + \beta_2 \ln COP_t + \eta_t \quad (1)$$

where: $\ln GDPC_t$ stand in for the natural log of GDP per capita, $\ln EXC_t$ is the natural log of Exchange rate, $\ln COP_t$ is the natural log of Crude oil price and η_t is a disturbance term.

The co-integration approach of the ARDL model has been employed to test for co-integration relationships between the variables of interest. Despite that there are other methods for achieving the same purpose, this approach has several advantages that include; its applicability regardless of the order of the variables in the model (*i.e.*, whether they are all I (0), I (1) or mixture of the two); with the ARDL, both the short-run and long-run coefficients can be simultaneously obtained; it is also a good model for small sample (*i.e.* 30 to 80 observations); it has an indirect co-integration test within the model; and lastly it has the diagnostic tests within the model (e.g. using Microfit statistical software).

On the basis of these advantages, this study chose this approach and formulated the conditional error correction model as;

$$\Delta \ln GDPC_t = \delta_0 + \sum_{i=1}^k \lambda_i \Delta \ln GDPC_{t-i} + \sum_{i=0}^k \lambda_i \Delta \ln EXC_{t-i} + \sum_{i=0}^k \vartheta_i \Delta \ln COP_{t-i} + \psi_1 \ln GDPC_{t-1} + \psi_2 \ln EXC_{t-1} + \psi_3 \ln COP_{t-1} + \mu_t \quad (2)$$

Equation (2) is estimated using the OLS method to test for co-integration relationship among crude oil price and exchange rate on economic growth by conducting a Wald test/F-test to ascertain the joint significance of the lagged

coefficients of the variables. To accomplish this task, the null hypothesis if no co-integration in Equation (2) is defined as

$H_0: \psi_1 = \psi_2 = \psi_3 = 0$ as against the alternative hypothesis, which states that co-integration exists ($H_a: \psi_1 \neq \psi_2 \neq \psi_3 \neq 0$). To decide on the result, [26] recommended that the calculated F-statistic should be compared with the upper and lower bounds of the critical values. If the F-statistic exceeds the upper bound, co-integration exists. If the F-statistic lies in between the lower and upper bounds, the test result is said to be inconclusive. However, if the F-statistic lies below the lower bound, then no co-integration exist among the variables, the long-run and short-run models of the ARDL specification in Equation (3) and (4) then estimated, respectively.

$$\ln GDPC_t = \beta_0 + \sum_{i=1}^m \chi_{1i} \ln GDPC_{t-i} + \sum_{i=0}^m \lambda_{1i} \ln EXC_{t-i} + \sum_{i=0}^m \vartheta_{1i} \ln COP_{t-i} + \varepsilon_{1t} \quad (3)$$

$$\begin{aligned} \Delta \ln GDPC_t = & \beta_1 + \sum_{i=1}^m \chi_{2i} \Delta \ln GDPC_{t-i} + \sum_{i=0}^m \lambda_{2i} \Delta \ln EXC_{t-i} \\ & + \sum_{i=0}^m \vartheta_{2i} \Delta \ln COP_{t-i} + \Phi ECT_{-1} + \varepsilon_{2t} \end{aligned} \quad (4)$$

where the coefficient of the error correction term (ECT) is denoted by Φ that shows the speed of adjustment of the variables toward long-run convergence.

Lastly, this study diagnosed the model by conducting tests for serial correlation (using Breusch-Pagan LM test), heteroscedasticity (using ARCH test for heteroscedasticity), normality (using Jarque-bera test), functional form (using Ramsey RESET test) and stability test using CUSUM and CUSUMSQ to be able to assess how stable the model is along the sampled periods.

Robustness Check Using Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS)

To gauge the long-run estimate, we apply dynamic ordinary least square (DOLS) and fully modified ordinary least square (FMOLS). DOLS and FMOLS have the power to deal with endogeneity problem, simultaneity bias and small sample bias. These estimators are good for robustness check of ARDL estimates. DOLS and FMOLS have been advanced by Stock and Watson (1993) and Philip and Moon (1999), respectively to address the problem of serial correlation and small sample bias attributed to Ordinary Least Squares (OLS) estimator. The estimators can also be applied to mix order of integrated variables in co-integration framework. Considering the strengths of these estimators, their results will serve as robustness checks to ARDL long-run test results.

4. Results and Discussion

To begin the estimation, the time series properties of the data were first tested using augmented [27] and [28] tests statistics. Though to apply ARDL it is not necessary to check the order of integration of the variables under study, the study conducted the unit root test to ensure that none of the variables exceeded I

(1) and also to establish the appropriateness of applying the methodology. As far as the variables are either purely I (0), I (1), or mixed the methodology can be applied, but any presence of the I (2) variables would render the methodology invalid in any case. As such, the results of these tests are presented in **Table 1**. Both the ADF and PP results reveal that GDP per capita (GDPC) and Crude oil prices (COP) are stationary at first difference, that is, I (1), while the Official exchange rate (EXC) is stationary at level, that is, I (0). Therefore, considering the mix order of integration of the variables, the ARDL approach is the most efficient methodology rather than the standard or conventional co-integration approaches.

However, sometimes, ADF and PP tests may not produce reliable estimates if there is a presence of structural break in the series and as such they could produce a biased result. To avoid such doubt, we have equally employed Zivot-Andrews (1992) structural break trended unit root test. **Table 2** shows the results of Zivot-Andrews unit root test, which reveal that two of the variables GDP per capita (GDPC) and Crude oil price (COP) are stationary in first difference form, that is, I (1), whereas Official exchange rate (EXC) is stationary in level form, that is I (0). This indicates that the result is the mixture of I (1) and I (0). Therefore, the result of the Zivot-Andrews test also supports the application of ARDL approach.

Before testing the co-integration relationship among the variables using Equation (2), it was important to identify the optimum lag length to be used. From the results of the unrestricted vector autoregressive optimum lag selection criteria in **Table 3** below, using Sequential Modified LR test Statistic, Final Prediction Error (FPE), Akaike Information Criterion (AIC), Hannan-Quinn criteria (HQ) and Schwarz Information Criteria (SC) revealed that lag 1 should be selected. Therefore, the maximum lag to be used in this study is lag 1. Hence, we lagged the variables 1 times in order not to lose the degree of freedom.

Having identified the optimum lag length, the next step was to estimate the long-run relationship among the variables by using ordinary least square (OLS). The null hypothesis of no co-integration ($H_0: \psi_1 = \psi_2 = \psi_3 = 0$) was tested against the alternative hypothesis of the existence of a co-integration relationship ($H_a: \psi_1 \neq \psi_2 \neq \psi_3 \neq 0$). The result of this test presented in **Table 4** indicated that the null hypothesis could not be accepted for the period under study (*i.e.* 1982 to 2018), at 5% level of significance. The F-statistics (5.667) exceeded the upper bound value (4.85) of the critical value at the aforementioned levels of significance. As such, a co-integration relationship exists in this case.

The Johansen Juselius test for co-integration using model with Trace statistics and model with Max-Eigen value confirmed the existence of one co-integration equation in the trace statistics model. Therefore, we conclude that there is a long-run relationship among the dependent and independent variables and that the variables moved together in the long-run. This test result supported the result of ARDL bound test for co-integration (**Table 5**).

Table 1. Unit root test using Augmented Dickey Fuller (ADF) and Philips Perron (PP).

| Variables | Level | | | | First Difference | | | | I (d) |
|-----------------|-------------------|------------------|-------------------|------------------|---------------------|---------------------|---------------------|---------------------|-------|
| | ADF | | PP | | ADF | | PP | | |
| | Constant | Constant & trend | Constant | Constant & trend | Constant | Constant & trend | Constant | Constant & trend | |
| $\ln GDP_{i,t}$ | -0.44 (0.889) | -1.54 (0.793) | -0.08 (0.943) | -2.76 (0.218) | -5.20*** (0.000) | -4.92*** (0.001) | -5.17*** (0.000) | -4.92*** (0.001) | I (1) |
| $\ln COP_{i,t}$ | -1.00 (0.741) | -2.36 (0.391) | -1.00 (0.741) | -2.36 (0.391) | -5.58*** (0.000) | -5.54*** (0.000) | -5.57*** (0.000) | -5.53*** (0.000) | I (1) |
| $\ln EXC_{i,t}$ | -2.93* (0.051) | -1.81 (0.675) | -2.91* (0.053) | -1.23 (0.887) | -3.50** (0.013) | -4.31*** (0.008) | -3.53** (0.012) | -4.30*** (0.008) | I (0) |

Source: Eviews 9; Note: ***, ** & * stand for 1%, 5% & 10% levels of significance and values in parenthesis are the P-values, while I (d) stands for the interpretation of the results.

Table 2. Unit root test results based on Zivot-Andrews.

| Variables | Level | | | | First difference | | | | I (d) |
|-----------------|------------|-------------|------------------|-------------|------------------|-------------|------------------|-------------|-------|
| | Constant | Break Point | Constant & trend | Break point | Constant | Break point | Constant & trend | Break point | |
| $\ln GDP_{i,t}$ | -2.988 (2) | 2001 | -3.029 (2) | 1994 | -4.839 (1)* | 2000 | -3.805 (1) | 2010 | I (1) |
| $\ln COP_{i,t}$ | -3.670 (0) | 2003 | -2.602 (0) | 2011 | -6.257 (0)*** | 2008 | -6.038 (0)*** | 2005 | I (1) |
| $\ln EXC_{i,t}$ | -1.949 (0) | 1991 | -5.562 (0)*** | 1995 | -4.266 (4) | 1996 | -3.042 (4) | 2007 | I (0) |

Source: Eviews 9; Note: ***, ** & * stand for 1%, 5% & 10% levels of significance and values in brackets are the lag lengths, while I (d) stands for the interpretation of the results.

Table 3. VAR maximum lag selection result.

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|-----|-----------|-----------------------|-----------------------|------------------------|------------------------|------------------------|
| 0 | -53.05599 | NA | 0.005999 | 3.397333 | 3.533379 | 3.443108 |
| 1 | 87.67932 | 247.3530 ^b | 2.05e-06 ^b | -4.586625 ^b | -4.042441 ^b | -4.403524 ^b |
| 2 | 95.55101 | 12.40387 | 2.23e-06 | -4.518243 | -3.565920 | -4.197815 |
| 3 | 102.9613 | 10.32948 | 2.56e-06 | -4.421896 | -3.061435 | -3.964142 |
| 4 | 108.5848 | 6.816327 | 3.39e-06 | -4.217258 | -2.448658 | -3.622178 |

Source: Authors' computation 2019 using Eviews 9. Note: ^bindicates lag order selected by the criterion.

Table 4. Bound test result.

| Model | F-stat. | Lag | Bound test critical values | | |
|---|---------|-----|-------------------------------------|-------|-------|
| | | | [Unrestricted intercept & no trend] | | |
| | | | Level of significance | I (0) | I (1) |
| 1982 to 2018 | 5.667 | 1 | 1% | 5.15 | 6.36 |
| $F(\ln GDP_{i,t}/\ln COP_{i,t}, \ln EXC_{i,t})$ | | | 5% | 3.79 | 4.85 |
| K = 2 & n = 36 | | | 10% | 3.17 | 4.14 |

Source: Authors' computation 2019 using Eviews 9.

Table 5. Johansen Juselius Test for co-integration.

| Hypothesized | Eigenvalue | Trace Statistic | 0.05 | Max-Eigen | 0.05 |
|--------------|------------|------------------|----------------|----------------|----------------|
| No. of CE(s) | | | Critical Value | Statistic | Critical Value |
| r = 0 | 0.430 | 32.952** (0.021) | 29.797 | 19.130 (0.093) | 21.131 |
| r ≤ 1 | 0.264 | 13.821 (0.088) | 15.494 | 10.422 (0.185) | 14.264 |
| r ≤ 2 | 0.095 | 3.399 (0.065) | 3.841 | 3.399 (0.065) | 3.841 |

Sources: EViews 9; Note: Values in parentheses are the P-values and **represent statistically significant at 5% level.

After establishing a co-integration relationship among the variables, the long-run model in Equation (3) was estimated to obtain the long-run coefficients as presented in **Table 6**. The results revealed that Crude oil price is positive and significant at 1% level in determining economic growth. Meaning that increase in crude oil price will increase economic growth likewise decrease in oil price will decrease economic growth. Precisely, a 1% increase in crude oil price will lead to 5.319% increase in economic growth, this result corroborate the findings of [29] [30] and [31]. But contradict the finding of [32] who showed that crude oil price have negative and significant impact on economic growth.

The official exchange rate is also positive and significant at 1% level of significance which is more stringent. Meaning that, 1% increase in exchange rate will lead to 0.069% increase in economic growth of Nigeria in the long run. This result contradicts the findings of researchers such as [33] [34] and [35], who found exchange rate to be negatively influencing economic growth but the finding is in line with the work of researchers such as [36] [37] and [38].

The short run results from the estimation of Equation (4) are reported in **Table 6**. The crude oil price and the exchange rate are found to be positive and significant at 1% in explaining the economic growth. The error correction term (-0.196) satisfied the econometrics requirement as it is negative, significant and less than one, which shows that the feedback or convergence rate to long-run equilibrium as 19.6%. Precisely, the error correction term value also indicates that the long-run deviation from the economic growth is corrected by 19.6% annually. The result further suggested that as crude oil price and exchange rate rises, so also will the economic growth in the short run. To show the goodness of fit of the model, R-squared, DW-statistic and F-statistics are all reported for the model in **Table 6** and the all suggested that the model is good fitted.

To further ensure the reliability of the estimates, diagnostic tests of serial correlation, functional form, normality and heteroscedasticity were conducted and reported in **Table 7**. The result shows that the null hypothesis of all the tests could not be rejected in the model. This means that the model is free from serial correlation, heteroscedasticity, model misspecification and normality problems.

As such, the model could produce reliable result. As suggested by Pesaran, Shin and Smith (2001), cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) tests for stability of the model along the studied period were conducted. The results are shown in **Figure 1** to **Figure 2** illustrate that the

Table 6. Estimated long run and short run coefficients.

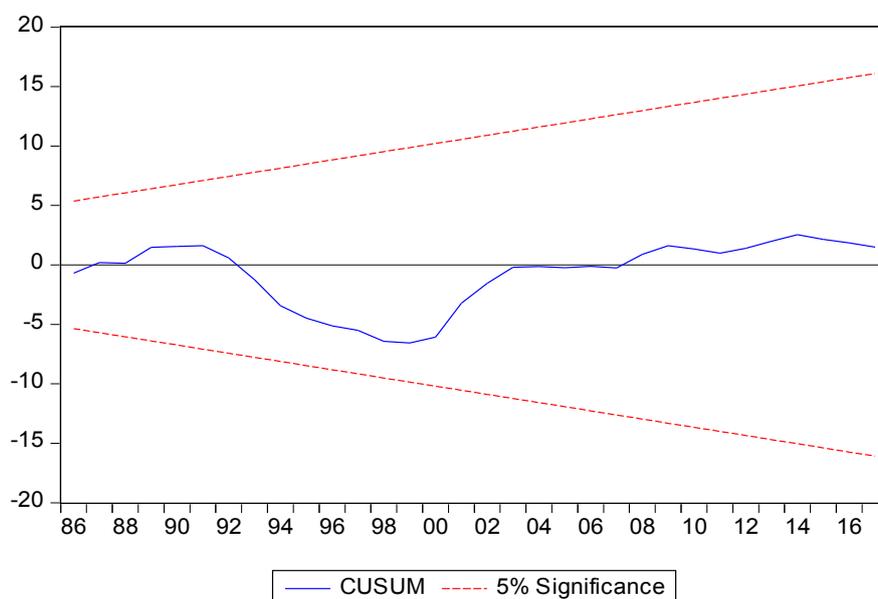
| Dependent variable, $\ln GDP_t$ | Regressors | Coefficients | T-ratio (P value) |
|---|-------------|--------------|-------------------|
| | $\ln COP_t$ | 0.292 | 5.319*** (0.000) |
| | $\ln EXC_t$ | 0.069 | 2.915*** (0.006) |
| | Constant | 6.194 | 34.841*** (0.000) |
| Short-run estimation result | | | |
| Dependent variable, $\Delta \ln GDP_t$ | Regressors | Coefficients | T-ratio (P value) |
| | $\ln COP_t$ | 0.292 | 5.319*** (0.000) |
| | $\ln EXC_t$ | 0.069 | 2.915*** (0.006) |
| | Constant | 6.194 | 34.841*** (0.000) |
| | ECM (-1) | -0.196 | -3.544*** (0.001) |
| $ecm = \ln GDP_t - 0.2924 \times \ln COP_t + 0.0693 \times \ln EXC_t + \text{Constant}$ | | | |
| $R^2: 0.979, \text{DW-statistic: } 1.256, \text{F-stat: } 503.523^{***} (0.000)$ | | | |

Note. ECM = error correction model. *** represent statistically significant at 1% level.

Table 7. The estimated results using time series DOLS and FMOLS.

| $DV = \ln GDP_t$; | Dynamic OLS | | Fully modified OLS | |
|------------------------------|-------------------|-------|----------------------|-------|
| Regressors | Coefficients | SE | Coefficients | SE |
| Long-run coefficients | | | | |
| Crude oil price | 0.321*** (8.986) | 0.035 | 0.298*** (7.943) | 0.037 |
| Exchange rate | 0.040** (2.719) | 0.014 | 0.039** (2.734) | 0.014 |
| Constant | 6.123*** (43.878) | 0.139 | 6.240484*** (53.770) | 0.116 |

Note. Numbers in brackets are the t-statistics. DV = Dependent variable, DOLS = dynamic ordinary least squares; FMOLS = fully modify ordinary least square; OLS = ordinary least square; SE = standard error. *** and ** indicate significant at 1% and 5% levels respectively.

**Figure 1.** Plot of cumulative sum of residuals for the model.

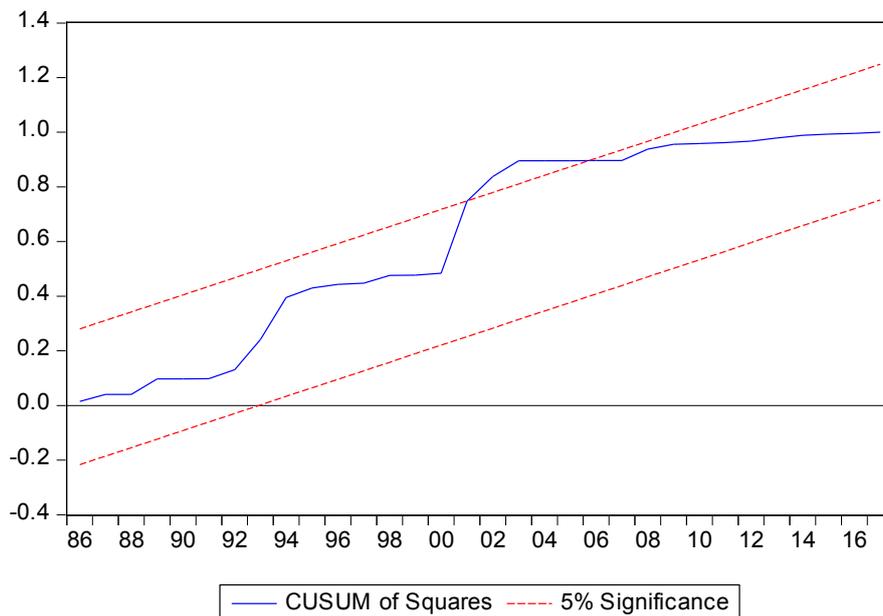


Figure 2. Plot of cumulative sum of square residuals for the model.

model was stable along the studied periods as the residuals were within the critical bounds at 5% significance level except that there is a slight deviation in the cumulative sum of square (CUSUMSQ).

As a robustness check to the ARDL results, we have employed dynamic DOLS and FMOLS, and their estimated results are reported in **Table 7** above. Both the DOLS and FMOLS indicates that crude oil price (COP) and exchange rate (EXC) have a significant positive relationship with GDP per capita. This finding substantiates the long-run results of the ARDL, where Crude oil price (COP) and exchange rate (EXC) have a positive and significant impact on GDP per capita. Therefore, the main focus of this study, which is impact of crude oil price and exchange rate on economic growth, has been revealed to impact positive and significantly on economic growth as earlier shown by the long-run and short run ARDL results.

Next is the causal relationship between the variables and was examined by employing Granger causality test to test the direction of causality among the variables in the model. The existence of co-integration necessitates the existence of a causal relation in at least one direction. The Granger causality test results are presented in **Table 8**. The result suggests that there is a unidirectional causality running from crude oil price to economic growth. And again there is a unidirectional causality running from crude oil price to exchange rate. The result implies that increase in the price of crude oil in the oil market will increase the economic growth and the same thing applies to exchange rate in Nigeria.

5. Conclusions and Policy Recommendations

This study employed an ARDL approach to co-integration to ascertain the impact of crude oil price and exchange rate on economic growth in Nigeria. The

Table 8. Granger causality test result.

| Null Hypothesis: | Obs | F-Stat (P value) | Direction of causality |
|---|-----|------------------|--------------------------|
| $\ln COP_t$ does not Granger Cause $\ln GDPC_t$ | 34 | 3.008 (0.047)** | Unidirectional causality |
| $\ln GDPC_t$ does not Granger Cause $\ln COP_t$ | | 1.488 (0.240) | No causality |
| $\ln EXC_t$ does not Granger Cause $\ln GDPC_t$ | 34 | 1.244 (0.312) | No causality |
| $\ln GDPC_t$ does not Granger Cause $\ln EXC_t$ | | 1.462 (0.247) | No causality |
| $\ln EXC_t$ does not Granger Cause $\ln COP_t$ | 34 | 1.814 (0.168) | No causality |
| $\ln COP_t$ does not Granger Cause $\ln EXC_t$ | | 2.576 (0.074)* | Unidirectional causality |

Note. Values in parentheses are the P-values and ** & * represent statistically significant at 5% and 10% significance levels.

study further employed Granger causality to test for the direction of causality among the variables. At first, this study tested for co-integration among the variables in the model after selecting optimum lags and found that all the variables in the model were co-integrated. The long-run model was estimated and the result revealed both the crude oil price and exchange rate impacted positively and significantly on economic growth within the study period. Besides, the long-run model estimations, a short-run model were also estimated for the model. The results also indicated that all the explanatory variables, that is, crude oil price and exchange rate were positive and significant in influencing economic growth in the short run. This suggested that both crude oil price and exchange rate could affect economic growth in both the long-run and the short-run periods.

The robustness check was conducted using dynamic OLS and fully modified OLS, and their results confirmed the result of the long-run ARDL model. The direction of causality was equally tested using Granger causality test, which revealed significant unidirectional causality running from crude oil price to economic growth and from crude oil price to exchange rate in the model.

The main policy recommendation from this study is that since crude oil price and exchange rate have significant positive impact on economic growth in both the short-run and long-run periods which means that increase in earnings from crude oil and appreciation of Naira increases the economic growth of the country and decrease in crude oil earnings and depreciation of Naira decreases the economic growth of the country. Therefore government should diversify its earnings in agriculture, industrialization and investment in order to reduce the heavy reliance on crude oil and income fluctuation resulting from the fluctuation in crude oil prices in order to protect the country's economy.

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