

Analysis of the Nexus between Oil Prices, Exchange Rate and Economic Growth in Nigeria

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Abstract. The study empirically investigated the short and long run interaction effect of oil price cum exchange rate on the Nigerian economy. Data were drawn from Macrotrend.net and World Bank from 1970 to 2020. The interaction effect was examined using Fully Modified Ordinary Least Squares, as well as, Dynamic Ordinary Least Squares. The finding of the study has shown that exchange rate and oil price with the inclusion of interaction term exerted significant impact on economic growth. In addition, exchange rate and oil price have significant impact on economic growth in the short without inclusion of interaction term while it is only oil price that is relevant in the short run with inclusion of interaction term. The study recommended that policy, which will influence both oil price and exchange rate should be put in place.

Keywords: Oil price, exchange rate, economic growth, Nigeria

1. Introduction

Nigerian economy has been significantly dominated by oil in terms of its contribution to revenue and export. Being an oil based economy, the value of the revenue generated is therefore a subject of international price of oil and the exchange rate. Since the country over time has not been able to diversify the economy, the share of its contribution to the world export is low; thereby causing instability in the balance of payment account. In line with Jhingon (2002), the exchange rate is very important determinant of international competitiveness and the performance of Nigerian economy. The impact of exchange rate passed beyond the boundary of any country. On the other hand, in the oil dependent

country like Nigeria, oil price may not be a macroeconomic variable but it has exerted great impact on the domestic economy especially for oil importing countries (Berument, Ceylan & Dogan, 2010).

The global competitiveness and globalisation have led to great advancement in exchange of goods and services; and this have led to exchange rate and oil price being powerful decisive forces in the economies of countries of the world. This has made exchange rate and oil price to be one of the areas of studies by researchers and policy makers. In this regard, studies have emerged, which have examined the relationship among oil price, exchange rate and economic growth. Notable among these are Berument, Ceylan and Dogan (2010) and Welsh and Lin (2018). Nevertheless, there is seemed to be some gap in the literature on impact of oil price and exchange rate on economic growth. Studies that basically examine the interaction effect of oil price and exchange rate on economic growth are quite few. It is on this basis that this study intends to examine both short- run and long – run interaction effect of oil price and exchange rate on economic growth.

2. Literature Review

Studies on exchange rate, oil price and economic growth have received great attentions, especially in the oil dependent countries such as Nigeria. This relationship between exchange rate, oil price and economic growth has been empirically investigated by authors, which include Berument, Ceylan and Dogan (2010). In the study by Ali- mulali (2010) in Norway, the focus is on the impact of oil shocks on the real exchange rate and economic growth. The

result of Ali- mulali's Vector Autoregressive showed that increased oil price has led to increase in Norway's GDP. Using Vector Autoregressive, Berument, Ceylan and Dogan (2010) showed that increase in oil price contributes significantly to the growth in output of some MENA countries while the oil price shocks do not have the expected impact on the Bahrain, Djibouti, Egypt, Israel, Jordan, Morocco and Tunisian.

Osigwe (2015) examined the effects of exchange rate fluctuations on crude oil price and economic growth. Osigwe adopted both Ordinary Least Squares and Two- Stage Least Squares. The findings of Osigwe showed that real exchange rate and crude oil price exerted positive impact on economic growth. Wesseh and Lin (2018), using unrestricted VAR model, examined the nexus between oil, exchange rate and growth. The findings of Wesseh and Lin showed that oil price seemed to have moderate impact on Liberian GDP and exchange rate depreciation weakened the GDP. Further on the study on exchange rate, oil price and economic growth in Nigeria is by Musa, Maijama'a, Shaibu and Muhammad (2019). Musa, Maijama'a, Shaibu and Muhammad employed the use of Autoregressive Distributed Lag to examine the relationship among exchange rate, oil price and economic growth and found out that crude oil price and exchange rate exerted positive significant impact on economic growth.

Akinsola and Odhiambo (2020) investigated the impact of oil price on economic growth in seven sub-Saharan African (SSA) countries, using panel Autoregressive Distributed Lag and Non- Linear Autoregressive Distributed Lag. The findings of Akinsola and Odhiambo showed that mixed effects of impact of oil on economic growth both in short run and long run. With the use of Toda- Yamamoto model and drawing data from 1995 to 2018, Gylych, Jibrin, Celik and Isik (2020) examined the impact on oil price on monetary instruments in Nigeria. The authors found out that oil price exerted significant impact on exchange rate and interest rate.

3. Methodology

This study adapted the model used by Musa, Maijama'a, Shaibu and Muhammad (2019) to examine the relationship between exchange rate, oil price and economic growth. The model is specified as:

$$GDPPC = f(EXC, OILP)$$

(1)

The model is written econometric form as:

$$\ln GDPPC_t = \beta_0 + \beta_1 \ln EXC_t + \beta_2 \ln OILP_t + \mu_t$$

(2)

Where, GDPPC = Gross domestic product per capita, EXC = Exchange rate, OILP = oil price, \ln = natural log, β_0 to β_2 coefficient to be estimated, t = time and μ = stochastic term.

Equation (2) can be adapted to include the interaction term between exchange rate and oil price. The equation can be rewritten as follows:

$$\ln GDPPC_t = \beta_0 + \beta_1 \ln EXC_t + \beta_2 \ln OILP_t + \beta_3 \ln EXC_t \bullet \ln OILP_t + \mu_t$$

(3)

Where, EXC·OILP is the interaction term in the equation.

Equation is estimated in this study using Ordinary Least Squares (OLS), Fully Modified OLS and Dynamic OLS. The estimation of equation by Fully Modified OLS and Dynamic OLS requires conducting Unit root test and Cointegration test.

In this study, the Augmented Dickey Fuller (ADF) is applied for the Unit root test while the cointegration via residual method is applied for the cointegration test. The presence of series being stationarity at First Difference and existence of long- run relationship mean that the model can be estimated using Fully Modified OLS and Dynamic OLS. The advantage of two techniques is that it accounts for endogeneity and serial correlation. The inclusion of interaction term in the model is to be justified if the slopes of the exchange rate and oil price are not parallel (Rekah, 2019; Star Trek, 2021). The authors will plot the graphs of the two variables to examine the relative importance of including the interacting term in the model. If the graphs are not parallel, there exists an interaction between exchange rate and oil price. Lastly, the need not to exclude the interaction term in the final estimation depends on either (i) it is significant or (ii) the coefficient of determination (R squared) in the model with interaction term performs better than the model without interaction terms.

All the data are sourced from Macrotrends.net and Worldbank.org from 1960 to 2020. The choice of 1960 to 2020 is informed by the estimation techniques, which require a long period of time for robust estimation.

4. Data Analysis

This section involves explanation of the analysis of data used in the study. The section is divided into descriptive statistics, trend analysis and regression output.

Descriptive statistics

Table 1: Descriptive statistics

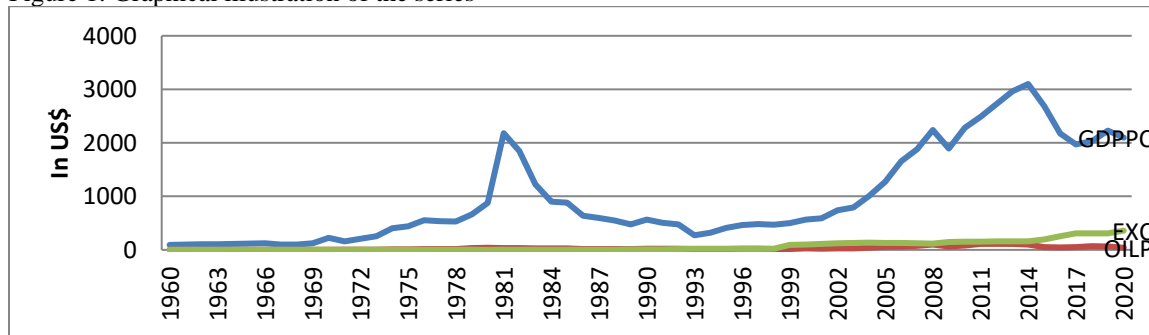
Statistics	GDPPC	EXC	OILP
Mean	968.06	66.31	31.12
Median	567.53	8.04	20.00
Maximum	3098.99	358.81	111.67
Minimum	92.96	0.55	1.80
Std. Dev.	875.91	94.31	30.26
Skewness	0.93	1.43	1.26
Kurtosis	2.50	4.24	3.77
Jarque-Bera	9.37	24.84	17.71
Probability	0.01	0.00	0.00
Observations	61	61	61

Source: Authors' computation

In all the series the values of the mean were ₦968.06 billion, ₦66.31 and ₦31.12 for gross domestic product per capita (GDPPC), exchange rate (EXC) and oil price (OILP) respectively. These values of mean were greater than their corresponding values of median. These showed that there is possibility of all the series being positively skewed. The value of the Skewness in the table confirmed the existence of positive Skewness of the series, and as such, the series are rightward skewed. GDPPC is moderately skewed while OILP and EXC are highly skewed. The values obtained for Kurtosis showed that there is possibility of outliers in the series. From the values obtained for Jarque- Bera, it can be concluded that the series are not normally distributed. Hence, there is need to transform the series to remove the outliers and all the series are converted into natural logarithm.

Trend Analysis

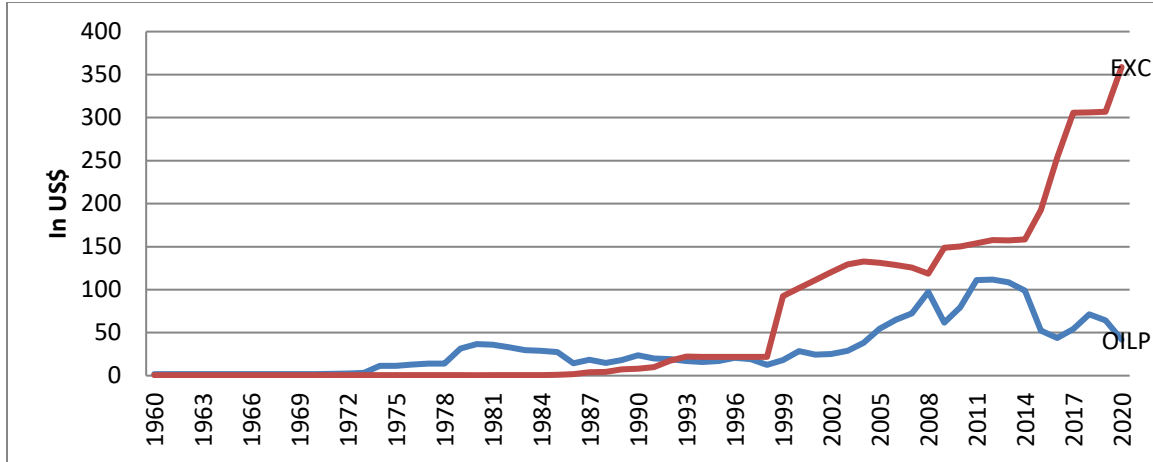
Figure 1: Graphical illustration of the series



Source: Authors' computation

The figure above showed the values in natural logarithm for all the series. A cursory look at the figure revealed that all the series exhibited cyclic trend throughout the period under study. There was sharp rise for GDPPC in 1982 and the exchange rates (EXC) were at the lowest from 1975 to 1985. There was sharp rise in exchange rate from 1996 to date. The oil price has exhibited a moderate cyclic trend than the other series. One fact to draw from these trends is that the exchange line seemed to be steeper in nature than oil price (OILP) (See Figure 2), which provided some evidence for possible interaction between oil price (OILP) and exchange rate (EXC) (StarTrek, 2021).

Figure 2: Graphical illustration showing Possible Interaction between EXC and OILP



Source: Authors' computation

From Figure 2, the graphs of both the exchange (EXC) and oil price (OILP) exhibited cyclic nature and between 1991 and 1992 the two graphs intersected. This was due to a fall in oil price and depreciation of naira in Nigeria. Similar scenario was also nearly experienced in 1996. It can be concluded as such that the graphs of the two series did not parallel throughout the period under study.

Regression output

The authors executed unit root test to investigate the stationarity of the series and the result obtained is summarised in Table 2.

Table 2: Unit root test

Variables	Test for Unit root in:	ADF Statistics	ADF Critical	Order
lnGDPPC	Level	-1.3656	-2.9109	
	First difference	-6.4881	-2.9117	1(1)
lnOILP	Level	-1.5180	-2.9109	
	First difference	-6.7282	-2.9117	1(1)
lnEXC	Level	0.4159	-2.9109	
	First difference	-6.0550	-2.9117	1(1)
lnOILP-lnEXC	Level	0.1838	-2.9109	
	First difference	-5.8639	-2.9117	1(1)

Note: *5% Level of significance

Source: Authors' computation

The result from the Table 2 has shown that all the series are stationary at First difference. This provided the first step in applying the cointegration regressions, which are Fully Modified OLS and Dynamic OLS to investigate the relationship among the series. The second step is to investigate the existence of cointegration among the series. The authors carried out this by using cointegration via residual method. According to the method, cointegration is said to exist if the residual obtained from the OLS is stationary at level. The result was provided in Table 3.

Table 3: Cointegration via residual based method

Model	Series	Statistic	Critical	Prob.
Model without interaction term	Residual	-3.0769	-2.9109	0.0337
Model with interaction term	Residual	-4.1331	-2.9109	0.0018

Note: *5% Level of significance

Source: Authors' computation

Using cointegration via residual based method, as shown in Table 3, the residual is stationary at level at 5 percent. As such, there is long- run relationship among the series. Hence, the model specified can be regressed using Fully Modified OLS and Dynamic OLS; and the ECM can be carried out to obtain the speed of disequilibrium.

Having established the presence of long- run relationship among the series, the authors proceed to estimate the model using Ordinary Least Squares, Fully Modified OLS and Dynamic OLS. Table 4 showed the results of the long run relationship among the series.

Table 4: Regression output (Long run)

	OLS	OLS [†]	Fully Modified OLS	Fully Modified OLS [†]	Dynamic OLS	Dynamic OLS [†]
Dependent Variable: lnGDPPC						
Constant	4.204* (40.576)	4.249* (46.070)	4.207* (25.909)	4.221* (35.999)	4.228* (24.662)	4.241* (33.193)
lnEXC	-0.019 (-0.768)	-0.286* (-4.213)	-0.026 (-0.704)	-0.354* (-4.230)	-0.037 (-0.962)	-0.384* (-3.567)
lnOILP	0.795* (17.563)	0.766* (18.851)	0.819* (11.172)	0.782* (15.365)	0.833* (11.280)	0.785* (13.969)
lnEXC· lnOILP		0.073* (4.151)		0.090* (4.138)		0.095 (3.420)
R- squared	0.915	0.935	0.908	0.931	0.932	0.956
Adj. R- Squared	0.913	0.932	0.905	0.928	0.920	0.954
F- statistic	314.037	273.688				
	0.000 ^a	0.000 ^a				
Durbin Watson	0.633	0.966				
Jarque Bera	0.698	8.595				
	0.705 ^a	0.013 ^a				
Serial Correlation	23.618	11.138				
	0.000 ^a	0.000 ^a				
Heteroscedaticity	0.167	0.350				
	0.847 ^a	0.789 ^a				
Wald Test	314.037	273.688	404.479	519.548	373.082	429.341
	0.000 ^a	0.000 ^a	0.000 ^a	0.000 ^a	0.000 ^a	0.000 ^a

Note: [†]With interaction term, *1%, **5% and ***10% Level of significance, t- statistic in parenthesis, ^aProb

Source: Authors' computation

In the estimated models, the coefficient of interaction term is statistically significant and the R- squared performed better in all the models when interaction term is included. Since both of the conditions are satisfied, the presence of the interaction term is meaningful in the model. In line with Rekah (2019), this means the inclusion of the interaction term contributed meaningfully ‘to the explanatory power of the model’. Based on this conclusion, the authors proceed to discuss the findings of the study.

The values obtained for coefficient of determinations were high for all estimations. They were 0.928 and 0.954 when the interaction term was included for estimation with Fully Modified OLS and Dynamic OLS. This showed that 92.8 percent and 95.4 percent of the variation in the GDPPC was explained by the independent variables. The value of 273.688 obtained for F- statistic in estimation done through OLS showed that the model was statistically significant at 5 percent level. It cannot be said that there was problem of serial correlation and endogeneity because the use of Fully Modified OLS and Dynamic OLS has taken care of such issues. As such, the Durbin Statistic in OLS estimation can be ignored.

In all estimations, the coefficient of exchange rate was significant only when the interaction term was included and possessed the expected sign in all estimations. This showed that the exchange rate exerted negative impact on the GDPPC in the period under study. On the other hand, the coefficient of oil price was significant in all estimation as well and has the expected sign. Lastly, the coefficient of interaction term was positive and significant in all estimations. A conclusion to be drawn from this is that the performance of Nigerian economy is influenced by oil price being conditioned by the exchange rate.

The authors also examined the short run relationship among the series and Table 6 showed the results obtained. The authors reported the parsimonious ECM for Model without interaction term and the one without interaction term.

Table 6: Regression output (Short run)

Dependent variable: D(GDPPPC)	OLS	OLS [†]
Constant	0.057* (2.115)	0.027 (1.0950)
D(lnOILP)	0.392* (4.594)	0.407* (4.827)
D(lnEXC(-1))	-0.270* (-2.668)	
ECM(-1)	-0.288* (-3.480)	-0.401* (-4.250)
R- squared	0.381	0.380
Adj. R- Squared	0.347	0.358
F- statistic	11.272	17.453
Durbin Watson	0.000 ^a	0.000 ^a
Jarque Bera	1.954	1.696
Serial Correlation	82.491	154.101
Heteroscedaticity	0.000 ^a	0.000 ^a
	0.358	1.073
	0.965 ^a	0.349 ^a
	0.167	0.302
	0.918 ^a	0.740 ^a
Wald Test	11.272	17.453
	0.000 ^a	0.000 ^a

Note: [†]With interaction term, *1%, **5% and ***10% Level of significance, t- statistic in parenthesis, ^aProb
Source: Authors’ computation

The coefficient of determination of the parsimonious ECM for Model without interaction term was 0.381 and for Model with interaction term was 0.380. This showed that 38.1 percent of the variation in GDPPC was explained by the independent variable in Model without interaction term and 38.0 percent of the variation in GDPPC was also explained by the independent variables in Model with interaction term. The F- statistics of 11.272 and 17.453 showed that the models were statistically significant at 5 percent level.

The EMCs have the expected sign and the rates of adjustment to the previous periods were 28.8 percent and 40.1 percent respectively. In the Model without interaction term, the current oil price, D(lnOILP) and previous exchange rates, D(lnEXC(-1)) were correctly sign and significant at 5 percent level of significance. This showed that the current oil price is the major force to be reckoned with influencing economic growth in the country and also the previous price of dollar to naira has decisive force on the performance of the economy. In addition, in the Model with interaction term, it was clearly seen that the current oil price, D(lnOILP) not the exchange rate is the major determinant of economic growth. One fact to be drawn from this finding is that it has shown the relative importance of oil on the Nigerian economy. The oil has impact on the exchange rate and this assertion is visible when the oil price and the exchange rate interacted. This finding is tandem with Abed et al (2016), who found out that oil price is the

major factor influencing the determinant of domestic currency.

5. Conclusion and Recommendations

This study has basically examined the interaction effect of exchange rate and oil price on the economic growth. The finding of the study has shown that the performance of the economy is conditioned on the performance of oil in the international market. The findings further showed the current oil price matters for economic growth in Nigeria. In addition, in the absence of interaction between oil price and exchange rate, the previous exchange rate exerts significant impact on the economic growth. Lastly, the interaction between exchange rate and oil price should not be ignored in matter relating to economic growth. As such, policy that will influence both oil price and exchange rate should be put in place. In conclusion, the authors suggest that there is need for further investigation on the interaction effect of oil price and exchange rate on the economy.

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