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Interaction Between Economic Growth and Oil Products Importation in Nigeria Using Autoregressive Lagged Ordered Model (ARLOM)

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Abstract:

The paper investigates the interaction between economic growth and oil products importation in Nigeria both in the long-run and short-run adopting autoregressive lagged ordered model (ARLOM). The data on the two variables span from 1983 to 2021. The pre-test analysis shows that both variables have the same order of integration, co-integrated in their normal levels and stationary at first difference. Estimation based on the least square method, shows that importation of oil products interacts significantly with economic growth at the long-run at 5% level. Moreover, there is no evidence of relationship in the short-run. Therefore, we recommend that if resources are well managed and oil importation dealings are very transparent, then Nigeria economy can grow better.

Keywords: *Autoregressive lagged ordered model (ARLOM), oil products importation, economic Growth, Nigeria.*

Introduction

In January, 2023, Nigeria retains the first position as the largest oil producing country in the whole of Africa by the organization of petroleum exporting countries (OPEC) as it pumped 1.235 million barrels per day. Despite this status, Nigeria, imports virtually about 100% of all oil products used by her citizenry and according to National Bureau of Statistics (NBS) reported in the Premium Times in November 17, 2022, over 133 Nigerians living in poverty. This is not a healthy report for a growing economy.

It is a worrisome phenomenon to see a continuous increase in the importation of oil and non-oil products in Nigeria despite its position in OPEC and an economy that depends largely on crude oil export but be-devilled by corruption in subsidy payment due to importation of crude oil products and huge external debt outstanding. It is incredible to expect a country occupying the eleventh prime position in oil production internationally importing crude oil products such as household kerosene (HHK), petroleum motor spirit (PMS), aviation turbine kerosene (ATK), automotive gas oil (AGO), liquefied petroleum gas (LPG) and low pour fuel oil (LPFO) and so on. In 2019, Nigeria's importation is about 20.89 billion liters Premium Motor Gasoline (PMS), 5.15 billion liters Motor Gasoline (AGO), 128.11 million liters Household Kerosene (HHK), 1.07 billion liters Aviation Turbine Kerosene (ATK. Ib) reported that it was exported.), 45.98 million liters of lowfat fuel oil (LPFO) and 526.06 million liters

of liquefied petroleum gas (LPG) (National Bureau of Statistics, 2020).

So, different regimes in Nigeria have tried to reform the energy sector through different policies other to revitalize or diversify the economy, thereby supporting the domestic economy and reducing dependence on the oil exports. The petroleum industry act (PIB) is an amendment made by the government to increase the competitiveness of the oil industry. In May 2011, the government announced that fuel subsidies were lifted and fuel pump prices were raised above 130 naira from the current regulatory price of 65 naira per litre, sparking unprecedented protest in the country against the government's decision to increase the price of petrol pumps. Since then different governments have claimed to be paying an unending debt accrued by subsidizing fuel. In May 29, 2023, the present government announced the removal of fuel subsidization and fuel pump price rose to N550 per liter. This sudden step to remove the so called subsidy, without any palliative measure or rise in salary doubled the poverty level of an average Nigerian.

In 1981, calculating from data as published by CBN (2021) statistical bulletin, the percentage ratio of oil import to total import was 0.93% and that of non-oil products was 99.1%, in 2020, the percentage ratio of oil import to total import rose to 13.6% and that of non-oil import came down to 80.4%. After about four decades, the ratio of Nigeria's oil import to total import increase by 12.67%. The question remains, what impact has the importation of oil products played in Nigeria's economic growth? Suppose a country that highly depends on crude oil export for foreign earnings also becomes highly import dependent on finished oil products, what net effect has this on its economic growth? Nigeria's economy is as presumed and presently imports about 100% of petroleum products from Diaspora. These questions and supposition constitute the problems that require answer in this study.

Literature Review

There is little research on the related subject matter and conflicting results. Olomola and Adejumo (2006) analyzed the impact of oil price shocks on productivity, inflation, real exchange rate and income in Nigeria during the period 1970 to 2003. Data were analyzed using the vector autoregression (VAR) method. Their findings showed that the decline in oil prices shocks does not affect productivity and inflation, but has an impact on income and exchange rates. This means that real oil prices will have a positive effect, leading to the "Dutch disease".

Relationship between oil prices and economic growth was examined by Delavari *et al.* (2008) using quarterly data from 1989 – 2007 from Iran. They found that that the impact of oil shocks on economic growth is asymmetrical. The long-run interaction between oil prices and economic activities was examine by Lardic and Mignon (2008) in the US, G7, European and Eurozone economies, they discovered that rising oil prices have a greater impact on GDP than falling oil prices.

The relationship between export trade and Nigeria's economy growth was investigated by Ugochukwu and Chinyere (2013) and they concluded from the mutual result that oil and non-oil export has significant impact on economic growth.

Ijirshar (2015) investigated the impact of non-oil trade on the economic growth of Nigeria for 41 years using data spanning from 1970 to 2011. Oil export price, market openness, exchange rate inflation rate and rate of non-oil exports are independent variables and GDP as the explained variable. The results of the error correction model showed that non-oil trade has positive impact on Nigeria's economic growth.

Nwanna and Eyedayi (2016) examined the impact of crude OPV on economic growth inf Nigeria over the period 1980-2014. The findings showed a strong positive relationship between oil prices and Nigeria's economic growth.

Lawal and Ezeuchenne (2017) analyzed the relationship between international trade and economic growth using annual data from 1985 to 2015 and using a vector error correction model (VECM), While the relationship of openness is important in the long-run, the

balance of exports and trade is important in short and long-run. The Granger causality test again shows that economic growth is independent of exports, exports and trade balance, but, the trade deficit and economic growth are unidirectional. Stephen and Obah (2017) examined the impact of international trade on Nigeria's economic growth using data from 1981 to 2015. Economic growth is measured by GDP and international trade using non-oil imports, oil imports, non-oil exports and oil exports. Their result showed that international trade is very beneficial for Nigeria's economic development.

Amaefula (2017) examined the impact of oil prices, volatility, and removal of subsidies on economic growth in Nigeria. Gross domestic product(GDP) and crude oil price (COP) tine series data spanned from 1973-2017. He showed that the COP and its variability exact positive impact of Nigeria's economic growth while the removal of subsidy indicated negative impact on the economic growth.

Dumani (2018) examined the impact of oil exports, oil imports, non-oil imports and non-oil exports on in Nigeria's economic growth from 1981 to 2016. Using multiple regression model it was discovered that oil import exacted insignificant positive effect on economic growth, non-oil imports and exports have significant positive impact on economic growth. However, oil exports have no linear and insignificant effect on Nigeria's real economic growth.

Okeke and Eze (2019) specifically examined the impact of oil and non-oil components on Nigeria's gross domestic product (GDP) using data from 1981 to 2016. The results obtained using the multiple regression showed that the positive impact of petroleum products on Nigeria's economic growth is not significant but non-oil products has significant positive impact on Nigeria's economic growth.

Materials and Methods

The materials used for this empirical study are briefly presented below.

Data source and Variable Measurement

Annual GDP and petroleum products imports data from the Central Bank of Nigeria (CBN, 2021). A total of 41 time series observations covering 1983 to 2021 were transcript from the bulletin. Nigeria's economic growth is measured using GDP. The oil products import measured in millions of naira (the Naira value of the volumes of all transaction in the importation of oil products). The GDP as the dependent variable is represented by Y_t and X_t as the predictor represents the oil product imports. The *t* is time domain index.

ARLOM Specification

Autoregressive lagged ordered model (ARLOM) attributed to Amaefula (2022) is a dynamic model that integrates a long and short-term parameters in a single equation form. The model specification for one exogenous variable is of the form;

$$Log(y_t) = c_0 + \sum_{i=1}^{p} c_i Log(y_{t-i}) + \sum_{j=1}^{q} \eta_j Log(x_{t-j}) + \phi SRET_{t-1} + a_t \quad (1)$$

where $SRET_{t-1}$ represents the short-term adjustments between y_t relative to x_t , η_j measures the long-term effect, ϕ is the coefficient of the short-term effect and the noise term $a_t \sim IID(0, \sigma^2)$, The a_t accounts for random noise infiltration not adjusted for in the system and presumes to be stationary. The expression of SRET is given as;

$$SRET_t = u_t - \rho u_{t-1} = (1 - \rho L)u_t \quad (2)$$

The parameter $\rho < 1$ and in this case, p is unrestricted and expected to be less than 1. The variable SRET~IID (0. σ^2) and measures the short-run equilibrium effect.

Order of Integration Test

Examination of the integration order via auxiliary AR (3) as introduced by Amaefula (2021) is given as

$$z_t = \beta_0 + \delta tre + \sum_{i=1}^{3} \beta_i z_{t-i} + e_t \qquad (3)$$

where δ represents the coefficient of the trend (tre), β_0 denotes the constant term. Both δ and β_0 in (3) are included discretionarily. The residual is denoted by e_t. $\beta_i (i = 1,2,3)$ are the coefficients of lagged dependent variable. The $\beta' s$ are restricted such that for integrated order one I(1), $|\beta_1| \geq 1, |\beta_2| < 1, |\beta_3| < 1$ and $\frac{|\beta_1|}{|\beta_2|} > 1$ and for I(2) it is expected that two of the $\beta' s$ are greater than or equal to one, and $\frac{|\beta_2|}{|\beta_3|} \geq 1$. The null hypothesis for the case of I(1), $H_{01} : \beta_1 < 1$ versus $H_{a1} : \beta_1 \geq 1$ and in the case I(2), the null hypothesis $H_{02} : \beta_2 < 1$ versus $H_{a2} : \beta_2 \geq 1$.

Co-Integration Test

Johansen (1991) will be adopted for co-integration test and it is of the form;

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta x_{t-1} + B z_t + \varepsilon_t \qquad (4)$$

where $\Pi = \sum_{i=1}^{p} \Psi_i - 1$, $\Gamma_i = -\sum_{i=1}^{p} \Psi_j$, the vector z_t represents deterministic variables, x_t is I(1) k-vector, The random error component ε_t is independent and identically distributed with mean zero and variance σ^2. The Π coefficient matrix represents the number of co-integrating vector. The test is carried on the null hypothesis that there exists at most r co-integratiing equation. The null is rejected if the value of the trace statistic is less than that of the critical value.

Model Estimation and Bound Test

The model estimation is based on least square method and a suitable model lag structure can be identified using bound test. The partial autocorrelation function (PACF) is a tentative lag selection technique and may not be adequate. Bound test for lag inclusion and model adequacy can be achieved using model information criteria.

Data Analysis and Findings

The time plots of the variables, summary results of the data analysis and the discussion of findings are sequentially presented in the sub-sections below.

Graphical Analysis

The time plot of GDP (Y) and oil products import (X) are presented in Figure 1.

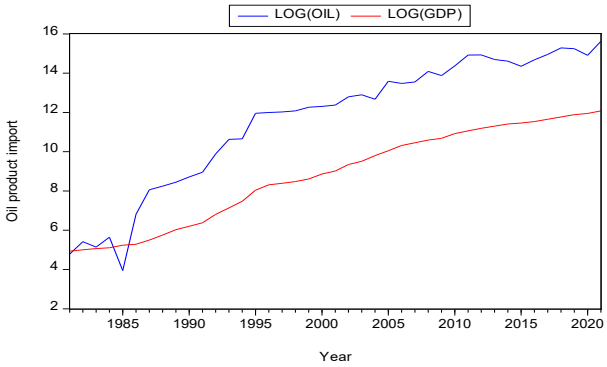

Figure1. Time Plot of Log(X) and Log(Y) in Nigeria (1981 – 2021) Variables Under study

The plot in Figure1 shows that GDP(Y) and oil importation (X) exhibit upward trend for the period under review with 2019 accounting for the highest oil import and 2021 accounting for the highest GDP.

The summary results of order of integration test for the variables under study are shown in Equation (5)-(8) below ;

$$\begin{aligned}\text{Log } y_t &= 0.3510 + 0.0089t + 1.3617 Log\ y_{t-1_t} \\ \text{prob.} \quad & (0.0971) \quad (0.4124) \quad (0.0000) \\ & -0.2303 Log\ y_{t-2} - 0.1849 Log\ y_{t-3} + e \\ & (0.4313) \qquad (0.2973)\end{aligned} \tag{5}$$

The test equation (5) shows that GDP(y) is I(1) so for

$|\beta_1| = 1.3617 > 1, |\beta_2| = |-0.2303| < 1,\ |\beta_3| = |0.1822| < 1$ and $\frac{|\beta_1|}{|\beta_2|} = \frac{|1.3617|}{|-0.2303|} = 5.9127 > 1$.

The value of β_1 is significant under 5% level satisfying the necessary condition. This finding shows only one unit root existing in y variable. So, differencing log y one time is enough to achieve stationarity.

$$\begin{aligned}\Delta Log\ y_t &= 0.1793 - 0.0030t + 0.3454 \Delta Log\ y_{t-1} \\ \text{prob.} \quad & (0.0056) \quad (0.0694) \quad (0.0535) \\ & +0.1128 \Delta Log\ y_{t-2} - 0.03548 \Delta Log\ y_{t-3} + e_t \\ & (0.5398) \qquad (0.8320)\end{aligned} \tag{6}$$

The value of $|\beta_1| = 0.3454 < 1$ in (6) and the value of the probability is greater than 5% level, therefore, first log difference of GDP is I(0), in other words, stationary.

$$\begin{aligned}\text{Log } x_t &= 1.6596 + 0.0217t + 0.6171 \text{Log } x_{t-1} \\ \text{prob.} \quad & (0.0117) \quad (0.4765) \quad (0.0009) \\ & +0.1270 \text{Log } x_{t-2} + 0.1052 \text{Log } x_{t-3} + e_t \\ & (0.5304) \qquad (0.5436)\end{aligned} \tag{7}$$

The finding in (7) shows that Log(X) is I(1) since the value of probability is less than 5% level and the value of $\beta_1 = 0.6171,$ is closer to 1 than zero (0) $|\beta_2| = 0.1270 < 1,$ and $\frac{|\beta_1|}{|\beta_2|} = \frac{|0.6171|}{|0.1270|} = 4.8591 > 1$. So, differencing log x once is adequate to achieve stationarity.

$$\begin{aligned}\Delta Log\ x_t &= 1.0367 - 0.0242t - 0.3789 \Delta Log\ x_{t-1} \\ \text{Pob.} \quad & (0.0038) \quad (0.0370) \quad (0.0387) \\ & -0.2283 \Delta Log\ x_{t-2} - 0.1749 \Delta Log\ x_{t-3} + e_t \\ & (0.2131) \qquad (0.3197)\end{aligned} \tag{8}$$

Since $|\beta_1| = |0.2286| < 1$ in (8), therefore, first log difference of X is I(0).

Table2. ADF unit root test analysis

Variable	Deterministic Term	Lag	Test Value	Level 1% 5% 10%	Prob.
Log(y)	,T	0	0.1793	-4.2050 -3.5267 -3.1946	0.9970
ΔLog(y)	C,T	0	-3.6740	-4.2119 -3.5297 -3.1964	0.0363
Log(x)	C,T	0	-1.9118	-4.2050 -3.5267 -3.1946	0.6298
ΔLog(x)	C,T	0	-7.9971	-4.2119 -3.5297 -3.1964	0.0000

The ADF test value for log of GDP(Y) and oil product import(X) are all greater than the critical values respectively, implying that two variables are I (1) in their log levels and I (0) in their first log differences. The finding is similar with that of AR (3) OIT in Equations (5) – (8).

Co-Integration Test Analysis

The test result between *log y* and *log x* are presented in Table2 below.

Table3. Estimate of Co-Integration Test

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	5% critical value	Prob. value
None*	0.2909	16.6095	15.4947	0.0339
At most 1	0.0788	3.2025	3.8415	0.0735

In the Johansen co-integration result of Table3 above, there is only one co-integrating equation that is significant at 5% level, hence, the null hypothesis of no co-integration between *log y* and *log x* is rejected.

PACF for Lag Order Identification

The plot of PACF is use for tentative lag order identification. However, the PACF of *log y* and *log x* are presented in Figure2 and Figure3 below;

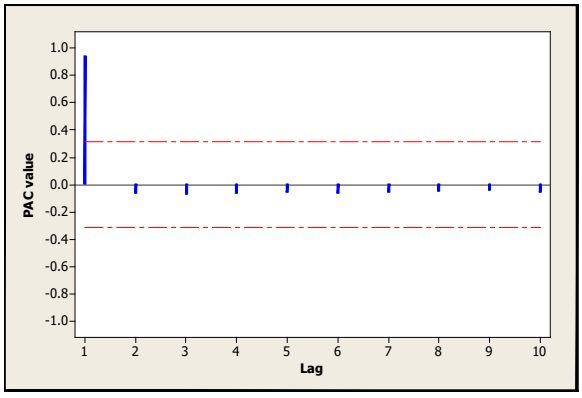

Figure2. Partial Autocorrelation Function for log y

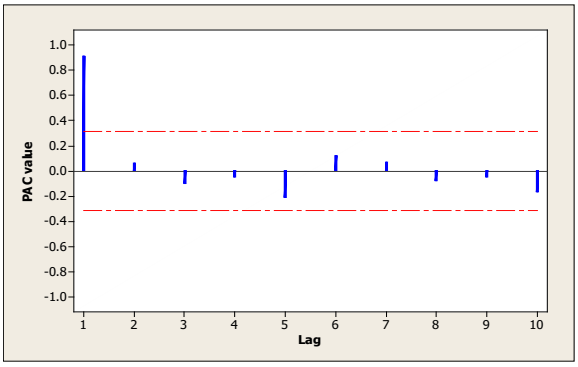

Figure 3. Partial Autocorrelation Function for log x

The PACF in Figure2 and 3 for *log y* and *log x* respectively show significant spike at lag 1 for the two variables and this suggest the fitting of ARLOM (1, 1). However, we will determine the optimal model using bound testing.

Lag Selection Using Bound Test

The appropriate lag selection will be base on Schwarz criterion as shown in Table3 below.

Table 4. Result of Model Bound Test

Lag specification for (Y, X)	SC	AIC
(1, 1)	-1.6522*	-1.8246*
(1, 2)	-1.5578	-1.7733
(2, 1)	-1.5752	-1.7907
(2, 2)	-1.4795	-1.7381
(2, 3)	-1.3867	-1.6884
(3, 2)	-1.3867	-1.6884

Note: The preferred model specification is indicated with asterisk (*)

The result as shown in Table4 indicates that both AIC and SC support ARLOM (1, 1) as earlier identified using PACF and the fitted model is as presented in (9) below;

$$Log\ y_t = 0.2975 + 0.9045 Log\ y_{t-1} + 0.0623 Log\ x_{t-1}$$
$$p-val.\ \ (0.0000)\quad (0.0000)\quad (0.0022)$$
$$+ 0.2149 SRET_{t-1} + a_t \qquad (9)$$
$$(0.1853)$$

R - squared = 0.998476 Durbin = Watson stat = 1.925323

AIC = - 1.824608 SC = -1.652231

F - stat = 7425.020(*prob.* = 0.0000)

Table5. Serial Correlation Test Using Breusch and Godfrey LM Test

F-statistic	0.4986	Prob.F(24,10) 0.9211
Obs*R-squared	20.7002	Prob.Chi-Square(24) 0.6563

The estimates of the model parameters in (9) show that at log-run, GDP relate positively with oil product imports significant at 5% level. The relationship is not significant at short-run. But previous year GDP has significant positive effect on current GDP. However, about 99.8 % of variation in GDP is account for by the lag dependent and explanatory variables. Though D-W statistic is approximately 2, indicates no of autocorrelated residuals, further test on this serial correlation test is presented in Table5 below.

The Table 5 serial correlation test for both probability values of F-statistic and Chi-square are all greater than 5% level of significant, implying there is no serial correlation in the estimated model's residuals. Hence, the fitted model is considered to be adequate.

Table 6. Heteroskedasticity Test

F-statistic	1.2906	Prob. F(3,34) 0.2934
Obs*R-squared	3.8849	Prob. Chi-Square(3) 0.2742
Scaled explained SS	5.72026	Prob. Chi-Square(3) 0.1260

The heteroskedasticity test via Breusch-Pegan-Godfrey test in Table6 is carried out to check whether the residual of the fitted model has time varying mean and variance. The probability values of the three statistics are not significant, implying time invariant mean and variance, hence, the fitted model is adequate.

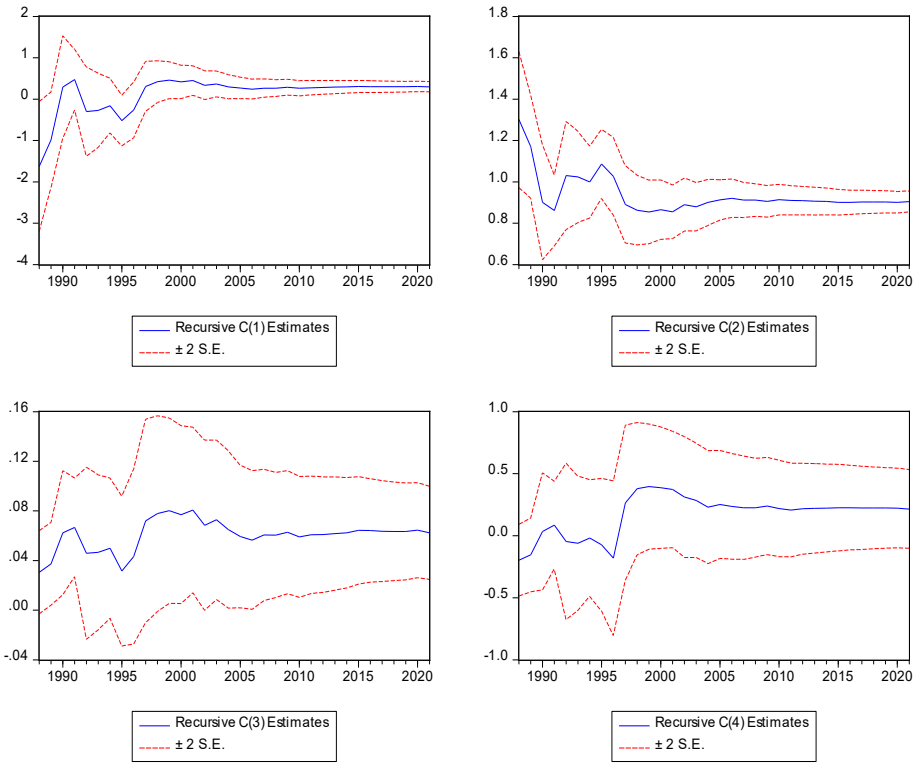

Figure4. Coefficient Stability Test Using Recursive Estimates

The recursive estimates of coefficient stability test indicates that all the parameter coefficient in the estimated ARLOM (1, 1) are stable. Therefore, the model is adequately specified and the outcome is reliable.

Discussion

The result shows that oil product import has significant positive impact at the long-run on Nigeria's GDP and there is no short-run effect. The later agrees with that of Dumani (2018) who used multiple linear regression to show that oil import has no significant influence on the economic growth of Nigeria. The diagnostic tests indicate that the specified ARLOM (1,1) model is adequate.

This study suggest that ARLOM is relevant for examining the interaction between a response variable and one or more explanatory variable(s) both in the long-term and short-term. The study does not only widen the scope of literature on the related subject matter but is a plus econometric modelling in a single equation framework.

Moreover, as opined by Amaefula (2022), the lag inclusion in the long-run parameters of the model reveals the delay or lapse of time in the relation and this is very important to portfolio management, investment strategy, portfolio management and policy making.

The practical result of this study implies that despite the speculated negative effect of oil product imports to Nigerian economy, at long-run however, oil product imports has significant positive influence on Nigeria's economic growth.

Conclusion

On the bases of the empirical findings, we conclude that importation of oil products has significant long-run positive influence on economic growth of Nigeria. Therefore, if resources are well utilized and oil importation dealings are very transparent, then Nigeria economy can grow better.

Acknowledgement

None

Conflict of Interests

No conflict of interest.

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