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Effect of Nigeria's Petroleum and Solid Mineral Exports to South Africa on Real GDP Growth in Nigeria

Ogechi Hope Njoku[1], Chibuike R. Oguanobi[2], Okpala Theodore Emenike[3]
Department of Economics, University on the Niger, Umunya campus, Anambra State, Nigeria [1], Department of Economics, Chukwuemeka Odiegwu Ojukwu University, Igbariam, Anambra State, Nigeria[2], Department of Economics, Nnamdi Azikiwe university Awka, Anambra State, Nigeria[3]
Email: ogechih026@gmail.com, cr.oguanobi@coou.edu.ng, theodoreemenike@gmail.com

Article Info

Corresponding Author
Ogechi Hope Njoku
Email: ogechih026@gmail.com

ABSTRACT

This paper has explored how Nigeria exports of petroleum and solid minerals to South Africa impacted the growth of real GDP in Nigeria. The research was inspired by the necessity to assess how bilateral trade in the key natural resources can lead to the economic performance and the export diversification agenda of Nigeria. The paper was based on the Import-Led Growth (ILG) and Export-Led Growth (ELG) theories which predict the stimulating role that imports and exports play in economic growth. ILG points out that the imports of machinery, technology and intermediate goods enhance productivity, industrial capacity and competitiveness. ELG argues that exports will create foreign exchange, enhance balance of payment and boost output. The paper applied a modified Cobb-Douglas production model to identify an ARDL model to explore the relationship between Nigeria petroleum and solid mineral exports to South Africa and the GDP growth. The data were analyzed using E-Views 10 based on quarterly data (19962023) of the following sources; WITS, WDI, WGI, CBN and NBS. According to the correlation matrix, multicollinearity among the variables is not serious since the coefficients are moderate and below critical values, which confirm that it is appropriate to be estimated. The ARDL bounds test gave F-statistic value of 4.249006, which is greater than the upper limit of 3.38 (5 percent) which demonstrates that the variables are in a long-run relationship. The long-run outcomes indicate that petroleum exports have a tremendous and positive effect on the real GDP of Nigeria, whereas solid minerals exports are not substantial. Institutional quality has a large negative impact in the short-run and petroleum exports are positive but not significant. The lack of autocorrelation and heteroscedasticity is established by diagnostic tests, and the overall model stability and reliability is provided by the CUSUM test. The paper found that petroleum exports continue to be at the heart of economic development in Nigeria, but that the solid minerals industry is poorly developed and under exploited. The research advised the diversification of the export income by strategic investment in the solid minerals sector, institutional quality, mining infrastructure, and intensified relations in trade with South Africa in a way that would result in sustainable growth.

Keywords: Petroleum exports, Solid mineral exports, South Africa, Real GDP growth, ARDL, Nigeria.

INTRODUCTION

The implications of the Nigeria petroleum and solid minerals exports to South Africa on the real GDP growth can be explained within the context of the export-led growth perspective which states that the growth of exports stimulates the growth of domestic production, improvement of foreign exchange earnings and the growth of the economy in general. In the case of Nigeria, petroleum exports have been the dominant export of the country in the external sector with solid mineral still underdeveloped but gaining popularity in terms of its growth potential. The exports of petroleum forms a major source of real GDP growth in Nigeria as it has a large contribution on the government revenue and foreign exchange income. There is empirical evidence that oil export has a positive effect in economic performance as it finances public expenditure and macroeconomic stability (Odularu, 2008). Likewise, research has revealed that the growth of oil exports leads to more sustainable growth in African economies, such as Nigeria, by raising capital inflows and the fiscal capacity (Alege & Osabuohien, 2021). This impact is further enhanced by trade relations with other countries like South Africa which provide a stable market to trade crude oil which helps to sustain the external equilibrium and path of economic development in Nigeria. Nevertheless, the high dependence on petroleum exports also presents the economy with volatility in the global oil prices and changes in the exchange rates, which will hinder growth (Abogan & Akinola, 2020; Eneji et al., 2020).

The exports to South Africa, being one of the major African trade partners of Nigeria, help to integrate and diversify the economic conditions in the region. The export-led growth hypothesis underlines that export growth in the long term results in productivity improvement and technological spillovers (Waithe et al., 2011). The exports of petroleum to South Africa in the context of Nigeria contribute to the creation of foreign exchange needed to import capital goods and intermediate inputs that in turn promote local production and industrial development (Nwosa, 2021). However, exchange rate dynamics are very vital in the determination of the effectiveness of these exports. The instability in the exchange rate may diminish the competitiveness of exports and decrease the positive effects on the GDP growth (Eke and Ogundipe, 2021; Onifade et al., 2022). Contrastingly, solid mineral export contribution to real GDP growth is relatively small, but has huge potential in Nigeria. Nigeria is blessed with large deposits of solid mineral resources but the industry has never been exploited fully because of the institutional weaknesses, lack of proper infrastructure and inconsistency on policies. Studies have shown that solid mineral development has a positive but a small impact on economic growth; this is mainly because it is underutilized (Muftau & Onaopemipo, 2022; Nwogwugwu et al., 2021). The diversification of trade would lead to more sustainable and inclusive development as trade with South Africa on solid minerals would improve their dependence on oil exports.

Moreover, the solid minerals industry can be developed, which will activate connections with other industries, including manufacturing and energy. Research indicates that exploring solid minerals more can contribute to industrialization and to better energy use, which are vital to economic development (Adedoyin et al., 2021). Also, the industry will be able to generate job opportunities and develop the region, which in turn will have an indirect effect on the GDP growth. Nonetheless, the lack of robust institutional frameworks and good governance has curtailed the sector to make a considerable contribution to the economic performance (Asogwa, 2023; Lawal et al., 2021). Although the effect of

petroleum exports on real GDP growth in Nigeria is more direct and significant in the short run (due to South Africa), it will create weaknesses in terms of exposure to external shocks and price changes. Conversely, solid mineral export, which is presently not as important, is a potential route of diversifying the economy and stability in growth in the long run. To gain maximum value out of both industries, proper institutional changes, infrastructural development, and policies to promote diversification in exports are essential (Okunlola and Aluko, 2022).

The research will be significant as it will help explain how the export of petroleum and solid minerals to South Africa by Nigeria will impact on the real GDP growth and fill some significant gaps in existing literature. Past studies are limited on the theme of oil export and volatility of growth, but little has been said about bilateral trade between Africa and its particular effects on GDP (Odularu, 2008; Eneji et al., 2020). The literature on solid minerals emphasizes their growth opportunities, but does not always focus on the performance of exports and trade connections of the region (Muftau and Onaopemipo, 2022; Nwogwugwu et al., 2021). This paper combines the two industries into a South Africa-Nigeria trade model, which can be used to diversify and achieve sustainable development.

Research Question

To what extent has Nigeria's petroleum and solid minerals exportation to South Africa affected the real GDP growth of Nigeria?

Hypothesis

Nigeria's petroleum and solid minerals exportation to South Africa does not have any significant impact on the real GDP growth of Nigeria.

METHOD

This research is based on the theoretical framework of the import and export-led growth hypotheses. According to the ILG hypothesis imports, especially the capital goods, intermediate goods and the products with high levels of technology are some of the goods that drive economic growth because they help in increasing the productivity, efficiency and competitiveness. In the case of Nigeria, importing industrial machinery, technological inputs and manufactured products of South Africa would: enhance capacity and efficiency of industrial operations; increase productivity due to transfer of technology and help to develop other sectors such as manufacturing, telecommunications and finance. According to ELG theory, the growth in the economy is driven by the rising exports because they generate a foreign currency, boost the balance of payments and stimulate output. The Export-Led Growth theory is the reason why the export of petroleum and solid minerals can be employed as an explanatory variable in GDP. The export-led growth theory, as articulated by Waithe et al. (2011), commences with a fundamental neoclassical production function:

$$Y_t = A_t K^{\alpha}_t L^{\beta}_t \quad (1)$$

Yt denotes the total economic output at time t; It indicates the level of total factor productivity; Kt and Lt represent the capital stock and labor stock levels, respectively; α and β are constants between zero and one, reflecting the income shares assigned to capital and labor, respectively. The models in this study are derived from the framework created by

Waithe et al. (2011), as previously demonstrated. This is achieved by specific modifications consistent with the study's objectives.

The function in 1 was amended to include exports, in accordance with the export-led development model, and imports, in alignment with the import-led growth model. The inclusion of exports as a variable provides an additional approach to assessing total factor productivity growth. Assuming total factor productivity (At) is a function of exports (Xt), imports (Mt), and other exogenous factors (Ct) that are believed uncorrelated with Xt and Mt, the following equations arise:

$$A_t = f(M_t, X_t, C_t) = M^{\delta}_t X^{\gamma}_t C_t \quad (2)$$

Combining equation (2) with (1), we obtain:

$$Y_t = C_t K^{\alpha}_t L^{\beta}_t M^{\delta}_t X^{\gamma}_t \quad (3)$$

The superscript terms represent the elasticities of production about Kt, Lt, Mt, and Xt.

Equation (3) shows that:

$$Y_t = f(C_t, K_t, L_t, M_t, X_t) \quad (4)$$

The ARDL model is explicitly justified as consistent with the dynamic nature of these theories, it captures both short- and long-run relationships between trade (imports/exports) and sectoral performance, reflecting the theories' emphasis on gradual productivity and adjustment effects. also, the model specification operationalize the theoretical expectations by specifying some likey variables that affect the dependent variables.

Model Specification

The model was developed from the Cobb-Douglas production function as presented by Waithe et al. (2011), which originally relates output to capital and labor. This framework was modified to include exports and imports as determinants of total factor productivity in line with the export-led and import-led growth theories. Mathematically, total output (Yt) was expressed as a function of capital (Kt), labour (Lt), imports (Mt), exports (Xt), and other exogenous variables (Ct). From this, three empirical models were specified to meet the study objectives. Model One captured the effect of petroleum and solid minerals exports to South Africa on Nigeria's real GDP growth, with control variables such as real exchange rate (RER), institutional quality index (IQX), and population growth (POPG). The model was estimated using the Autoregressive Distributed Lag (ARDL) bounds testing approach to capture both short-run and long-run relationships, where the variables entered the models either as dependent (economic growth, manufacturing, or agriculture) or independent (exports, imports, and control variables) components based on their theoretical relevance and the study's objectives.

This research specifies its model in a linear form, progressing from a general to a specific framework in accordance with theoretical principles. Model specification represents a maintained hypothesis (Koutsoyiannis, 1997) and involves expressing the model in a mathematical form to empirically analyze the economic phenomenon. With re-modification or adjustment of the framework, the study has real GDP growth (RGDPG), manufacturing sector output (MFO), and agricultural sector output (AGRT) to represent Y_t, while electrical power machinery (EPM), textile fabric (TEX), iron and steel (IRS), agricultural raw materials (AGRM), represent M_t whereas petroleum (PET) and solid minerals (SLM) represents X_t.

Additionally, this study incorporates control variables, including total population growth (POPG), institutional quality index (IQX), and real exchange rate (RER). To

effectively address all research objectives, the study adopts the ARDL bounds testing approach due to its dynamic properties. To ensure that the estimated outcomes are robust, the study employed additional estimation technique such as the Fully Modified ordinary Least Square (FMOLS) method. To capture the objective to evaluate the extent Nigeria's petroleum and solid minerals exportation to South Africa affects the real GDP growth in Nigeria. Consequently, the functional specification of model one in this study is articulated as follows:

RGDPG=F(PET,SLM,RER ,POPG, IQX) (5)

where RGDPG = real Gross Domestic Product growth; PET = petroleum; SLM = solid minerals; RER = real exchange rate; IQX =institutional quality index, and POPG = population growth. For empirical computation equation is transformed into a mathematical form as given below:

$$RGDPG = \alpha_0 + \beta_1 PET + \beta_2 SLM + \beta_3 RER + \beta_4 POPG + \beta_5 IQX \quad (6)$$

For econometric analysis, equation (7) is specified adopting the generalized form of ARDL (ρ, γ) model;

$$RGDPG_t = \alpha_0 + \sum_{j=1}^{\rho} \sigma_j \, RGDPG_{t-j} + \sum_{i=0}^{\gamma} \delta_i \, LOGPET_{t-i} + \sum_{k=0}^{\gamma} \theta_k \, SLM_{t-k} + \sum_{d=0}^{\gamma} \tau_d \, RER_{t-d} + \sum_{s=0}^{\gamma} \varphi_s \, POPG_{t-s} + \sum_{q=0}^{\gamma} \vartheta_q \, IQX_{t-q} + \varepsilon_t \quad (7)$$

The limits test for cointegration is conducted using the provided conditional ARDL (p, γ) model.

$$\Delta RGDPG_t = \alpha_0 + \beta_j RGDPG_{t-j} + \omega_i LOGPET_{t-i} + \psi_k SLM_{t-k} + \Omega_d RER_{t-d} + \phi_s POPG_{t-s} + \infty_q IQX_{t-q} + \sum_{j=1}^{\rho} \sigma_j \, \Delta RGDPG_{t-j} + \sum_{i=0}^{\gamma} \delta_i \, \Delta LOGPET_{t-i} + \sum_{k=0}^{\gamma} \theta_k \, \Delta SLM_{t-k} + \sum_{d=0}^{\gamma} \tau_d \, \Delta RER_{t-d} + \sum_{s=0}^{\gamma} \varphi_s \, \Delta POPG_{t-s} + \sum_{q=0}^{\gamma} \vartheta_q \, \Delta IQX_{t-q} + \varepsilon_t \quad (8)$$

The hypothesis for the limits test posits that the coefficients of the long-run equation are all equal to zero, in contrast to the alternative that they are not equal to zero.

H_0:$\beta_j = \omega_i = \psi_k = \Omega_d = \phi_s = \infty_q = 0$

However, the study can only specify the short-run model which is the ARDL (ρ, γ) model if we are unable to reject the null hypothesis (that is, there is no cointegration). The ARDL model is specified thus;

$$\Delta RGDPG_t = \alpha_0 + \sum_{j=1}^{\rho} \sigma_j \, \Delta RGDPG_{t-j} + \sum_{i=0}^{\gamma} \delta_i \, \Delta LOGPET_{t-i} + \sum_{k=0}^{\gamma} \theta_k \, \Delta SLM_{t-k} + \sum_{d=0}^{\gamma} \tau_d \, \Delta RER_{t-d} + \sum_{s=0}^{\gamma} \varphi_s \, \Delta POPG_{t-s} + \sum_{q=0}^{\gamma} \vartheta_q \, \Delta IQX_{t-q} + \varepsilon_t \quad (9)$$

Consequently, the short-run and long-run model, specifically the error correction model (ECM), may be delineated if we can reject the null hypothesis, indicating the presence of cointegration. The error correction model (ECM) is defined as follows;

$$\Delta RGDPG_t = \alpha_0 + \sum_{j=1}^{\rho} \sigma_j \, \Delta RGDPG_{t-j} + \sum_{i=0}^{\gamma} \delta_i \, \Delta LOGPET_{t-i} + \sum_{k=0}^{\gamma} \theta_k \, \Delta SLM_{t-k} + \sum_{d=0}^{\gamma} \tau_d \, \Delta RER_{t-d} + \sum_{s=0}^{\gamma} \varphi_s \, \Delta POPG_{t-s} + \sum_{q=0}^{\gamma} \vartheta_q \, \Delta IQX_{t-q} + \lambda ECT_{t-i} + \varepsilon_t \quad (10)$$

Definition of Variables

The analysis was conducted to study the impact of the exports, sectoral outputs, and macroeconomic indicators, and institutional factors on the economic growth of Nigeria. Major export commodities that were traded between Nigeria and South Africa were petroleum export (PET) and solid minerals (SLM). Fossil fuel which is refined to produce gasoline, diesel and petrochemicals like petroleum is still a major source of foreign exchange and industrial energy. Solid minerals comprising of naturally found inorganic resources are also a good source of diversification in export. The production of the agricultural sector (AGRT) was applied to measure the sum total of the output of crops and livestock and it was used to determine the contribution of agriculture to national productivity and national development. Output (MFO) as a dependent variable in one of the objectives was an indicator of manufacturing activities in engineering, construction, electronics, chemicals, textiles, food and beverages and transport equipments.

Other trade related variables were electrical power machinery (EPM), textile fabrics (TEX), iron and steel (IRS) and agricultural raw materials (AGRM). These economic variables were used to include the contribution of industrial and agricultural goods to trade and internal economic performance. Electrical power equipment encompasses generators, motors as well as other equipment involved in power conversion and industry. Textile fabrics are woven or knitted fabrics which are based on either natural or manmade fibers. The most important industrial materials are iron and steel that are extensively utilized in the infrastructure, machinery, transport, and manufacture. Raw materials in agriculture are raw products found in nature which are used in the production and food processing industries.

The macroeconomic control variables were the real exchange rate (REER), institutional quality index, population growth (POPG) and real GDP growth (RGDPG). REER determines the competitiveness of currencies in the presence of inflation, in comparison with trading partners. The institutional quality index sums up governance effectiveness, accountability, political stability, regulatory quality, and rule of law, which affect the results of investment and development. The population growth is an indicator of the yearly changes in the total population and depicts the labor force and demographic pressure. The dependent variable and the proxy of economic growth was the real GDP growth. The research used the Auto-Regressive Distributed Lag (ARDL) model as it was able to capture the short and the long-term relationships that exist among the variables. ARDL uses variables at varying levels of integration, addresses the problem of autocorrelation and endogeneity, flexible lag structure, and is good with small samples. ARDL was selected as the most appropriate estimation tool based on its simplicity and strength to use in the study.

Evaluation Procedure

1. Descriptive Statistics

Descriptive statistics encapsulate the essential attributes and features of the dataset employed in the research. They include metrics of central tendency (mean, median,

mode) and dispersion (range, variance, standard deviation). These statistical metrics are crucial for both parametric and non-parametric methodologies, as well as quantitative and qualitative research, enabling a comprehensive knowledge of the dataset.

2. Unit root test

The ARDL framework does not mandate simultaneous unit root testing of the variables; rather, it is imperative to assess the sequence of integration to ascertain the appropriateness of the ARDL approach (Pesaran, Smith & Shin, 2001). The augmented Dickey-Fuller (ADF) test is performed on three distinct equations outlined below:

$$\Delta Y_t = \delta + \omega t + \partial y_{t-1} + \sum_{i=1}^{k} B\Delta Y_{t-1} + \varepsilon_t \quad (3.11)$$

$$\Delta Y_t = \delta + \partial y_{t-1} + \sum_{i=1}^{k} B\Delta Y_{t-1} + \varepsilon_t \quad (3.12)$$

$$\Delta Y_t = \partial y_{t-1} + \sum_{i=1}^{k} B\Delta Y_{t-1} + \varepsilon_t \quad (3.13)$$

Where Δ represents the first difference, Yt is the series under examination, δ and ωt are the intercept terms, t denotes the time trend, Yt−1 is the lagged variable under investigation, k indicates the lag length, ΔYt−1 signifies the first difference of the lagged series typically employed to mitigate serial correlation issues (Dickey and Fuller, 1979), and ε is the white noise process. The parameter k in this test is automatically established using the Schwarz information criteria or the Akaike information criterion to ascertain the ideal lag duration and guarantee the white noise process of the residual ε. To ensure robustness, the Phillips-Perron test is utilized as a secondary assessment of the study's validity.

3. Multicollinearity Test

Multicollinearity occurs when there is a strong or perfect linear relationship among one or more predictor variables. To identify its presence, a multicollinearity test is conducted. A significantly wider confidence interval indicates potential multicollinearity, which can lead to a quicker acceptance of the null hypothesis. Several methods exist for detecting multicollinearity; however, this study utilizes the correlation matrix to examine its presence among the model's variables. If the correlation coefficient between independent variables exceeds 0.8, it suggests the existence of multicollinearity.

4. Co-integration Test

The co-integration test assesses the existence of a long-term link among numerous time series variables. This indicates that two or more variables may demonstrate a co-integrated relationship over time, sustaining equilibrium despite transient perturbations. The concept was initially presented by Nobel laureates Robert Engle and Clive Granger in 1987, drawing upon the prior research of British economists Paul Newbold and Clive Granger regarding spurious regressions.

Co-integration tests ascertain instances where non-stationary time series are integrated in a manner that prevents them from diverging indefinitely across time. A collection of time series variables, represented as (X_1, X_2...Xk), is deemed co-integrated if each series is integrated to the same order, and a linear combination of these variables has a lower integration order than the individual series. This study used the co-integration test to evaluate the long-term link between tax income and investment in Nigeria. The

investigation will utilize long-run and F-bound co-integration tests. Should the trace statistic and Max-Eigen statistic surpass the 5% critical values, the null hypothesis of no co-integration will be rejected in favor of the alternative hypothesis, thereby affirming the presence of a long-term link.

5. Test for Autocorrelation

Autocorrelation in time series data refers to the relationship between error terms at different time points. The autocorrelation test is used to determine whether these error terms are correlated, which violates the assumptions of Ordinary Least Squares (OLS) regression. When autocorrelation is present, OLS estimators lose their Best Linear Unbiased Estimate (BLUE) properties. In this study, we apply the Breusch-Godfrey Serial Correlation test to detect potential autocorrelation in regression residuals. This test is preferred over the Durbin-Watson test because it is more comprehensive and imposes no restrictions. It follows the criteria below:

Hypothesis:

H_0: No serial correlation

H_1: Serial correlation exists

Decision Rule: If the p-value is less than the chosen significance level (0.05 or 5%), we reject the null hypothesis of no serial correlation and accept the alternative hypothesis that serial correlation is present.

6. Heteroskedasticity Test

A fundamental assumption of OLS regression is that the variance of the error components is constant across all observations. When this assumption is breached, heteroskedasticity arises, resulting in inefficient coefficient estimates and biased standard errors, which eventually distort statistical tests and confidence ranges. While OLS estimation is not the primary focus of this work, it is imperative to handle heteroskedasticity to guarantee the dependability of the results. Consequently, we utilize the Heteroskedasticity ARCH test to evaluate the stability of the regression model. If the chi-square probability surpasses the 5% significance threshold, it signifies that the data does not demonstrate heteroskedasticity.

7. Stability Test

This assessment evaluates the model's stability. Should instability be identified, the model may necessitate reconfiguration. The stability of the model is assessed by the CUSUM and CUSUMSQ tests, with stability signified by the blue line remaining within the two red border lines. If the blue line surpasses the red lines, it indicates instability. For this examination, an effective Recursive Residuals approach adopted was the Cumulative Sum of Recursive Residuals (CUSUM).

Test of Research Hypotheses and Decision Rule

Before we state our statistical yardstick for the Test of Hypotheses, let us recall our working hypotheses: Nigeria's petroleum and solid minerals exportation to South Africa does not have any significant impact on the real GDP growth of Nigeria. The above-stated hypotheses were tested at a 5% level of significance. The probability at which the t-value of the major variables is significant as compared with the chosen level of significance (5%). The Hypotheses tested are:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ (No Significance in relationship)

Decision Rule: Reject H_0 if $p<0.05$ and accept H_1. But if $p > 0.05$, reject H_1 and accept H_0 all at $\alpha = 5\%$ (Gujarati, 2004).

Sources of Data Collection

The study utilized quarterly secondary time-series data spanning 28 years (1996–2023) to examine the relationships among the selected macroeconomic and trade variables. Data were obtained from credible international and national sources, including the World Bank Integrated Trade Solution (WITS), World Development Indicators (WDI), World Governance Indicators (WGI), Central Bank of Nigeria (CBN) Statistical Bulletin, and the National Bureau of Statistics (NBS). Economic growth was measured using Real Gross Domestic Product in constant 2015 U.S. dollars, while sectoral outputs such as manufacturing and agriculture were captured in billions of naira. Trade variables including petroleum exports, solid minerals exports, textile imports, iron and steel imports, agricultural raw material imports, and electrical machinery imports were measured in U.S. dollars. Control variables such as real effective exchange rate, population growth, and institutional quality index were also incorporated. The use of multiple reliable data sources enhanced the validity and robustness of the study. E-Views 10 software was employed for data analysis due to its efficiency in handling econometric estimations, time-series modelling, and diagnostic tests relevant to the research objectives.

RESULTS

The standard correlation matrix allows for the assessment of multi-collinearity among the series prior to estimate. This solely demonstrates the absence of multicollinearity within the series. The table below presents the correlation matrix for the several models evaluated in this study.

Table 1: Correlation Matrix for Objective One

VARIABLES	RGDPG	PET	SLM	RER	POPG	IQX
RGDPG	1.000000					
PET	-0.022148	1.000000				
SLM	-0.339336	-0.370815	1.000000			
RER	-0.197961	-0.020798	-0.124299	1.000000		
POPG	0.472642	-0.298228	-0.222438	-0.174913	1.000000	
IQX	-0.137972	0.758679	-0.294888	-0.083102	-0.395863	1.000000

This study evaluated the lag length criteria test to determine the appropriate lag length for the ARDL model using Akaike's Information Criterion (AIC). The E-view estimate program automatically determined the ideal lag lengths during the analysis, as evidenced by the primary regression outputs for all models. The Bound Test (BT) approach utilizing F-statistics was employed to assess the presence of a long-run relationship among the variables in the models. The table below summarizes the boundaries test approach.

H_0: No long-run relationship exists

If the F-value falls between the lower and upper bounds, the outcome is inconclusive.

Table 2: ARDL Bounds Test for Cointegration Result

Test Components	Statistic/Level	Value
Test Statistic	F-Statistic	4.249006
Number of Regressors	K	5
Critical Value Bounds (Asymptotic: n = 1000)		

10% Significance Level	I(0) Bound	2.08
10% Significance Level	I(1) Bound	3.00
5% Significance Level	I(0) Bound	2.39
5% Significance Level	I(1) Bound	3.38
2.5% Significance Level	I(0) Bound	2.70
2.5% Significance Level	I(1) Bound	3.73
1% Significance Level	I(0) Bound	3.06
1% Significance Level	I(1) Bound	4.15

Decision Rule: The study rejected the null hypothesis since the test statistic (F-statistic = 4.249006) exceeds the upper bound at a 5% significance level [1(1) Bound = 3.38], so concluding that a long-run link is present in the model. This test ascertains the existence of long-term associations among the pertinent variables of interest.

Estimation and Interpretation for the Model

To achieve the specific objective one of the study, which seeks to evaluate the extent Nigeria's petroleum and solid minerals exportation to South Africa affects the real GDP in Nigeria, the study adopts the ARDL estimation technique, having established anlong-run relationship. Firstly, the model estimated the long-run coefficients is summarized in Table 3.

Table 3: Long-Run Estimation Result for Model One

Dependent Variable: *RGDPG*

Variables	Coeff.	Std. Error	Prob.	Coeff.	Std. Error	Prob.
	ARDL MODEL			FMOLS MODEL		
LOGPET	3.3177*	1.1477	0.0097	0.6883	0.7137	0.3484
SLM	0.0153	0.0130	0.2536	0.0001	0.0040	0.9897
RER	0.0364	0.0220	0.1150	0.0206	0.0109	0.0759
POPG	0.6730	4.8285	0.8907	-5.1445	7.9729	0.5274
IQX	-1.5974	1.0230	0.1358	-1.8927*	0.4926	0.0013
C	-45.8731**	22.6331	0.0578	-26.9357**	12.5469	0.0465

Source**:** Author's computation, E-views 10

Note: * denotes significance at 1%, ** denotes significance at 5%

The coefficient of petroleum export is 3.3177 and statistically significant at the 1% level (p = 0.0097), implying that a 1% increase in petroleum exports to South Africa leads to approximately a 3.32 point rise in Nigeria's real GDP in the long run. This positive relationship suggests that petroleum exports remain a key driver of Nigeria's economic growth, reflecting the dominance of oil in Nigeria's export structure. This finding aligns with Ogunleye and Ayinde (2023), who reported that crude oil export significantly boosts Nigeria's GDP through foreign exchange earnings and fiscal revenues. Similarly, Alege and Osabuohien (2021) found that petroleum exportation exerts a long-run positive effect on growth across oil-dependent African economies. However, this result contrasts with Eneji, Uwajumogu, and Onabe (2020), who discovered that overreliance on crude oil exports exposes Nigeria to external shocks and volatility, leading to unstable growth patterns. Likewise, Odularu (2008) argued that despite its positive short-run impact, the petroleum sector's long-run contribution is weakened by weak institutions and low value addition.

The coefficient of solid mineral exports is 0.0153 and statistically insignificant (p = 0.2536), suggesting that solid mineral exports to South Africa have not contributed

meaningfully to Nigeria's real GDP in the long run. This insignificance may stem from underdeveloped mining infrastructure, poor regulatory frameworks, and low foreign investment in the sector. This finding is consistent with Audu and Nwankwo (2022), who observed that solid mineral exports have an insignificant effect on Nigeria's GDP due to limited production capacity and inadequate value chain development. Similarly, Okorie and Onyekuru (2020) found that the non-oil mineral sector has not significantly influenced Nigeria's growth because of its informal nature and export of raw minerals. Conversely, Adedoyin et al. (2021) reported a significant positive impact of solid mineral exploitation on long-term growth when complemented with sound institutional and fiscal reforms, suggesting that the sector's growth potential depends on effective governance and capital investment.

The coefficient of real exchange rate is 0.0364 and statistically insignificant ($p = 0.1150$), implying that exchange rate fluctuations do not significantly influence real GDP in the long run. Although positive, the insignificance may indicate that the benefits of a depreciated currency for export competitiveness are offset by higher import costs and macroeconomic instability. This result supports Eke and Ogundipe (2021), who found that exchange rate volatility had an insignificant long-run effect on Nigeria's growth due to structural rigidities in the export sector. Similarly, Abogan and Akinola (2020) noted that exchange rate misalignment hinders trade and reduces growth in oil-exporting economies. However, Onifade et al. (2022) contradicted this, reporting that exchange rate depreciation stimulates export-led growth in the long run when accompanied by stable macroeconomic management.

The coefficient of population growth is 0.6730 and statistically insignificant ($p = 0.8907$), indicating that changes in population size do not have a long-run effect on Nigeria's GDP growth. This suggests that population increases have not translated into productive economic participation, likely due to unemployment and low human capital productivity. This finding aligns with Aiyedogbon and Ohwofasa (2020), who observed that population expansion in Nigeria exacerbates unemployment and poverty without driving growth. Similarly, Aliyu and Dada (2022) found that population growth has an insignificant or even negative impact on growth when education and healthcare systems are weak. On the other hand, Kazeem et al. (2023) reported a positive long-run relationship between population growth and GDP when human capital investment is strong, highlighting that the population-growth nexus depends on the quality rather than the size of the labor force.

The coefficient of institutional quality is -1.5974 and statistically insignificant ($p = 0.1358$), suggesting that weak institutional quality undermines the positive growth effects of trade and resource exports in Nigeria. The negative sign implies that poor governance, corruption, and regulatory inefficiency reduce the potential benefits of export diversification. This outcome is in line with Asogwa (2023), who found that institutional weaknesses significantly dampen the growth effects of resource endowments in Sub-Saharan Africa. Similarly, Lawal, Olayiwola, and Adebayo (2021) concluded that low institutional quality erodes the efficiency of the extractive sector in Nigeria. Conversely, Okunlola and Aluko (2022) found that institutional reforms and transparency in export management can reverse the negative relationship, supporting the hypothesis that governance improvements are a prerequisite for sustainable growth in resource-rich countries.

In comparing the ARDL and FMOLS estimation results in Table 4.5a, the ARDL model reveals that petroleum export has a strong and statistically significant positive impact on Nigeria's real GDP at the 1% level, with a coefficient of 3.3177, indicating that a 1% increase in petroleum exports to South Africa leads to approximately 3.32% growth in Nigeria's real GDP. Conversely, the FMOLS model shows a weaker and statistically insignificant relationship (0.6883; p = 0.3484), suggesting that FMOLS underestimates the dynamic influence of petroleum exports on economic growth. Similarly, while the real exchange rate is positive in both models, it is only marginally significant in FMOLS (p = 0.0759) and insignificant in ARDL (p = 0.1150). Institutional quality, on the other hand, is negatively signed in both estimations but significant only in the FMOLS model (p = 0.0013), implying that weak institutions may hinder growth when evaluated using long-run cointegrating techniques. Other variables, such as solid minerals export and population growth, are statistically insignificant across both estimations, suggesting limited direct long-run influence on Nigeria's GDP in the context of trade with South Africa.

Overall, the ARDL model is preferred to FMOLS because it captures both short-run and long-run dynamics, accommodates variables of mixed integration orders (I(0) and I(1)), and provides consistent estimates even in small sample sizes. Moreover, ARDL's ability to separate the short-run adjustments from long-run equilibrium effects offers deeper policy insights into how petroleum and solid minerals exports influence growth over time, unlike FMOLS which focuses solely on long-run relationships. Hence, the ARDL model was adopted as the main estimation technique due to its robustness, flexibility, and suitability for the underlying data structure in the study.

Table 4: Short-Run Estimation Result for Model One

Dependent Variable: *RGDPG*

Variables	Coefficient	Std. Error	T-Statistic	Prob.
D(LOGPET)	1.0205	0.5993	1.7028	0.1058
D(SLM)	-0.0002	0.0036	-0.0564	0.9556
D(POPG)	-2.1946	6.9287	-0.3167	0.7551
D(IQX)	-1.9022*	0.4425	-4.2991	0.0004
CointEq(-1)*	-0.6870*	0.1091	-6.2974	0.0000

Source: Author's computation, E-views 10

Note: * denotes significance at 1%, ** denotes significance at 5%

The coefficient of differential lag of petroleum export is 1.0205, indicating that a 1% increase in petroleum imports leads to about a 1.02% rise in manufacturing output growth in the short run, though the effect is statistically insignificant (p = 0.1058). This positive association suggests that petroleum imports may complement industrial production processes by supplying energy and lubricants necessary for manufacturing machinery operation. This finding aligns with Ehinomen and Adeleke (2020), who found that energy imports had a positive but insignificant short-run impact on Nigeria's industrial output. Similarly, Mabrouk and Saidi (2022) established that imported fuel supports short-term industrial productivity in developing economies by stabilizing energy supply. However, this result contradicts Olayungbo and Quadri (2019), who reported that petroleum imports exert a negative effect on Nigeria's manufacturing output due to import dependence and foreign exchange pressures that crowd out domestic production capacity.

The coefficient differential lag of iron and steel imports from South Africa is -0.0002, and the probability value (p = 0.9556) indicates an insignificant negative relationship between iron and steel imports and manufacturing output growth in the short run. This suggests that imported iron and steel materials from South Africa do not significantly enhance Nigeria's manufacturing output, possibly because of limited domestic value addition or inefficient utilization of imported inputs. This finding is consistent with Akanbi (2021), who found that imported capital and intermediate goods had an insignificant or even adverse impact on Nigeria's industrial growth due to infrastructural and absorptive capacity constraints. Conversely, Edeh, Nwokolo, and Ike (2023) reported a positive effect of steel imports on manufacturing productivity in Sub-Saharan Africa, arguing that imported steel improves capital stock quality and production efficiency when complemented by adequate technology transfer.

The coefficient differential lag of population growth is -2.1946, with an insignificant probability (p = 0.7551), indicating a negative but statistically insignificant effect of population growth on manufacturing output in the short run. This implies that a rising population does not immediately stimulate industrial output, possibly due to high unemployment and underutilized human capital. This finding is in line with Omodero (2020), who reported that population growth in Nigeria exerts a negative impact on industrial output due to low productivity and job creation lag. On the contrary, Adeniyi and Olasunkanmi (2022) found that population growth positively influences industrial expansion in the long run through market size effects and labor force advantages, suggesting that the short-run negative relationship may be transitional.

The coefficient differential lag of institutional quality index is -1.9022 and is statistically significant at 1% (p = 0.0004), implying that a 1% increase in the importation of electrical power machinery from South Africa leads to a 1.90% decline in Nigeria's manufacturing output growth in the short run. This negative relationship suggests that heavy reliance on imported electrical machinery may crowd out domestic technology development or reflect inefficiencies in the adaptation of foreign machinery to local industrial contexts. The finding supports Nwosa (2021), who found that the importation of capital goods had a negative short-run effect on industrial productivity due to high maintenance costs and inadequate technical know-how. Conversely, Ebere and Alabi (2023) argued that imported power machinery improves manufacturing performance when supported by energy infrastructure and skilled labor, implying that Nigeria's short-run inefficiencies might stem from institutional weaknesses rather than trade patterns.

Tests for Autocorrelation

The stated Models below are tested for autocorrelation using the Breusch-Godfrey Serial Correlation LM Test. This test ascertains if the model's residuals are free from serial correlation which would undermine the potency of the assumptions of the model. The hypothesis to be tested is given in the null form;

H_0: There is no autocorrelation

Table 5: Tests for Autocorrelation

	F- Statistic	Observed R^2
Test Statistic	0.158875	0.623124
P-Value	0.8544	0.7323
Durbin Watson test statistic	2.122473	

Test for Heteroscedasticity

The Heteroscedasticity test is performed to determine whether the variance of the error term remains consistent across all observations. This constitutes one of the assumptions of ordinary least squares (OLS); if this assumption is violated, we encounter the issue of heteroscedasticity. Consequently, to verify that the variance of the error term remains constant, the Breusch-Pagan-Godfrey heteroscedasticity test was employed. The estimations are given in Table 6.

H_0: The residuals are Homoscedasticity

Table 6: Test for Heteroscedasticity

	F- Statistic	Observed R^2	Scaled explained SS
Test Statistic	2.577272	20.81652	9.818177
P-Value	0.0621	0.0766	0.7087

Model Stability Test

The diagnostic test to be conducted for model 1a is the CUSUM test to certify the stability of the model. The null hypothesis being tested here is that the $CUSUM_t$ statistic is drawn from a $CUSUM_{(t-k)}$ distribution, thus the $CUSUM_{(t-k)}$ is a symmetric distribution centered at 0 with its dispersion increasing as t-k does.

Evaluation of Research Hypotheses

To achieve the specific objectives of the study and to make a valid evaluation of the research hypotheses, an ARDL estimation technique was used as an estimation procedure.

Here is an evaluation of the four research hypotheses based on the findings:

Hypothesis One (H_{01}): Nigeria's petroleum and solid minerals exportation to South Africa does not have any significant impact on real GDP growth in Nigeria.

The first objective evaluated the extent to which Nigeria's petroleum and solid minerals exportation to South Africa affects real GDP growth. The ARDL results revealed that petroleum exports have a positive and statistically significant effect on real GDP growth at the 1% level (p = 0.0097), implying that increases in petroleum exports to South Africa stimulate Nigeria's economic growth. Conversely, solid minerals exports were statistically insignificant, suggesting weak linkages between the sub-sector and GDP. Therefore, the null hypothesis (H_{01}), that petroleum and solid minerals exports have no significant impact on Nigeria's real GDP growth is rejected for petroleum but accepted for solid minerals.

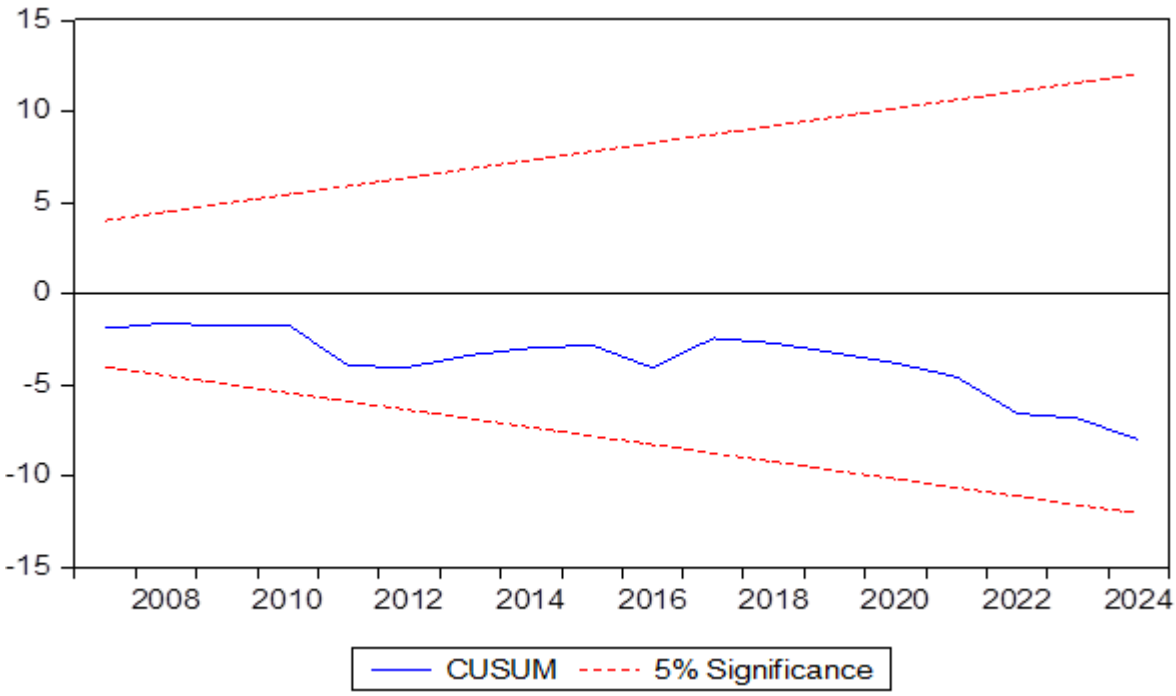

Figure 1: The CUSUM Stability Test

Figure 1 presents the CUSUM stability test used to examine the structural stability of the estimated model over the study period. The blue CUSUM line remains within the 5% critical bounds represented by the red dashed lines throughout the sample period. This indicates that the estimated coefficients are stable and free from structural breaks. Although the trend declines gradually toward the end of the period, it does not exceed the critical boundaries. Therefore, the model is stable, reliable, and suitable for policy inference.

Discussion of Findings

The first objective examined how Nigeria's petroleum and solid minerals exportation to South Africa affects Nigeria's real GDP growth. The ARDL long-run result in Section 4.2.1 showed that petroleum export had a positive and significant impact on real GDP (3.3177, $p < 0.01$), implying that a 1% rise in petroleum exports to South Africa increases Nigeria's GDP by about 3.32%. This result suggests that petroleum exportation remains a dominant driver of Nigeria's economic growth, primarily due to foreign exchange inflows and fiscal revenues from oil trade. This finding is consistent with Ogunleye and Ayinde (2023) and Alege and Osabuohien (2021), who confirmed that oil exports significantly promote growth in oil-dependent African economies. In contrast, Eneji, Uwajumogu, and Onabe (2020) and Odularu (2008) found that excessive reliance on crude oil exports exposes Nigeria to external shocks, undermining long-term growth stability. In the short run, the ARDL error correction term was negative and significant, suggesting that short-term fluctuations in petroleum exports adjust toward a stable long-run equilibrium.

However, solid minerals export (SLM) was positive but insignificant both in the short and long run, indicating that the sector's contribution to growth remains underexploited due to weak institutional and infrastructural frameworks (see Nwogwugwu et al., 2021; Muftau & Onaopemipo, 2022). The implications of the findings of this study are that Nigeria has had to remain reliant on petroleum exports as a form of economic growth which on one hand gives the economy a boost of growth but on the other hand subjects the economy to external shocks, price volatility and poor diversification. The immense positive impact of

petroleum exports implies that export earnings may be used to boost growth subject to proper management. But the negligible role of solid mineral exports shows the unutilized possibilities due to poor institutions, infrastructure and investment. This helps argue that an efficient community and economic development need to mobilize the resources and involve everyone (Iwuno, 2021).

The poor performance of the solid minerals industry is also a pointer to better governance, security and investment climate as insecurity does not encourage productive economic operations and the utilization of resources (Iwuno et al., 2025). It also requires efficient delivery of its public services and strategic management to help coordinate the trade and industrial policies that will make it competitive in exports (Iwuno & Uzor, 2025). Education and capacity building of human capital are also crucial in enhancing mining and petroleum industries technical skills (Iwuno, 2025; Chukwurah et al., 2020). Moreover, resource management accountability can be enhanced by institutional reforms, digital governance, and transparent communication systems (Obikeze et al., 2022). The results also indicate that the potential of solid minerals sector can be unleashed by private investment, innovation, and proper management systems due to the presence of the public-private partnerships (Obi et al., 2026). Thus, diversification of exports, enhanced institutions, and fruitful collaborations are the only way sustainable GDP growth will be realized in Nigeria.

CONCLUSION

This paper explored the impact of petroleum and solid mineral exports of Nigeria to South Africa on the growth of Nigeria real GDP by considering quarterly time-series data (1996-2023) and the ARDL estimation methodology. The findings established the existence of a long-run relationship among the variables, indicating that export performance and macroeconomic factors are important determinants of economic growth in Nigeria. The empirical results revealed that petroleum exports to South Africa exert a positive and statistically significant effect on Nigeria's real GDP growth in the long run. This confirms that petroleum exports remain a major driver of Nigeria's economy through foreign exchange earnings, government revenue generation, and increased external trade receipts. The result further reflects Nigeria's continued dependence on crude oil as the dominant export commodity and its strategic importance in bilateral trade with South Africa.

Conversely, solid mineral exports were observed to positively but statistically insignificantly impact on the growth of real GDP. This indicates that the solid minerals sector is yet to play significant roles in economic growth of Nigeria, mainly because of poor infrastructure, insufficiency of investment, poor regulations, lack of technology, and reliance on the petroleum sector. The untapped potential in the sector means that Nigeria has not diversified its exports base in spite of the rich mineral deposits. The short-run dynamics showed that deviations from equilibrium are corrected over time, as indicated by the significant error correction mechanism. Diagnostic tests confirmed that the model is free from serial correlation and heteroscedasticity, while the CUSUM test established structural stability of the estimated model. These outcomes validate the robustness and reliability of the empirical findings.

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