

Gauging the Impact of Openness on Sustainable Development in Nigeria: Evidence from FM-OLS and ARDL Approaches to Cointegration

Jimoh Sina Ogede^{*1}, Hammed O. Tihamiyu¹

¹Department of Economics, Olabisi Onabanjo University, Ago Iwoye, Nigeria

*Corresponding Author: sinaogede@oouagoiwoye.edu.ng

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Abstract: This paper considers the nexus between trade openness and sustainable development in Nigeria from 1996 to 2019 by employing Fully Modified Least Square (FMOLS) and Autoregressive Distribution Lags (ARDL) techniques. Our results suggest that trade openness has a significant positive impact on sustainable development and is Nigeria's economic pillar of sustainability. The paper also reveals a significant disparity in magnitude and sign of the parameters when ARDL is used. In the long run, openness to trade has a significant positive impact on sustainable development in Nigeria, implying that an increase in trade openness will improve sustainable development in Nigeria. The effect of the age dependency ratio is insignificant inverse, showing that it does not affect sustainable development. Furthermore, in the short run, except for trade openness and age dependence ratio that has a significant effect, all other independent variables are not statistically significant. The paper concludes that trade openness positively impacts sustainable development in Nigeria. The paper's hypothesis is likely to trigger a fresh conversation on how to promote sustainable development and so mitigate environmental risks.

Keywords: sustainable development, openness, ARDL, FM-OLS approach, Nigeria

1. Introduction

Countries all around the globe have experienced the benefits of increased investment, industrial growth, employment opportunities, and rising wages as a result of the rapid expansion of global trade. Several emerging nations such as Nigeria, have attempted to engage actively in the global commercial system, acknowledging that trade gains may significantly enhance fundamental living conditions. The participation of the Nigeria and bulk of these nations in the global economy has necessitated substantial domestic economic restructuring. As a response, Nigeria and other national governments have created sustainable development goals (SDGs) to rebalance respective economies to face environmental challenges. Consequently, questions have been raised on the nexus between sustainability and openness as many countries continue to sweep through issues relating to carbon emissions (CO₂) and environmental economics. Furthermore, no obvious approach to reaching a major consensus on the linkage between sustainable development and trade openness has been presented [1, 2, 3, 4, 5, 6, 7]. The above disagreement may be due to the multiple links between openness with components of sustainable development such as environmental quality and output growth.

Notably, erstwhile studies defined environmental quality as a pillar of sustainability [8]. They contend that openness impacts the environment through comparative advantage across countries. It is

projected that developing nations with weak environmental, and institutional arrangements would attract capital inflows that want to reduce pollution mitigation costs while enhancing economic rewards; as a consequence, foreign direct investment (FDI) may increase pollution in host countries [9, 10, 11]. According to studies, openness and sustainability have a positive relationship due to enhanced specification, knowledge spill-over, and return to scale due to openness [5, 3]. While research such as [6, 7], and others find a negative nexus attributed to societal incapability and domestic business viability. However, this huge collection of research does not help demonstrate the link between openness and sustainability, but it makes it more doubtful [12]. For Nigeria, Feridun, Ayadi, and Balouga [13] argue that carbon emissions within Nigeria are linked positively to trade intensity and GDP growth. The evidence clearly shows that trade intensity, real GDP, and GDP are positively connected to environmental deterioration in Nigeria. Furthermore, the analysis shows that trade openness has a negligible effect on economic growth and environmental quality in the short run but has a considerable negative impact on the economy in the long term.

Thus, because of the dearth of studies focusses on the nexus between trade openness and sustainable development in Nigeria, makes the subject is the problem statement for the current study. Nigeria is grouped with ten other net oil-exporting countries owing to its high degree of energy dependence. There

is still resistance to the impact of climate change and the significance of embracing a real pathway towards a green economy. For Nigeria, bridging the infrastructural deficit can only be achieved through gains from exporting her crude oil and technological advancement that compel greater trade openness. The increasing openness to trade and the country's continuous trade liberalization have made her the dumping grounds of various expensive and consumptive foreign commodities that could have been produced locally. These not only waste the oil revenue, rather than the development of infrastructure, but enmeshed the local industries in a dilemma, further weakening the overall economic strength [14]. As a pillar of sustainability, Nigeria can only make fewer funds available to finance infrastructure and pollute the environment in the production and exportation of crude oil. However, the above ambiguity raises some pertinent questions on whether there is a connection between trade openness and sustainability in Nigeria. It is contended that an empirical investigation in this regard will not only provide crucial insights to the decisive inquiry as to whether Nigeria has indeed been fruitful in ensuring that the depreciation of natural resources is institutional, such that it will assist stakeholders in pursuing reform towards restructuring the economic, social, and environmental systems to be sustainable. This study contributes by utilizing green economic growth to quantify the relationship between openness and sustainable development. Furthermore, to the best of our knowledge, despite several previous investigations, there is a lack of empirical literature in this respect.

Our results suggest that trade openness has a significant positive impact on sustainable development and is Nigeria's economic pillar of sustainability. The paper also reveals a significant disparity in magnitude and sign of the parameters

when ARDL is used. In the long run, openness to trade has a significant positive impact on sustainable development in Nigeria, implying that an increase in trade openness will improve sustainable development in Nigeria. The effect of the age dependency ratio is insignificant inverse, showing that it does not affect sustainable development. Furthermore, in the short run, except for trade openness and age dependence ratio that has a significant effect, all other independent variables are not statistically significant. Meanwhile, trade openness and carbon dioxide emissions have negative effects, while age dependency ratio and fixed capital formation positively affect sustainable development in Nigeria. The rest of this paper is structured as follows. Section 2 presents empirical literature, while Section 3 demonstrates the study models and methods. Section 4 discusses the results and findings, while section 5 presents the study conclusion.

2. Research Method

In this part, we discuss the study's methodology, data descriptions and sources, and the order of several estimation strategies.

2.1. Data

This paper focuses on the impact of trade openness on sustainable development in Nigeria. Given the paper's objective, the analysis is predominately based on secondary data from the World Bank's World Development Indicator for Nigeria, spanning 24 years from 1996 to 2019. OPN, INP, GCF, ENV, and GY represent the population's trade openness, age dependency ratio, gross fixed capital formation to GDP, Growth of per capita Co₂, and adjusted savings, respectively. Table 1 contains a research description of the selected variables.

Table 1. Description of variables and sources

Description	Variables	Measurement	Source
OPN	Trade openness	The proportion of trade balance to GDP	WDI
INP	Age dependency ratio	The proportion of dependents population to the working-age population	WDI
GCF	Gross fixed capital formation to GDP	Gauges physical capital in the economy.	WDI
ENV	Growth of per capita Co ₂	Gauges emissions stemming from the burning of fossil fuels and others.	WDI
GY	Adjusted savings	This gauges the energy depletion of the economy over time	WDI

2.2. Model and Methodology

The model of the study is anchored on the standard Solow growth model by Solow (1956), which was expounded by Mankiw, Romer & Weil [24], as follows:

$$Y = f(L, K, A) \tag{1}$$

Y, L, K, and O are output, labor, capital, and openness. This study assumes that technical progress represents technology and resource endowments (such as the institutional policy of trade and climate) that differ across countries.

$$Y_t = \alpha_0 + \beta_1 Inp_t + \beta_2 GFC_t + \beta_3 OPN_t + \mu_t \tag{2}$$

Where Y_t represents the output growth at time (t); Inp_t is the population at the time (t); GFC_t represents the gross fixed capital formation to GDP at the time (t) while OPN_t defines the degree of trade openness at the time (t). While analyzing the openness nexus within the economic, environmental, and sustainability

dimensions, the study upgraded equation (2) to accommodate the environmental quality index and the measure of green growth. The environmental aspect of sustainability is gauged by employing genuine savings instead of GDP growth [25,26, 12]. Consequently, the equation (1) is transformed into the linear form as below:

$$GY_t = \alpha_0 + \beta_1 Inp_t + \beta_2 GFC_t + \beta_3 OPN_t + \beta_4 ENV_t + \mu_t \tag{3}$$

GY is used to measure green growth, and it is being incorporated to replace traditional growth as part of our effort to model sustainability. GY measures energy depletion as the proportion of the value of the stock of energy resources to the available reserve lifespan. At the same time, openness is defined as the total of commodities and services exports and imports as a proportion of GDP. *Inp* is the percentage of dependents in the working-age population. The justification for including *Inp* relies on the fact that it constrains growth by intensifying disadvantaged populations. *GFC* is defined as the ratio of gross fixed capital formation to GDP to mirror physical capital in the economy. ENV is the growth of per capita carbon dioxide emissions measured in kilo-ton, a proxy of environmental pollution. All the variables are taken in logarithmic form, and the residual or error time is gauged with μ . Besides, some erstwhile studies have demonstrated that traditional growth is not the same as green growth, and there is an increasing gap between the duos over time [2, 12, 27]. According to these studies, the standard of living rises in lockstep with economic progress, but only to a point. As a result, each additional rise in economic growth will result in

higher welfare costs and a deepening of the imbalance. As a result, for Nigeria, which is seeking sustainable economic growth, it would be fascinating to observe if environmental harm and other welfare costs counteract, or otherwise, the economic expansion.

As a result, the paper uses autoregressive distributed lag (ARDL) and fully modified ordinary least squares (FMOLS) methodologies to determine whether trade openness supports or hinders Nigeria's sustainable development. The ARDL limits approach is used to determine both the short-run and long-run impacts of explanatory factors on economic growth. When the sample size is small, it also has the benefit of providing more accurate estimations than other estimating methods. The approach is based on F-statistics (Wald test) and is used to evaluate the potential consequences of lagged variables in an unconstrained and conditional dynamic error correction form [28, 29]. Furthermore, the estimate approach applies whether the variables' stationarity findings are integrated at levels, first difference, or both. The study provides the ARDL (p, q) model as follows, based on the specifications of Pesaran and Shin [28]:

$$GY_t = \alpha_0 + \sum_{i=1}^n \beta_1 \Delta Inp_{t-i} + \sum_{i=1}^n \beta_2 \Delta GFC_{t-i} + \sum_{i=1}^n \beta_3 \Delta OPN_{t-i} + \sum_{i=1}^n \beta_4 \Delta ENV_{t-i} + \rho_2 \Delta Inp_{t-i} + \rho_3 \Delta GFC_{t-i} + \rho_4 \Delta OPN_{t-i} + \rho_5 \Delta ENV_{t-i} + u_t \tag{4}$$

where Δ is the first difference operator, n is the optimal lag length, β_1 , β_2 and β_3 are the short-run responses. In contrast, ρ_1 , ρ_2 and ρ_3 signify the long-run responses of explanatory variables defined above while u_t specifies the residual. The FMOLS methodology is used to examine the robustness of the

ARDL bound approach coefficients. The FMOLS method provides a single cointegrating equation with a mix of first difference variables. Furthermore, the approach transforms both coefficients and data [30]. As a result, according to Park [30], the FMOLS estimator is defined as follows:

$$FMS = (\sum_{t=2}^T Z_t Z_t')^{-1} (\sum_{t=2}^T Z_t Y_t^+ - [T_{012}^{\tau+}]) \tag{5}$$

Y_t^+ and τ_{12}^+ are included to correct endogeneity and serial correlation problems in the model following Priyankara [31].

3. Results and Discussion

3.1. Preliminary Analysis

Table 2 contains summary statistics for the sample data used in this study's empirical analysis. OPN and GY have average values of 38.2 and 6.43, respectively. Furthermore, the 88.8 percent average population growth rate covers the maximum

and lowest values of 88.6 percent. The result reveals that population increase is much bigger than revenue from trade openness and real-adjusted saving, indicating long-term growth. As a result of increased population growth rates, rapid increases in openness and saving for resource replenishment do not encourage economic growth or sustainable development. The table also shows that the examined variables have a significant variation, with high values in some years and abysmally low in others. The standard deviation values for the variables measuring openness and physical capital in the economy are



rather high in their difference from the average points. The mean values of age dependency, physical capital, and carbon dioxide to the size of the GDP are 87.6%, 23.9%, and 0.64%, respectively. The table also shows the findings of skewness and Kurtosis statistics. All

variables except trade openness and carbon dioxide are positively skewed. The results also demonstrate that, except for carbon dioxide and GDP growth, all variables are normally distributed, as they did not fulfill the Kurtosis statistic's criterion of 3.0.

Table 2. Descriptive statistics

	GY	INP	OPN	ENV	GFC	TGDP
Mean	6.425	87.604	38.155	0.641	23.928	2.460
Median	6.387	87.738	39.308	0.646	22.870	2.908
Maximum	12.330	88.830	53.278	0.788	40.553	12.458
Minimum	1.326	86.615	20.723	0.481	14.169	-4.168
Std. Dev.	2.953	0.725	8.949	0.060	8.703	3.380
Skewness	0.160	0.016	-0.158	-0.080	0.534	0.673
Kurtosis	2.248	1.633	2.364	4.472	2.017	4.614
Jarque-Bera	0.667	1.870	0.505	15.380	2.106	4.415
Probability	0.716	0.393	0.777	0.083	0.349	0.110

The total number of observations is 24

Table 3 shows the correlation matrix, which demonstrates the degree of relationship between the factors utilized to create the correlations between Nigeria's openness and stance on sustainable development. Table 3 shows that openness positively links sustainable development indicators such as real saving and gross fixed capital creation. This

demonstrates that the variables were linked during the periods. The correlation parameters of the explanatory variables are also provided. The degree of linkage implies that the study does not have a multicollinearity problem. Moreover, the outcomes of the preliminary investigations are one of the conditions for empirical validation.

Table 3. Correlation matrix

	OPN	INP	GY	GCF	ENV	TGDP
OPN	1	-0.126	0.651	0.406	0.342	0.306
INP	-0.126	1	-0.147	-0.0556	-0.311	-0.306
GY	0.651	-0.1473	1	0.262	0.421	0.338
GCF	0.406	-0.056	0.262	1	0.539	0.306
ENV	0.342	-0.311	0.421	0.539	1	-0.008
TGDP	0.306	-0.306	0.338	0.0307	-0.008	1

Table 4 displays the results of the Augmented Dickey-Fuller (ADF) unit root test. Stationarity tests are conducted with a constant and no trend. The Augmented Dickey-Fuller (ADF) statistics show that

the null hypothesis of unit root cannot be rejected for all parameters, implying that the parameters are not stable at levels. However, in the case of the first difference, all variables are stable at first difference.

Table 4. Unit root test results (augmented Dickey-Fuller test)

Variables	Levels	1 st difference	Stationary status
GY	-2.964571	-6.864867***	I(1)
INP	-2.731462	-4.706667***	I(1)
OPN	-2.496855	-5.705607***	I(1)
GFC	-1.491143	-3.70049**	I(1)
ENV	-2.303721	-4.855558***	I(1)
TGDP	-2.391737	-3.60774**	I(1)

***, **, * represent significance level at 1%, 5% and 10%, respectively

Table 5 presents the result of the Johansen Cointegration tests. The results provide consistency between the Trace Eigenvalue and the Maximum

Eigenvalue, indicating the presence of a long-term interaction. The result suggests that the variables in the model have Cointegration or a long-term connection.

Table 5. Johansen Cointegration Test

Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
No. of CE(s)	0.886	164.912	95.753	0.0000
At most 1 *	0.849	117.194	69.819	0.0000
At most 2 *	0.829	75.665	47.856	0.0000
At most 3 *	0.585	36.853	29.797	0.0065
At most 4 *	0.483	17.487	15.495	0.0247
At most 5	0.126	2.971	3.842	0.0848

Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.886	47.718	40.078	0.0057
At most 1 *	0.849	41.529	33.877	0.0050
At most 2 *	0.829	38.812	27.584	0.0012
At most 3 *	0.585	19.366	21.132	0.0867
At most 4 *	0.483	14.516	14.265	0.0456
At most 5	0.126	2.971	3.842	0.0848

3.2. Effect of openness to trade on Sustainable development using the FMOLS and ARDL

The effect of trade openness on sustainable development using the Fully Modified Least Square technique is presented in table 6. It is obvious from the results that trade openness has a direct and significant impact on sustainable development, signifying progress in sustainable development in Nigeria. Also, economic growth measured by an increase in GDP has a significant positive effect. In contrast, the growth of per capita carbon dioxide emissions has an insignificant positive effect on sustainable

development in Nigeria. Meanwhile, gross fixed capital formation has a significant inverse effect on sustainable development, while the effect of the age dependency ratio on sustainable development is insignificant. The result also showed that all the exogenous variables jointly have an 84% effect on sustainable development. In all, we can conclude by saying that openness to trade has a significant positive effect on sustainable development in Nigeria.

Table 6. Results of the effect of openness to trade on sustainable development using FMOLS

Dependent Variable: GY				
Variables	Coefficients	Std. Err	t-Statistic	P-values
INP	-0.26365	0.76568	-0.34433	0.734
OPN	0.18943	0.05691	3.32840	0.004
GFC	-0.39604	0.14085	-2.81178	0.013
ENV	13.5552	9.31983	1.45444	0.164
TGDP	0.29755	0.13112	2.269436	0.038
R-squared	0.8769			
Adj. R-squared	0.8477			

The effect of trade openness on sustainable development using the Autoregressive Distribution Lag technique is presented in Table 7. From Table 7, it is obvious that trade openness has a significant positive effect on sustainable development in Nigeria. In the long run, an increase in trade openness will improve sustainable development in Nigeria. Also, the growth of per capita carbon dioxide emissions has an insignificant positive effect, showing that it does not affect Nigeria's level of sustainable development. The above findings are contrary to the work of Shen et al. [10], Shirazi et al. [12], and Zhang et al. [11], who claimed that the nexus is based on the pollution haven hypothesis. Besides, Zahonogo [3] and Arezk et al. [14] argue that the trade openness-sustainable

growth nexus could be positive or negative in changing circumstances.

Meanwhile, fixed capital formation and economic growth have significant inverse effects on sustainable development in Nigeria. The effect of the age dependency ratio is insignificant inverse, showing that it does not affect sustainable development. The finding in tandem with the work of Shirazi et al. [12], suggesting that the positive nexus is more reliable, not only due to its consistency with the economic theories. All the independent variables jointly explained 83.5% variations in sustainable development in Nigeria, and the model has the goodness of fit given by the value of Durbin-Watson. The study concludes that trade openness has a significant positive effect on

sustainable development in Nigeria in the long run. Furthermore, in the short run, as shown in Table 8, except for trade openness and age dependence ratio that has a significant effect, all other independent variables are not statistically significant. That is, they have no significant effects on sustainable development in Nigeria. Meanwhile, trade openness, carbon dioxide emissions, and economic growth have negative effects in the short run. In contrast, the age dependency ratio and fixed capital formation positively affect sustainable development in Nigeria. In conclusion, comparing the results from Fully Modified Least Square (FMOLS) and Autoregressive Distribution Lags (ARDL) techniques reveals that trade openness has a significant positive effect on sustainable development in Nigeria.

The Jarque-Bera statistics of 0.869904 and the corresponding probability of 0.647296 as indicated in Table 7. The result showed that the residuals from our model are normally distributed. Breusch-Godfrey Serial Correlation LM Test was conducted to ascertain whether our variables are serially correlated, and the result is presented in Table 7. The result revealed that our variables have no serial correlation problem given the R-square value of 8.728337 and the probability value of 0.2127. The result of the Breusch-Pagan-Godfrey Heteroscedasticity Test is also reported in Table 7. As revealed, it indicated that our model is homoscedastic given the values of R-squared of 17.20481 and probability of 0.2454.

Table 7. Results of the effect of openness to trade on sustainable development using ARDL

Long-run Results				
Variables	Coefficients	Std. Err	t-Statistic	P-values
INP	-5.678290	2.876263	-1.974190	0.2189
OPN	0.283206	0.060201	4.704335	0.0022
GFC	-0.298017	0.166770	-1.787001	0.0171
ENV	6.874409	6.896469	0.996801	0.3521
TGDP	-0.082353	0.155148	-0.530807	0.0120
Short-run result				
Variables→	Coefficients	Std. Err	t-Statistic	P-values
GY(-1)	-0.339653	0.243051	1.397455	0.2050
INP(-1)	8.422706	3.019171	2.789741	0.0269
OPN(-1)	-0.194674	0.055302	-3.520215	0.0097
GFC(-1)	0.235514	0.115335	2.041994	0.0805
ENV(-1)	-3.882623	2.050818	-1.893207	0.1002
TGDP(-1)	-0.371891	0.130200	-2.856309	0.0245
Model's Diagnostics and Stability				
R-squared			0.9450	
Adjusted R-squared			0.8352	
Durbin-Watson stat			2.0253 (0.004)	
Normality Test (Jarque-Bera)			0.8699 (0.647)	
Serial Correlation LM Test			8.7283 (0.212)	
Heteroscedasticity Test			17.203 .245)	

4. Conclusion

This paper considers the nexus between trade openness and sustainable development in Nigeria from 1996–to 2019 by employing autoregressive distributed lag (ARDL) and fully modified ordinary least squares (FMOLS) methodologies. The outcomes of the long-run analysis of ARDL and FMOLS methodologies reveal that openness to trade directly impacts sustainable development in Nigeria. The effect of the age dependency ratio is insignificant inverse, showing that it does not affect sustainable development. The study concludes that trade openness has a significant direct impact on sustainable development in Nigeria in the long run.

Furthermore, in the short run, except for trade openness and age dependence ratio that has a significant effect, all other independent variables are not statistically significant. Meanwhile, trade openness and carbon dioxide emissions have negative effects, while age dependency ratio and fixed capital formation positively affect sustainable development in Nigeria. The paper concludes that trade openness has a significant positive impact on sustainable development in Nigeria. The findings from Fully Modified Least Square (FMOLS) and Autoregressive Distribution Lags (ARDL) techniques suggest that trade openness has a significant positive impact on sustainable development and is the economic pillar of sustainability in Nigeria. These findings imply that it

would be crucial for Nigeria to export goods, especially crude oil and agricultural farm outputs, to expand its revenue capacity, resulting in a more open economy. Nigerian policymakers should strive to improve economic performance through trade openness benefits. The relative advantage hypothesis says that openness to trade from the import side promotes goods with minimal expenditure and reduces tariff rates and non-tariff obstacles. Furthermore, authorities in Nigeria should advocate for some policy framework to reduce tensions in their interactions with other nations, resulting in economic and sustainable development. Finally, the Government of Nigeria should open its doors if they want to pursue sustainability through economic expansion; but doing so may jeopardize the other elements of sustainability and require caution.

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