Infrastructures Development, Environmental Quality And Economic Growth In Nigeria

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Abstract

The earth as a planet supports human life, living and activities that attract extensive and intensive socioeconomic influences on the environment and the economy. Such activities like Infrastructures development exert increasing and divers environmental quality concerns and hence on economic growth. While these variables appear interrelated due to many factors including population growth, urbanization, industrialization etc., however, the nature of the interrelationship is not largely known especially in Nigeria. This study therefore investigated and examine their relationship using time series data between 1990-2019 by adopting Co-Integration estimation technique through the Bound Test approach of Auto Regressive Distributive Lag (ARDL) method, using percentage share of Building and Construction Sector (BCS) of GDP, Carbon dioxide percentage of fuel combustion (CTE), annual growth rate of Agriculture (AFF), population growth, GDP growth rate etc. as variables. The study revealed that infrastructures development, environmental quality explains economic growth and they all have both short and long run relationship while specifically population growth and AFF variables are positively significant to economic growth. The finding evidences the significance of the relationship and consequently recommended new roles for infrastructure sets and production processes that consider environmental quality mindsets to achieve positive green economic growth outcomes in Nigeria.

JEL Classification: Q5, O18, O44

1. Introduction

It is an established scientific fact that the earth is the only planet of the solar system that substantially supports human life and living. The dynamics of human living on earth have also attracted extensive and intensive socioeconomic activities while interacting with the environment- ecosystem. These activities include infrastructures (transport, housing, water and energy supplies) executed in the environment (biosphere, hydrosphere, atmosphere and lithosphere) that infuse externalities on the economy (Maliszewska and Mensbrugghe 2019).

Infrastructures construction activities involve large scale of nature use changes (Cumming and Cramon-Taubadelb, 2018), constitute externalities on other economic sectors (Foster and Anshul,2020) and are associated with the Building and Construction Sector (BCS) sector of the economy. BCS contribution to Gross Domestic Product (GDP) in Nigeria rose slightly from 2.88% to 3.70% between years 2010 and 2016 according to (National Bureau of Statistics (NBS), 2017) with projected potential of contributing over 15% growth by 2020 (Federal Government of Nigeria(FGN) 2017) and significantly enhances fixed capital formation.

Resultantly, Infrastructures development exerts increasing and divers environmental quality externalities concerns where they occur. In Nigeria, Greenhouse Gas (GHG) emissions from renewable energy activities increased air pollution to 65% between 2000 and 2015 (Akinyemi, Alege, Ajayi and Okodua, 2017). Deforestation rate at 11% (1.5m hectares annually) (Mba, 2018) leaves Nigeria with about 330,000

square kilometers of diminishing arable land, decreasing income per capita from agriculture etc., (Chukwueyem et al., 2015;Urhie et al.,2020).

Ideally, infrastructures development underscores economic growth and defines the economy of economies but not without environmental sustainability concern. For example, road infrastructures facilitate efficient movement of goods and services but their construction affect biodiversity; water supply dam development improves agriculture, health and sanitation but make the environment vulnerable to flooding, pollution, deforestation etc. The infrastructures-environment nexus has been adduced to many factors not limited to industrialization, increasing population growth, urbanization etc., (FGN, 2017; Sulaiman and Abdul-Rahim, 2018).

Nevertheless, the nexus creates positive and negative externalities for economic growth in developed and developing economies (World Resources Institute, 2017; Maliszewska and Mensbrugghe 2019) not limited to improved income per capita and output, yet decreasing agricultural output, increasing air pollution, health challenges etc. There is therefore tension between the need for infrastructure development for economic growth and the goal of ensuring environment quality. From Nigerian experience, studies on the infrastructures, environment and growth nexus seldom enjoy mention, though there are few related efforts like GHG emissions and economic growth (Issaoui, Toumi, and Touili, 2015), climate change, water availability and agriculture (Metu, Okeyika and Olisa, 2016), Environmental Impact Assessment for capital spending on infrastructures development for growth by (Babatunde, 2018)etc.

This noticed of infrastructures- environment and growth nexus in literature informed this study especially with respect to providing answers to these questions; Does environmental quality and or infrastructures development explain economic growth in Nigeria? What is the relationship between infrastructures development, environmental quality and economic growth in Nigeria? This study therefore intends to examine the relationship between infrastructures, environment and economic growth in Nigeria.

The essence of this study is on the contribution of infrastructures and environment to growth of economies, specifically that Infrastructures construction exerts positive and negative externalities on the environment and in turn influences on other economic sectors in developed and developing economies like Nigeria.

The rest of this study is organized as follows: literature review, research gap; methodology and the last section provide conclusion and policy recommendations.

2. Literature Review

2.1. Conceptual Review.

Infrastructures, in the views of (Buhr, 2009; Fasoranti, 2016; Regan, 2017 and Losos, Pfaff, Olander, Mason, and Morgan, 2018) are a set of heterogeneous, essential, hard and soft, social and economic assets. They are characteristically intangible, physical but capital intensive public goods of long life cycle

(Flyvbjerg, 2014; Iyortyer, 2017) and factor inputs of overall modern economy, long-term capital appreciation, welfare especially in the developing economies. Putten (2016) and (Chakrabarti, 2018; World Bank, 2019) argued that though infrastructures define economy of economies but recognized possible hindrances and constraint to ambitious infrastructure investment and growth as range of associated environmental and financial concerns, geopolitics, public policy, socio-cultural spatial linkages, etc.

The environment substantially supports human life and living activities that promote growth but is vulnerable to intensive and extensive risks e.g., pollution (air, water, soil and radioactive) (Ohiare, 2015). However, some alternative routes and attempts are being developed to reduce these environmental risks and its economic consequences such as, exploring renewable energy sources, encouraging green housing construction methods and materials, developing electric-powered transport system, improving road networks and traffic etc, according to (Olanipekun 2016; Losos et. al., 2018; Meng and Han, 2018 Li, Deng, Zhang, Olanipekun and Lyu, 2019).

Though economic growth has been severally construed (Adelakun, 2011: Fasoranti, 2016; Edeme, 2018) but central to the views that economic growth is the sustained and greater increase in output (or income) as a derivative of efficiency and amount of inputs factors in an economy over a long time period usually expressed in Gross Domestic Product (GDP). The changes in nominal Gross Domestic Product (GDP) from one year to the next across all economic sectors expressed in percentage reflects economic growth rate and serves as common bases for measuring performance and strength of nation's economy (Fasakin and Jegede, 2018). For example, the Nigerian economy grew at an average of 2.45% GDP between (years 1999-2017), specifically with 5.52% GDP in year 2000, 6.8% GDP in 2005 through 9.54% in 2010 but slowed to 2.79% (in 2013) and contracted by -1.5% in 2016 (NBS, 2016) but recovered with average of 1.95% since 2107/2018 fiscal years (NBS, 2017). Economic growth accounting includes intensity and scale of infrastructures spending but largely exclude production from the informal market and environmental vulnerabilities etc., in Nigeria ((Babatunde, 2018; Teo, et.al., 2019). Hence, growing economy at expense of environmental quality and or huge infrastructural development impairment is abnormal.

According to (Chukwueyem et al., 2015; FGN, 2017; Sulaiman and Abdul-Rahim, 2018; Wang, Li and Fang, 2018), quest for better standards of living and increased population drive increase in human activities such as infrastructure development, natural resources exploration, industrialization, GHG emissions, pollution, climate change and food insecurity etc., with long-run impact on the economy. This is evident in the Nigeria's population growth rate at about 3%, estimated 17million housing deficit, 66.9% land use change effects for urbanization, huge disruption to the ecosystem, social and economic costs that influence market failures (Maliszewska and Mensbrughe, 2019). Figure 1 below compares economic growth proxy by GDP growth rate and CO₂ emission in Nigeria, and underscores the common argument that environment impairment increases with increase in industrialization leading to economic growth, however, reversible with public regulatory policies.

Globally, regulatory policies have favored the concept of green economy across sectors (World Bank, 2019). These policies emphasizes sustainability concepts such as growing the economy yet improving environmental quality by exploring the routes of fight against climate change, environmental taxes, carbon pricing, renewable clean energy sources, innovative energy incentives etc.(Zelenáková, Fijko, Diaconu and Remenáková 2018). In Nigeria, green economy policies such as (Environmental Impact Assessment Act, (EIA) 1992, Sustainable Development Goal, 2015) indulge infrastructures planning stage nexus with the environmental quality and protection on certain class of economic infrastructures projects for which EIA report must be conducted and approved before implementation. Additionally, reducing negative effects of infrastructures development through effective preventive maintenance, motivation and innovation via alternative mode of transportation etc.

2.2. Theoretical review

Earlier thoughts on input- output assumption related to economic growth (Y) have been severally considered and agreed as a production function by the classical (Smith, 1776) centered on rate of population growth or Labour (l) and particularly Land (d) and its resources use (agriculture, minerals etc.) as disruptions that influence growth simply expressed as;

$$Y=f(l, d).....1$$

The neoclassical growth (Solow; 1956) theorists further argued that the use of Land (d), Labour (l) inclusive of Capital (k) (e.g. financial resources) with influence of technological progress (A) will result in a long-run output growth in an economy, simply expressed thus;

$$Y=f(A,l,dk).....2$$

Here A shows productivity level of technical progress (like infrastructures development and machines) that facilitate efficiency of other factor inputs for improved output and hence growth (Babatunde, 2018) assuming constant return to scale, except on capital.

From the foregoing models, it shows that environmental factors are taking for granted and seldom accounted for in growth modelling while knowing that natural resources input factors are high demand but scares in supply processes since they exert environmental risks as negative externalities in the production process (Maliszewska and Mensbrughe, 2019; Wolde, 2015). However, Environmental Kuznets Curve (EKC) is widely believed to explain the economic growth- environmental risk relationship emphasizing that as per capita income rise, pollution and other forms of environmental degradation would rise first and then fall in an inverted-U pattern. Further, critiques have emphasized that environmental risks nexus economic growth negatively (Cumming and Cramon-Taubadelb, 2018) especially in developed economies in modern growth theories. Therefore, environment impairment (e) assumes to increase with fixed capital (K)(infrastructures development) and in turn may increase/decrease economic growth;

$$Y=f(e,K).....3$$

Therefore modern growth modelling assumptions approach to input- output assumption related to economic growth (Y), is appreciably inclusive thus;

$$Y' = f(A(l, d, k, e)) \dots \dots \dots 4$$

2.3 Empirical reviews

Shuaibu and Oyinlola (2013) established no causal link between CO₂ emissions and energy consumption to economic growth due to structural shifts. Using time-series analysis on annual data from 1981 to 2013, and adopting residual-based cointegration test with a structural break, it was found that there is current account sustainability in Nigeria and structural changes were not very potent during the period under consideration. This implies that the Nigerian economy complied with the IBC hypothesis, suggesting that exports could actually finance imports. Sahrir, Bachok and Osman, (2014) studied Environmental and Health Impacts of Airport Infrastructure Upgrading: Kuala Lumpur International Airport and found that significant environmental concerns are noise and air quality. Using field survey, sampling and analyzing noise level and airborne particles of the outdoor and indoor at the Airport construction and adjacent sites thus, recommended increased construction site environmental sensitivity methodology and land use.

Chingoiro & Mbulawa, (2016) examined Economic growth and infrastructure expenditure in Kenya. Using annual data on GDP growth rate, infrastructure spending and labour for the period 1980 to 2013 and employed Granger-Causality approach, it was found that there is bidirectional flow of causality between economic growth and infrastructure, recommending that the government should commit more funds towards developing infrastructure in the short term. Alege, Adediran and Ogundipe, (2016) investigated Pollutant emissions, energy consumption and economic growth in Nigeria to find the direction of causal relationships among emissions, energy consumption and economic growth using annual time series data for the period 1970-2013 and adopting Johansen maximum likelihood cointegration and Granger causality tests. While the result showed existence of cointegrating vector between the variables at long run that is, fossil fuel enhances carbon emissions in the atmospheric, it also show existence of unidirectional causation from fossil fuel to CO₂ emissions and GDP per capita.

Cumming and Cramon-Taubadelb, (2018) studied Linking economic growth pathways and environmental sustainability by understanding development as alternate social-ecological regime by analyzing the red loop- green loop (RL-GL) model that proposes growth defined by Human Development Index (HDI) is explained by social-ecological interactions shift proxied by populations growth, traditional cultural practices, natural resources per capita GDP. using Pearson's correlation and found that environmental and ecological sustainability are increasingly significant in economic growth but with little effect in development practices. In Nigeria, (Mba, 2018) adopted primary and secondary sources in a study on Assessment of Environmental Impact of Deforestation in Enugu, Nigeria, and concluded that major contribution to deforestation in this area is urbanization and industrial development caused by population increase and recommended that government ensure public awareness, monitoring

and enabling laws to deter the trend. Babatunde, (2018) investigated government spending on infrastructure and growth using primary and secondary data from 1980 to 2016 in Nigeria and adopted Weighted least square model and found that government spending on transport and communication, education and health infrastructure has significant effects on economic growth in Nigeria.

Li, et al. (2019) examined the environmental impact assessment of transportation infrastructure life cycle using the three phases of construction, maintenance and repair, and demolition of the fast track transportation project in China, by taking measurement of materials used and the energy consumed as environmental emissions, and found that construction, demolition and maintenance phases have environmental impact in descending order especially in the use of steel material. Sturup and Low (2019) examined Sustainable development and mega infrastructure: an overview of the issues in China and found that a strong relationship between global ecosystem and mega infrastructure development, asserting a balanced sustainability concepts for physical development of infrastructures. Odugbesan and Rjoub (2020) assessed the relationship Among Economic Growth, Energy Consumption, CO2 Emission, and Urbanization: Evidence From MINT (Mexico, Indonesia, Nigeria, and Turkey) countries employing the ARDL Bounds test approach, and the result revealed that the energy–growth hypothesis has unidirectional causality from energy consumption in Nigeria and Indonesia amongst others and show a long-run relationship with economic growth, energy consumption, and CO2 emissions. Urhie et al., (2020) examined economic growth and environmental impacts relationship by adopting moderated mediation model to assess the cyclical effects of these economic relationships of air pollution and health outcomes and found significant interaction between air pollution and government expenditure on health performance hence asserting that environmentally friendly production and consumption pattern minimize environmental hazards and recommended that preventive public policies to adverse health outcomes on manufacturing firms.

Research gap

Some of the studies reviewed establish that infrastructures and or environmental concerns explain growth using different estimation techniques. However, none of the studies reviewed established infrastructures development, environment quality and economic growth nexus particularly as related to Nigeria, indicating paucity of studies in this area.

3. Methodology

3.1. Theoretical Framework and Data Sources

In order to achieve the objectives of this study, the quantitative analysis adopted a production function model with the econometric model specification from the work of (Sulaiman and Abdul-Rahim, 2018) with modifications. The modification involves the derivative decomposition of the exogenous parametric variables as related to economic growth. This study framework is premised on emerging modeling of economic growth as a function of climate change (environmental sustainability) induced by physical development activities. This may correspond GDP growth as an economic measure and increase in

environmental risk like pollution, deforestation GHG emission via deliberate economic activities of infrastructures development, to achieve and influence desired economic and social macro-economic objectives across economic sectors (Issaoui, Toumi, and Touili 2015). The linear function specified for the framework is:

$$GDP = f(h(e)) \dots\dots\dots (5)$$

Where, $e = (K, L)$ as in traditional production function defined as capital and labor respectively, and h depicts the rate of infrastructures development activities.

For this study, economic growth as the endogenous variable is proxy by GDP growth rate (**GDPr**), while population growth rate(**PPMr**), Building and construction sector (**BCS**) share of GDP, Carbon (CO₂) from transport, electricity and heat production(% of total fuel combustion)(**CTE**), and Agriculture, forestry, and fishing, value added (annual % growth)(**AFF**) are the exogenous variables. A standard log-linear transformation functional relationship was employ between endogenous and exogenous variables in order to stabilize the variance of the variables or avoid heteroscedacity. Time series secondary data (**AFF** and)(**CTE**) are obtained from World Bank World Development Indicators while (**GDPr**), (**BCS**) and (**PPMr**) are obtained Central Bank of Nigeria (CBN) Statistical Bulletins and CBN Economic Reports spanning years 1990 – 2019 and are used for the study.

Model Specifications

The endogenous model often specified for testing or explaining the effects of the independent variables on dependent variable are expressed in estimation equation or function. The linear function specified for the estimation in this study is:

$$GDP \text{ growth rate} = f(\text{environment} + \text{Infrastructures} + \text{Land} + \text{Labour}) \dots\dots\dots 6$$

Where, GDP growth rate (**GDPr**), Environment = $f(\text{CTE})$, Infrastructure= $f(\text{BCS})$, Land = $f(\text{AFF})$ and Labour = $f(\text{PPMr})$.

Then, the overall function is mathematically expressed as follows;

$$GDPr = f(\text{CTE} + \text{BCS} + \text{AFF} + \text{PPMr}) \dots\dots\dots 7$$

The set of variables in this study were used because of their conjectural strong influence on economic growth, as qualitatively discussed, with respect to Infrastructure development -Environment quality nexus. The above function (7) is further transformed into an econometric model as follows:

$$GDPr = \beta_0 + \beta_1 \text{CTE} + \beta_2 \text{AFF} + \beta_3 \text{BCS} + \beta_4 \text{PPMr} + u_t \dots\dots\dots 8$$

Where: GDP growth rate(**GDPr**), population growth rate(**PPMr**), Building and construction sector (**BCS**) share of GDP, Carbon dioxide (CO₂) from transport, electricity and heat production(% of total fuel combustion)(**CTE**), and Agriculture, forestry, fishing, value added (annual % growth)(**AFF**); while $\beta_0 =$

Intercept term, β_1 = Coefficient of **CTE**, β_2 = Coefficient of **AFF**, β_3 = Coefficient of **BCS**, β_4 = Coefficient of **PPMr**, and u_t = stochastic or disturbance term. On a priori ground the various theoretical expectations explained above are:

$$\beta_0 > 0, \beta_1 > 0, \beta_2 > 0, \beta_3 > 0, \beta_4 > 0$$

Furthermore, since the model variables are not in the same unit scale, this study specifies its model in a simple log-linear form by taking the partial natural logarithm of some variables in the equation 9. This gives the function below.

$$\text{GDPr} = \beta_0 + \ln \beta_1 \text{CTE}_{t-1} + \beta_2 \text{AFF}_{t-1} + \beta_3 \text{BCSr}_{t-1} + \beta_4 \text{PPMr}_{t-1} + e_t \dots\dots\dots 9$$

Where, $\beta_0 = \ln A_{t-1}$ or the intercept with lag and u_t remain the disturbance error term. Equation (7) is the long-run relationship Infrastructures development -Environment quality and economic growth nexus.

Estimation Technique

Adebiyi (2003) opined that macro time series data requires unit roots and co-integration tests before a structural relationship is estimated. On this bases, estimation process for this study involved unit root test of the series data adopting only the Augmented Dickey Fuller (ADF) technique(at level and difference) to estimate the series stationarity, which was found to be in mixed orders of integration. This is followed by co-integration analysis employing bounds test approach of the ARDL method in order to ascertain the relationships of the series variables in the model in equation 9, which was found to be of long run nature, as first developed in the work of Pesaran et al. (2001). The ARDL method is a type of ordinary least square model, useful and applicable to small samples size with both non-stationarity and stationarity time series at varied integration levels.

It further estimated the short run relationship equilibrium by exploring unrestricted Error Correction Model (ECM) thus;

$$\Delta \text{GDPr} = \beta_0 + \ln \beta_1 \text{CTE}_{t-1} + \beta_2 \text{AFF}_{t-1} + \beta_3 \text{BCSr}_{t-1} + \beta_4 \text{PPMr}_{t-1} + \sum \Delta \text{GDPr} + \sum \Delta \ln \beta_1 \text{CTE}_{t-1} + \sum \Delta \beta_2 \text{AFF}_{t-1} + \sum \Delta \beta_3 \text{BCSr}_{t-1} + \sum \Delta \beta_4 \text{PPMr}_{t-1} + e_t \dots\dots\dots 10$$

Equation (10) is a linear model of appropriate lag level length of one (1) of the variables used to estimate the both short run and long run effects of the variables, particularly with the second part with the summation signs (Σ) and (Δ) representing the estimation of the short run dynamic based on akaike information criterion, resulting in error–correction model. The short-run effects are revealed by the estimates of coefficients attached to first differenced variables. Following, the post estimation diagnostic statistics tests of the Infrastructures development -Environment quality and economic growth nexus such as multicollinearity, serial correlation, heteroscedacity and cumulative sum of squares of recursive residuals for model variables were carried out to ascertain the reliability of the parameter estimates.

4. Results And Discussions

The results in Table 4A below show the mean growth values of the variables and indicates that AFF (6.094) has the highest growth rate while PPGR has the least values of growth.

Table 1: *Descriptive statistics of the variables*

	GDPR	LNCTE	AFF	BCSR	PPGR
Mean	4.548	4.361	6.094	3.190	2.583
Median	4.823	4.358	4.022	1.850	2.582
Maximum	15.329	4.483	55.578	15.700	2.786
Std. Dev.	3.985	0.047	9.496	3.904	0.079
Observations	30	30	30	30	30

Source: Authors' computations, 2021

The highest degree of standard deviations is associated with AFF (9.496) while PPR (0.079) has the lowest amongst others variables. These indicate that the probability of obtaining positive outcome is high.

In table 2 below, only Augmented Dickey Fuller (ADF) technique was employed for the unit root test on the series data to examine their stationarity or otherwise at different orders of integration and critical value at 5% level of significant adopting model (9) in order to avoid the properties of stochastic error terms and spurious results in the model. The result is as show on table (2) below.

Table 2. Augmented Dickey-Fuller (A.D.F.) Level 1990–2019.

Variable	Level		First difference		Remark
	t-statistic	P-Value	t-statistic	P-Value	
GDPr	-2.96777	0.0168	-2.9719	0.0000	I(0)
logCTE	-2.9678	0.0712	-2.9719	0.0000	I(1)
AFF	-2.9678	0.0003	-2.9719	0.0000	I(0)
BCSr	-2.9678	0.0138	-2.9719	0.0000	I(0)
PPGr	-2.9678	0.9405	-2.9719	0.0000	I(1)

Source: Authors' computations, 2021,

The condition for stationarity is that the absolute value of the ADF statistic must be greater than that of critical value of corresponding variable and P-value is less than 5%. From table 2, the result of the series

variables at level shows that both **logCTE** and PPGR are not stationary indicating existence of unit roots. However, at first difference, all the variables were stationary. In all, there is a mix of orders of integration at I(0) and I(1) amongst the series variables underscoring the necessary condition for estimation using ARDL model technique.

Co-integration test

Table (3) presents the result of ARDL Bounds test for co-integration.

Table 3. ARDL Bounds Test

F-statistic	Critical Value Bounds		Significance	K
	UPPER I(1)	LOWER I(0)		
6.821	2.86	4.01	5%	4
	3.74	5.06	1%	

Source: Authors' computations, 2021

From table 3 above, the F-statistic is compared with the critical value at only 5% significance level, and shows that the calculated F-statistic value is 6.821 is far above the upper (4.01) or (5.06) and lower (2.86) or (3.74) bounds of the critical values, indicating that cointegration exists. It indicates that all the independent variables in the long run estimate (PPGR, LNCTE, BCSR and AFF) have positive relationship with GDPR, which are greater than 0 and hence consistent with the a-prior expectation of the study. Therefore, the null hypothesis of no cointegration is rejected at 1% and 5% significance levels and hence there is a long-run relationship among the variables in the model. This finding infers that economic growth is very responsive to changes in these exogenous variables specifically infrastructures development- environment quality nexus and sustainable in the long run and and underscores the study by Odugbesan and Rjoub (2020).

With the established result of co-integration above, short run model was estimated using unrestricted Error Correction Model (ECM) as specified in equation 10. The short run form regression technique in determining the coefficient of the error correction model (ECM) as shown on table 4 below.

Table 4 : ARDL Cointegrating And Long Run Form Dependent Variable: GDPR

Short Run Relationship

Cointegrating Form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PPGR)	12.795192	5.299042	2.414624	0.0245
D(LNCTE)	25.310400	13.392057	1.889956	0.0720
D(BCSR)	0.112160	0.134798	0.832057	0.4143
D(AFF)	0.180973	0.045701	3.959897	0.0007
CointEq(-1)	-0.891789	0.128586	-6.935372	0.0000

$$\text{Cointeq} = \text{GDPR} - (14.3478 \cdot \text{PPGR} + 48.3353 \cdot \text{LNCTE} + 0.1258 \cdot \text{BCSR} + 0.2029 \cdot \text{AFF} - 245.4065)$$

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PPGR	14.347777	5.713475	2.511217	0.0199
LNCTE	48.335275	11.701804	4.130583	0.0004
BCSR	0.125769	0.142850	0.880431	0.3881
AFF	0.202932	0.060268	3.367148	0.0028
C	-245.4065	54.970419	-4.464338	0.0002

$$R^2 = 0.760075, \text{Pro(Stat)} = 0.000007, \text{F-Test} = 11.6158, \text{Durbin-Watson Stat} = 1.9738$$

Source: Authors' computations, 2021,

The result of the ECM in Table 3 above showed that the overall estimated values of the model are good with R^2 0.7600 or 76% variation in GDPR (dependent variable) is explained by PPGR, LNCTE, BCSR and AFF (independent variables) while the remaining 34% would be explain by other variables not included in the model. The Durbin-Watson value (1.97) means that implies no autocorrelation in the model, while the Pro(Stat) value (0.000007) indicates the that the overall model is statistically significant at 5% level of significance. The Durbin-Watson value (1.97) means that implies no autocorrelation in the model, while the Pro (Stat) value (0.000007) indicates the overall model is statistically significant at 5% level of significance.

Furthermore, all the independent variables in the long run estimate (PPGR, LNCTE, BCSR and AFF) have positive relationship with GDPR indicated by their coefficients as in equation 11, which are greater than 0 and hence consistent with the a-prior expectation of the study. This result underscores the study by Odugbesan and Rjoub (2020).

$$\text{GDPr} = -245.40 + 48.34\text{CTE}_{t-1} + 0.203\text{AFF}_{t-1} + 0.125\text{BCSr}_{t-1} + 14.34\text{PPMr}_{t-1} \dots \dots \dots 11$$

In the short run however, the result showed that coefficient of D(PPGR) (12.795) and D(AFF) (0.1809) with prob stat (0.0245) and (0.0007) respectively are significant at 5% and positively correlated. There positive signs agree with (Sulaiman and Abdul-Rahim, 2018; Wang, Li and Fang, 2018), that increased population growth drives human activities such as infrastructure development, agriculture etc., leading to output and better standards of living. The CointEq(-1) value (-0.892) which measures the speed of adjustment flow is both negative and significant indicating that 89% of the errors are corrected and in approximately 26years for the economy to attain equilibrium. This supports the emphasized long

environmental risks effects on economic growth especially in developed economies and as in the postulation modern growth theories (Cumming and Cramon-Taubadelb, 2018).

Post Estimation Diagnostic Tests

The post estimation diagnostic tests such as multicollinearity, serial correlation, heteroscedasticity and cumulative sum of squares of recursive residuals for model variables were carried out thus.

Multicollinearity.

Table 4A below shows a test of multicollinearity amongst the variables in the model in whether the explanatory variables are highly interrelated. Where any value of the variables has Centered Variance Inflation Factors (VIF) greater or equal to 10, then there is multicollinearity, where it is less, then there no multicollinearity. From the table above, it show that none has value greater than 10, indicating that there is no multicollinearity variables.

Table 4B: Multicollinearity test

	Coefficient	Uncentered	Centered
Variable	Variance	VIF	VIF
C	3555.071	11841.91	NA
PPGR	51.73764	1151.239	1.055990
LNCTE	154.1180	9768.407	1.140710
AFF	0.004193	1.736645	1.217760
BCSR	0.022506	1.868157	1.104969

Source: Authors' computations, 2021

Serial Correlation Test

Table 4C: Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.881531	Prob. F(2,20)	0.4296
Obs*R-squared	2.349339	Prob. Chi-Square(2)	0.3089

Source: Authors' computations, 2021

In Table 4C, Breusch-Godfrey Serial Correlation LM Test model was used for serial correlation test. The Prob. Chi-Square value of (0.3089) obtained, which is not significant at @5%, shows that there is problem of serial correlation in the model and hence cannot reject the null-hypothesis of no auto correlation.

Heterscedacity

Table 5C: Breusch-Pagan-Godfrey Heteroskedasticity ARCH Test:

F-statistic	2.092131	Prob. F(4,25)	0.1119
Obs*R-squared	7.523730	Prob. Chi-Square(4)	0.1107
Scaled explained SS	13.16497	Prob. Chi-Square(4)	0.0105

Source: Authors' computations, 2021

Using the Breusch-Geofred Lagrange multiplier (LM) test, as shown in table 5C, shows that the Probability chi-Squared value of 0.0105 (1%), which is significant at @5% shows there is no problem of Heteroscedasticity or is ARCH effect in the model, hence rejecting the null-hypothesis.

5. Conclusion And Policy Recommendations

This study employed an ARDL approach to cointegration in a recursive form to examine the relationship between infrastructures development, environmental quality and economic growth in Nigeria using variables including GDP growth rate, population growth rate, Building and construction sector, Carbon (CO₂) from transport, electricity and heat production, and Agriculture, forestry, and fishing, value added. The behavior of the variables explained their significance in the long-run and short-run on the economic growth while the diagnostic tests conducted for the models revealed the good fit and satisfactory classical linear regression requirements. From the study it is concluded that a well-planned infrastructure dismisses negative influences on the environment that is crucial for economic growth and development. Yet, in attendance is a dark side to infrastructural investments that often lead to environmental concerns like degradation, fossil fuel generation and emissions, global warming etc. that impair green economic growth across economies.

However, in consideration of the results and conclusion from this study, it is recommended that;

- i. The diversity and intensity of infrastructures development, environmental quality and growth nexus across economies will require new roles for infrastructure sets and production processes that will consider environmental quality mindsets to achieve positive green growth economy outcomes in Nigeria.
- ii. In addition, government should pursue policies and programmes in infrastructures like renewable energy projects that will be eco-friendly yet enhancing economic activities and growth in Nigeria.
- iii. Promotion of efficiency in the design, development and use of infrastructure services, will reduce the need for new construction thereby ensuring saving revenue and environmental disruptions.

Declarations

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Figures

Figure 1

Comparing GDP growth rate and Carbon Emission (tons/thousand) in Nigeria Source: World Bank World Development Indicators and Author's Computation,2020

Figure 2

Cumulative Sum of Squares CUSUM of Recursive Residuals the CUSUM test and the CUSUM of Squares plots showing that the cumulative sum blue lines lies within/between the 5% critical lines(straight bounded upper and lower red), suggesting that the coefficients of the parameters in the error correction model at short-run and the long-run estimates are not only stable over the period of the study but also do not suffer from any structural instability.