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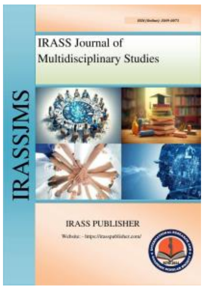

Natural Resource Depletion and Economic Growth in Nigeria

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Abstract: This study empirically investigated the relationship between resource depletion and economic growth in Nigeria. The specific objectives of the paper were to evaluate the impact of resource drivers on natural resource depletion as well as the impact of resource depletion and environmental pollution on economic growth. The study employed time series data from 1990 to 2022 on real gross domestic product (RGDP), population growth (POP), total natural resource depletion (R_DEP) and energy depletion (E_DEP) - proxied as the percentage of gross national income – while CO_2 emission and human capital index (HDI) served to proxy environmental pollution and human capital development, respectively. Moreover, the paper utilised the ARDL and the Johansen Cointegration approach in the estimation of the specified models. The findings of the study show that economic activities and population growth significantly devalue natural resources in the short run, while human capital index has a countervailing influence on natural resource depletion. In addition, the findings revealed evidence of the existence of long-run relationship between energy depletion, CO_2 emission, HDI and economic growth, as well as uni-direction causality from energy depletion to human capital development. The paper therefore recommended the strategic development of human resource capital as it is a vital ingredient for evolving alternatives to resource dependence.

Keywords: Resource depletion, Resource abundance, Resource dependence, ARDL

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1. Introduction

Natural resource-dependent countries are increasingly being confronted with the prospects of resource depletion after many decades of exploitation of naturally endowed resources to grow their economy. Although, there are no landmark cases of exhaustion of a mineral resource at a global scale for now, the point is clear that supplies of some natural resources (example: mineral resources) have a finite life-span, hence, the prospect of depletion should be a source of concern for a country whose economy is substantially dependent on foreign exchange earnings from natural resources.

One might expect that with the transformative effect of human capital over the years on technology and innovation which has led to the development of new industries and high-prized utility goods and services; and the remarkable impact it has had on balance of payment of some resource-poor nations, the level of dependence on natural resources for economic growth by some developing nations should have reduced and the drivers of resource depletion sustainably curtailed. However, the record suggests otherwise. For instance, in the late 1940s, resource rich Nigeria was one of the earliest countries in sub-Saharan Africa to discover crude oil in commercial quantity. In addition to this, the country has vast deposits of arable land, minerals, timber (forests), cotton, as well as the largest population in the region, but continues to depend more on the export of crude oil and natural gas for growing her economy.

Empirical literature on the proximate drivers of resource depletion suggests that they are centered on human activities. One of such drivers is the pursuit of the macroeconomic objective of economic growth, which is based on quantitative increases in the production of goods and services. Why this objective is germane, there seems to be an unnecessary connection between rising consumption of national resources and GDP. An instance of this is the contribution of petroleum and natural gas to economic growth in Nigeria. Figures from the National Bureau of Statistics on the ratio of gross domestic product to the contribution of petroleum and natural gas suggest an upward trajectory from 11.37% in 2017 to 17.97 in 2023 (NBS, 2023). Moreover, this correlation is also reflected in the steady rise of the annual sum of primary energy resources like fuel, firewood and cooking gas consumed vis a vis the growth of the economy. In essence, such a correlation suggests that so long as the goal of economic growth in the lens of capitalism, that is, the system that emphasizes the accumulation of capital through engagement in production activities, encourages countries to strive to attain successive increases in national output per time, resource depletion and overuse would remain a burning issue of discourse globally.

Population growth in a country such as Nigeria could give significant impetus to economic activities. Therefore, it is also a potent driver of resource depletion. In the case of Nigeria, its expanding youthful population puts additional pressure on the environment and its resources, causing degradation of land resources and soil quality as well as depletion of forest resources used as firewood and for lumbering activities. Moreover, where a country is assumed to have few alternatives to land for eking a living, a rapidly increasing population may cause depletion of soil quality, overuse of finite water resources and overgrazing of farm lands.

Continuing, resource depletion can also be attributable to such drivers as the presence of structural inequalities, institutional failure and poverty. The paper argues that when there is the presence of structural inequalities and poverty in a system, it is suggestive of the fact that opportunities for making a living are not evenly within the reach of people in that system. However, the relationship between these drivers and resource depletion may not be straight-forward but rather complex. For instance, why the poor may mount pressure on land resources (example: in agriculture) which could result to overuse, it is the wealthy class and the industrial sector that have the capacity to degrade the environment and deplete its resources through their consumption and production activities. That is, where there is sinstitutional failure, abuse of power, wealth and greed in the context of extractive industries, it may lead to environmental degradation, resource overuse and depletion (Shah. 2003).

On the reverse side, it is argued that investment in human capital and the promotion of research and development efforts could lead to the emergence of cost-effective alternative sources of energy that could help reduce the dependence of production systems and many human activities on some natural sources and curtail the rate of their depletion. Instances of this include the innovative use of wind energy in farms and solar energy to light up streets, homes and reduce the energy costs of small and medium scale industries. Also, where people are well educated and healthy, policies that promote sustainable environment practices may be better appreciated, and this could lead to the reduction in the rate of exhaustion of finite natural resources.

This paper focuses on the impact of resource depletion, human capital and environmental pollution on economic growth in Nigeria. The interest in Nigeria is due to the fact that it is not just rich in natural resources but is the most populous country in Africa. The interest is buoyed by the point that even though it is unarguably true that exploitation of fossil fuel deposits for foreign exchange has been going on for more than five (5) decades leading to significant earnings-and substantial amounts of mineral resources depleted in the process - the country seemed not to have escaped the resource curse neither is it focused on efforts to mitigate resource exhaustion which thus raises two pertinent questions: First, what is the magnitude and direction of impact of drivers of resource depletion in Nigeria?. Second, is the country on a sustainable growth path?

This study departs from other studies as its purpose is in two folds; first, is to test the impact of resources depletion drivers on the rate of natural resource depletion in Nigeria. This is done by taking into cognizance the effects of growth in national output and population as well as human capital index on total natural resource depletion. The second specific objective is to estimate the impact of energy depletion, human capital development and environmental pollution on economic growth in Nigeria and the direction of causality.

The rest of the paper is laid out as follows. Section 2 is an exposition on previous scholarly literature on the subject-matter and in Section 3, the methodology of the study is discussed. Section 4 is result and discussion of findings, while Section 5 is the discussion of the findings of the study. Section 6 provides an explanation of the conclusion and policy recommendations.

2. Literature Review

Theoretical Framework

Theory of Resource Depletion

The theory of resource depletion points to the possible mismatch that exist between resource expropriation and replenishment. The theory notes that the current rate of use of finite non-renewable resources is not sustainable, and this may have repercussions on the economic growth of nations heavily dependent of natural resources for foreign exchange, if nothing is immediate done. The theory basically points to the economic problems that resource shortages would create in the operations of the market system.

The warning on the dangers of resource depletion have been carefully echoed in Meadows, et al (1972) book, the "Limits to Growth", were they argued that the steady pursuit of prosperity by countries may have repercussions on the environment and economy in the long run. The study basically argued that heightened focus on continuous output growth in the face of finite natural resources could lead to shortages of raw materials, minerals, forests and fresh water, if sustainable alternatives are not promoted.

Previous Studies

Resource depletion and economic growth is one area of study that have generated a lot of interest among scholars from across the globe. For instance, Xu and Zhao (2023) studied the impact of energy depletion and human capital index on natural resource in China from 1971 to 2019. The paper also explored the influence of economic growth and environmental pollution (CO_2 emissions). The study utilised the Phillips-Ouliaris test, The estimation is done using the GEE population average model and the generalized linear model. The findings revealed depletion of natural resources is perpetuated by overexploitation and overuse of natural resources as well as unsustainable management practices and waster. Also, the findings show that environmental pollution (CO_2 emissions) and economic growth devalue natural resources. However, the human capital index and energy depletion increases the value of natural resources.

Ali et al. (2021) looked into the relationship between environmental degradation and the use of renewable energy and resource depletion. The panel least squares approach was employed in the analysis, and the study chose a panel data structure. The results demonstrate that while there is a considerable correlation between environmental deterioration and the depletion of natural resources in industrialized economies, there is a negligible correlation in developing nations. Furthermore, the study discovered a strong correlation between environmental deterioration in developing economies and the energy usage of fossil fuels. The study also showed that economic growth was a catalyst for environmental degradation in both rich and developing economies. The authors suggested the need for a threshold between the goal of economic growth and environmental pollution, so as to safeguard the environment of r future generations.

Haider (2023) simulated on the nexus between ecological resources depletion, inequality and poverty in Bangladesh. The study adopted the assumption of uniform distribution of loss. The study utilised the Gini inequality index, Foster, Greer and Thorbecke (FGT) poverty index and the ecological adjusted poverty (EAP) methods in the data analysis. The findings show the rise in inequality when effective income is considered and this has the potential of leading to ecologically adjusted income distributions.

Hussain et al. (2021) investigated how Thailand's ecological footprint was impacted by economic expansion, natural resources, and globalization. Annual time series data from 1970 to 2018 were used in the study. Additionally, the non-linear autoregressive distributed lag (ARDL) method served as the foundation for estimate. The study's conclusions demonstrated the substantial and non-linear impacts of natural resources and globalization on Thailand's ecological footprint. On the ecological footprint, however, the negative shocks from natural resources and globalization outweighed the positive shocks from both factors. As a result, the report recommended that regulations be developed to guarantee the efficient use of natural resources and assist the nation in adapting to environmental shocks brought on by globalization.

Through the lens of sustainable development, Xiaoman et al. (2021) examined the relationship between the quantity of natural resources, economic globalization, and carbon emissions. Data from nations in the Middle East and North Africa (MENA) were used in the panel study. The study's time frame was 1980–2018. The work estimated the functional model using completely modified and bias-corrected panel data cointegration approaches. The conclusion implies that the quantity of natural resources greatly enhances the quality of the environment. Similarly, the MENA countries' emissions are reduced by economic globalization. However, the results showed that trade openness, urbanization, and economic expansion all devalue environmental quality. Oyetunji (2019) investigated how Nigeria's forest resources affected the country's economic development. The research was based on data collected from 1990 to 2015. The author employed vector error correction mechanism in the data analysis. The findings show that the contribution to economic growth of forest resources is positive but insignificant. The study therefore concluded that there is the need reduce the pressure on forest resources and encourage its sustainable development.

The impact of natural resources on Brunei Darussalam's economic growth between 1989 and 2022 was examined by Tahir et al. (2021). The analysis was based on the autoregressive distributed lag (ARDL) technique. The results demonstrate that both in the short and long term, natural resources have a favorable and noteworthy impact on the nation's economic development. However, according to Ibrahim's (2017) article on natural resources and sustainable development, the presence of natural resources both increases the rate of resource depletion and positively influences the increase in aggregate output. This would suggest that a nation may not be wise to rely too heavily on its natural resources.

Amjad, et al (2021) demonstrated in a comparative analysis, the relationship of natural resources depletion, renewable energy consumption and environmental degradation in developed and developing countries of the world. The study's time frame was 1990–2014. The study's full sample analysis, which included both established and emerging nations, revealed a negligible correlation between environmental degradation and the depletion of natural resources. Additionally, the developed sample showed the same results, however the emerging economy sample revealed a substantial correlation between environmental deterioration and the depletion of natural resources.

Aquilas (2021) tested the environmental Kuznets hypothesis in the context of natural resource depletion for countries in the sub-Saharan African region. The analysis discovered that there was no inverted U-shaped correlation between natural resource depletion and rents. However, the results showed that the two variables had a monotonically growing connection. As a result, the study came to the conclusion that using natural resources excessively was bad for the ecosystem.

Musibau et al. (2020) looked into the connection between Nigeria's economic growth, energy consumption, and environmental deterioration. The study examined the environmental Kuznets curve's (EKC) applicability in Nigeria, and it covered the years 1981–2014. The analysis was conducted using the ARDL approach. The research's conclusions demonstrated the applicability of the EKC hypothesis in Nigeria. The findings show that economic growth reduces environmental quality in the short run, but raises it after some time.Ogunwusi and Ibrahim (2019) studied the effect of industrial development on natural resource depletion in Nigeria. The authors utilised a descriptive analytical approach to highlight the fact that soil fertility and nutrient content depleting due to soil salinity, desert encroachment, oil spillage, overpopulation and the absence of proper land use management practices. The study further observed that industrial development causes ground-water depletion, and deforestation in the country.

Zallé (2019) investigated the impact of human capital and institutional quality. on the association between natural resources and economic growth in Africa. The study was based on data from 29 countries in the continent and spanned from 2000 to 2015. The autoregressive distributed lag (ARDL) method was used in the analysis. The findings suggest that there is the need for countries in the continent to upscale their investments in human capital and in the fight against corruption to upturn the resource curse to economic prosperity.

Moslehpour, et al (2023) investigated the moderating role of the government in the relationship between natural resources depletion, socio-cultural degradation and the reduction of environmental pollution in Indonesia. The study found out that government support and policy intervention is a moderating factor that engenders tourism growth and development as well as the depletion of natural resources in the country.

Koirala and Pradhan (2019) evaluated the factors influencing sustainable development in twelve (12) Asian economies. The study covered the years 1990–2014. The study estimated the designated model using the random and fixed effects panel data approach. The results show that financial development and per capita income have a favorable and substantial impact on sustainable development. Additionally, the results showed that time, natural resource rent, and inflation rate all had a negative and significant impact on sustainable development. According to the study's findings, sustainable development depends on the appropriate balance of natural resource utilization.

Byaro et al. (2022) investigated the connection between environmental deterioration, renewable energy use, and the depletion of natural resources in sub-Saharan African nations between 2000 and 2020. The analysis in the study was conducted using the generalized quintile regression approach. The results showed that environmental deterioration in the sub-region is positively correlated with the 90th quintile of natural resource depletion. The study also demonstrated that environmental deterioration in the sub-region was adversely impacted by the depletion of natural resources at the bottom quintile (10th, 30th). Since poverty is one of the factors contributing to the depletion of natural resources in sub-Saharan Africa, the study promoted its alleviation.

Oyeranti and Obijole (2023) utilised the ARDL approach in the analysis of the association between natural resource capital and sustainable development in Nigeria. The study spanned from 1990 to 2020. The findings of the study indicated that natural resource capital positively influenced sustainable development, even though its impact was insignificant. The study concluded that the country must look beyond depleting its natural resources to sustainable means to developing the economy. Yu, et al (2023) examined the impact of natural resources and non-renewable energy on economic recovery in selected developing countries. The investigation was conducted between 1975 and 2018. The Fourier panel data approach served as the foundation for the estimation. Long-term economic recovery in Germany, Denmark, and France was aided by sustainable energy, but in eight (8) of the ten (10) nations in the panel study, economic recovery was reliant on the development of natural resources. Although non-renewable energy is the foundation of Italy's economy, the study also found that the preservation theory applies to Germany's power parameters and China's sustainable power. The study concluded that natural resource development policies should prioritize the reduction of urban oddities and encourage the preservation of ecological integrity.

3. Methodology

The broad objective of the study is to estimate the interaction of resource depletion and economic growth in Nigeria. Consequently, the research employed annual time series sequences from 1990 to 2022. Accordingly, historical sequences on the resource depletion(RD-proxied bynatural resource depletion), energy depletion (ED), population growth (POP), human development index (HDI-proxy for human capital), real gross domestic product (RGDP) and *Co2_Emissions* (proxy for environmental pollution) were obtained from the World Bank Development Indicators (2023). Moreover, preliminary investigation of the stationarity properties of the variables were conducted with the help of the Augmented Dickey- Fuller (ADF) test and the Philip-Perron tests for stationarity.

Model Specification

The study is anchored on the famous concept of resource depletability which suggests that the adjustment speed of a natural resource is slow because it is made available by nature only once, but, Every time a resource is utilized, its stock gradually declines, and the rate of stock decline is a monotonically rising function of the rate of resource usage. Accordingly, the remaining resource supply would fall more quickly the more the decreasing resource was consumed (Sweeney, 1992). Accordingly, following Koirala and Pradhan(2019), the study adopts the Cobb-Douglas framework in the estimation of the interaction between resource depletion and economic growth in Nigeria.The functional form of the resource depletion model is specified as:

IRDEP = f (rgdp, pop, hdi, Co2_Emissions) 3.1

Where:

IRDEP = Log of resource depletion (proxied by natural resource depletion)

rgdp = economic growth as measured by the real gross domestic product)

pop = Population growth rate

HDI = A stand-in for the development of human capital is the human development index

Co2_Emissions = Carbon-dioxide emission (proxy for pollution)

The theoretical expectations for the coefficients of equation 3.1 are $\propto_1 < 0; \propto_2 < 0; \propto_3 > 0; \propto_4 < 0$.

To determine which econometric method is best for estimating the economic growth function and the resource depletion function, the Augmented Dickey Fuller (ADF) and Philip Pherron (PP) unit root tests was used to determine the order of integration of the variables in the two models. The results shown a mixed order of integration for the resource depletion (See: Table 4.3). Accordingly, since the Autoregressive Distributed Lag approach (ARDL) permits estimation of variables with mixed order of integration, it was employed in the econometric analysis of the resource depletion model; while the Johansen-Julius cointegration approach was used in the economic model.

The ARDL(p,q) has the following general specifications:

$$\Delta y_t = a_0 + \sum_{i=1}^{p} a_{1i}\Delta\gamma_{t-1} + \sum_{j=1}^{q}\gamma_j X_{t-j} + \varepsilon_t \quad 3.3$$

Where yt is the dependent variable and p and q are the number of lags for the dependent and explanatory variables, respectively. The dynamic explanatory variables are represented by the vector Xt, and the error term εt should have a normal distribution with zero mean and constant variance $\varepsilon t \sim (0, \sigma 2)$.

The following is the bound test equation to determine whether yt and Xt have a long-term relationship (cointegration):

$$\Delta y_t = \beta_0 + \sum_{i=1}^{p}\beta_{1i}\Delta\gamma_{t-1} + \sum_{j=1}^{q}\varphi_{1i}\Delta X_{t-j} + \omega_0\gamma_{t-1} + \omega_1 X_{t-1} + \vartheta_t \quad . 3.4$$

Where the parameters of the long-term relationship are ω_0 and ω_1, while the parameters of the short-term relationship are $\beta 1$ and φ_1. Therefore, if the null hypothesis, H0: ω_0 = ω_1 = 0, is rejected versus the alternative, H1: ω_0 ≠ ω_1 ≠ 0, then cointegration between yt and Xt exists.

In addition, the existence of cointegration relationship in the models, also necessitates an evaluation of the error correction model (ECM). The equation of the ECM is specified as follows:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{p}\beta_{1i}\Delta\gamma_{t-1} + \sum_{j=1}^{q}\varphi_{1i}\Delta X_{t-j} + \emptyset_0 ECM_{t-1} + \vartheta_t \quad 3.5$$

Actually, the lagged value of the error term is used to determine the term of the ECMt-1. (μ_{t-1}) of the following long-run relationships:

$$y_t = a_0 + \sum_{j=1}^{q}\gamma_j X_t + \mu_t \quad . 3.6$$

$$ECM_{t-1} = \mu_{t-1} = y_{t-1} - \sum_{j=1}^{q}\gamma_j X_{t-1} \quad 3.7$$

and the ECMt-1 error correcting model's parameter ∅_0< 0 is that gauges how quickly any short-term shocks are adjusted back towards the long-term.

Furthermore, the study also evaluated the response of natural resource depletion on economic growth. The functional form of the economic growth model is depicted in equation 3.8 as:

RGDP = f (ed, pop, hdi,Co2_Emissions) 3.8

Where:

rgdp = real gross domestic product (proxy for economic growth)

ed = energy depletion

pop = Population growth rate

HDI = A stand-in for the development of human capital is the human development index.

Co2_Emissions = Carbon-dioxide emission (proxy for pollution)

It is expected that the coefficients will have the following signs: $\propto_1 < 0, \propto_1 > 0; \propto_2 > 0, \propto_3 > 0, \propto_4 > 0$

4. Data Analysis

a. Empirical results of the ARDL Resource Deletion model

Unit Root Test

The Augmented Dickey Fuller (ADF) and the Phillip-Pherron (PP) unit root tests were employed to assess the stationarity properties of variables in the model. The outcome of the ADF and PP tests is presented as Table 4.4. The output of the stationarity test show that there is a mixed order of integration. Moreover, no variable becomes stationary at second difference.The identification of a mixed order of integration is a pre-requisite for evaluating evidence of cointegration in the model variables.

Table 4.1: ADF and PP Unit Root Test

TEST	*IRDEP*	*RGDP*	*POP*	*HDI*	Co_2*_emission*
ADF_I^*	-3.568379	-2.960411	-2.951125	-2.960411	-2.957110
	(0.0026)*	(0.7675)	(0.0991)	(0.7300)	(0.0672)
ΔADF_I^*	-3.612199	-2.960411	-2.951125	-2.960411	-2.960411
	(0.6609)	(0.0575)**	(0.0000)*	(0.0098)**	(0.0000)*
PP_I^*	-2.960411	-2.957110	-2.954021	-2.957110	-2.957110
	(0.1232)	(0.8481)	(0.0814)	(0.7556)	(0.0672)
ΔPP_I^*	-2.963972	-2.960411	-2.960411	-2.960411	-2.960411
	(0.0001)*	(0.0061)*	(0.0003)*	(0.0106)*	(0.0000)*

Note: *&** indicates significance levels (i.e. 1% and 5% level, respectively).

Source: Researchers' Computation (2024)

Table 4.2: ARDL Bound Test Output

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.658157	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Author's Computation, 2024.

Therefore, the existence of cointegration between the dependent and explanatory variables in the model was ascertained using the ARDL bound test approach. The outcome is highlighted in Table 4.4. The result shows that the F. statistic value (9.658157) is higher than the lower and upper bound values at all the significant levels, which therefore suggest that there is a long run cointegration relationship between resource depletion and the dynamic regressors in the specified model.

Long-Run Estimates of the ARDL Resource Depletion Model

The signs and magnitude of the long run coefficients of the parameters in the resource depletion model are as shown in Table 4.3. The individual signs of the parameters are in line with a priori expectations, except for RGDP. The table suggest that population growth exerts a significantly negative influence on resource depletion. The finding highlights the fact this parameter could exert considerable pressure on the land, forest and mineral resources in the country. The result shows the implication of growth in population on natural resources. Precisely, a 1% rise in population growth may lead to depletion of natural resources. Interestingly, the sign of the coefficient of HDI (proxy for human capital development) indicates the contravening influence of human capital in consonance with a priori expectations.

Table 4.3: Long-run Output of the ARDL Model

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
LOG(RGDP)	11.84417	6.457999	1.834030	0.0916
POPULATION(-1)	-0.0000000827	4.23E-08	-1.954565	0.0743
LOG(HDI)	23.47343	10.56945	2.220875	0.0464*
C	-178.6297	92.18063	-1.937822	0.0765

Source: Author's Computation, 2024. * 5% significance respectively.

The ECM and short run estimates of the ARDL model are shown in Table 4.6. The findings show that the parameters are statistically significant at various lags. The ECM is correctly signed and its value (-0.508860) indicates that about 51% of shock run shock will be corrected annually. Interestingly, the table shows the effect of productive activities (RGDP) on resource depletion in the short run and suggests that a 1% increase in economic activities could cause the depletion of natural resources by as much as 10.3% in the first lag and 5.13% in the second lag, respectively. The highlight also shows the mixed influence of population growth on resource depletion, as the sign of the first lag is counteracted by the sign of the second lag. Again, the influence of human capital development (proxied by HDI) on resource sustainability is observed as an increase in human capital development mitigates the effect of other drivers of resource depletion. Moreover, the results show that CO2 emission is negatively related to natural resource depletion in Nigeria. This finding suggests that a 1% Co_2 emission causes about 0.349289% depletion of natural resources. The explanatory power of the model is high and the F. statistic value attest to the overall significance of the estimated model.

Table 4.4: ECM and Short Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(RGDP(-1))	-10.38540	1.804497	-5.755286	0.0001
DLOG(RGDP(-2))	-5.138913	1.417028	-3.626543	0.0035
D(POPULATION(-1))	4.51E-06	1.09E-06	4.126744	0.0014
D(POPULATION(-2))	-6.19E-06	1.13E-06	-5.499415	0.0001
DLOG(HDI)	8.346814	1.592800	5.240341	0.0002
CO2_EMISIONS	-0.349289	0.120625	-2.895667	0.0071
CointEq(-1)*	-0.508860	0.042555	-11.95769	0.0000
R-squared	0.925292	Mean dependent var		-0.069648
Adjusted R-squared	0.873930	S.D. dependent var		0.444387
S.E. of regression	0.157786	Akaike info criterion		-0.557629
Sum squared resid	0.398342	Schwarz criterion		0.013316
Log likelihood	19.80680	Hannan-Quinn criter.		-0.383085
Durbin-Watson stat	2.442784			

Source: Author's Computation, 2024.

Post-Diagnostic Tests

Additionally, post-estimation tests were performed on the output of the designated model. Table 4.5 below displays the outcome. The results of the Jarque Bera test for normalcy, the Breusch-Pagan-Godfrey heteroscedasticity test, and the Breusch Godfrey (BG) Serial correlation LM test are highlighted in the table. Given that the p-values for the BG and BPG tests are higher than the chosen 5% level of significance in the F test and Obs.*R-Square statistic, the results imply that the tests cannot be rejected given the null hypothesis of no serial correlation in the residuals and no heteroscedacity.

Table 4.5: Post Estimation Diagnostic Tests Output

Breusch-Godfrey (LM) Test for Serial Correlation			
F-statistic	2.938925	Prob. F(2,10)	0.0991
Obs*R-squared	0.263516	Prob. Chi-Square(2)	0.8766
Breusch -Pagan-Godfrey Test for Heteroscedasticity			
F-statistic	1.388497	Prob. F(11,12)	0.2902
Obs*R-squared	13.44029	Prob. Chi-Square(11)	0.2655

Source: Author's Computation, 2024.

Stability Tests

Figure 1 shows the output of the CUSUM and CUSUM Square tests for parameter stability. The output shows that there are no structural breaks in the regression model and that the model's parameters are stable over time since the cumulative sum of squares and cumulative total are within the 5% required range.

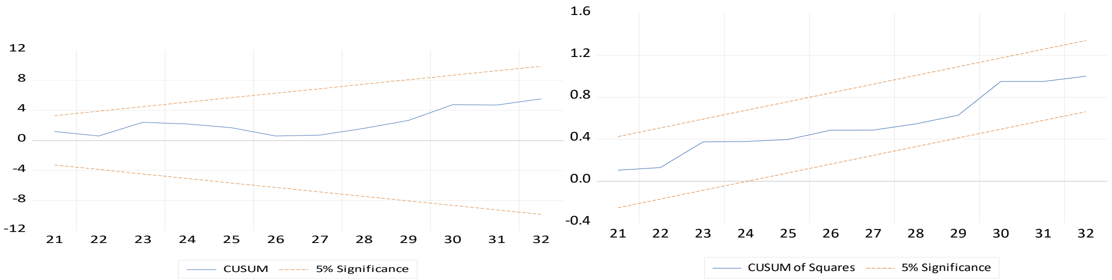


Figure 1: CUSUM and CUSUM of Squares test

b. Empirical Results of the VAR Economic Model

Unit Root Tests

Table 4.6 ADF and PP Unit-root Test

TEST	*RGDP*	*E_DEP*	*HDI*	*Co_2_emmission*
ADF_I^*	-2.960411 (0.7675)	-2.960411 (0.0953)	-2.960411 (0.7300)	-2.957110 (0.0672)
ΔADF_I^*	-2.960411 (0.0575)**	-2.991878 (0.6609)	-2.960411 (0.0098)**	-2.960411 (0.0000)*
PP_I^*	-2.957110 (0.8481)	-2.960411 (0.1246)	-2.957110 (0.7556)	-2.957110 (0.0672)
ΔPP_I^*	-2.960411 (0.0061)*	-2.963972 (0.0001)*	-2.960411 (0.0106)*	-2.960411 (0.0000)*

Source: Author's Computation, 2024. * 1% and ** 5% Sig. levels.

Table 4.6 indicates the presence of a cointegration relationship between the variables in the model, as it shows that all of the variables are stationary in the initial difference. Furthermore, it is a necessary precondition for applying the Johansen Cointegration technique to determine whether there is a long-term link between the variables in the given model. Therefore, it is essential to define the ideal lag time before determining the evidence of cointegration.

Continuing, Table 4.7 reveals the result of the Johansen and Julieus cointegration analysis on the economic model. The findings suggest that there is at least one (1) co-integrating equation in the specified model, which therefore attest to the existence of long run relationship between energy depletion (E_DEP), Human capital development (HDI), environmental pollution (CO2_EMM) and economic growth in the period of study. This evidence of co-integration among the variables rules out spurious correlations and can also be viewed as an indirect test for the evidence of long run causality among the variables.

Table 4.7: Johansen Cointegration Output

Variables	**Maximum Eigenvalue**				**Trace**			
Hypothesized No. of CE(s)	eigenvalue	eigenvalue Max-eigen statistic	5% critical value	Prob**.	eigenvalue	eigenvalue Max-eigen statistic	5% critical value	Prob.**
None * (H0: r=0, H_1: r=1)	0.618640	48.32192	47.85613	0.0452*	0.618640	27.95635	27.58434	0.0448*
At most 1 (H0: r=1, H_1: r=2)	0.369716	20.36556	29.79707	0.3983	0.369716	13.38597	21.13162	0.4174
At most 2 (H0: r=2, H_1: r=3)	0.155218	6.979597	15.49471	0.5800	0.155218	4.891615	14.26460	0.7555
At most 3 (H0: r=3, H_1: r=4)	0.069469	2.087982	3.841465	0.1485	0.069469	2.087982	3.841465	0.1485

*** denotes rejection of the hypothesis at the 5 % level**

**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's Computation, 2024.

Granger Causality

The study also evaluated the direction of causality amongst the variables in the economic model. the results are displayed in Table 4.8. The outcome reveals that there is uni-directional causality running from HDI to economic growth. Also, the findings suggest that there is uni-directional causality from CO2_EMM to energy depletion (E_DEP). Moreover, the probability of 0.005 is indicative of the joint influence of these variables (RGDP, HDI, CO2_EMM) on energy depletion (E_DEP). In addition, the findings reveal evidence of Granger causality from energy depletion (E_DEP) to human capital development (HDI).

Table 4.8: Granger Causality

Included observations: 30

Dependent variable: LOG(RGDP)			
Excluded	Chi-sq	Df	Prob.
ENERGY_DEP	0.582686	2	0.7473
HDI	7.179044	2	0.0276
CO2_EMISIONS	0.862622	2	0.6497
All	9.818931	6	0.1325
Dependent variable: ENERGY_DEP			
Excluded	Chi-sq	Df	Prob.
LOG(RGDP)	4.772740	2	0.0920
HDI	4.042345	2	0.1325
CO2_EMISIONS	6.586596	2	0.0371
All	24.28195	6	0.0005
Dependent variable: HDI			
Excluded	Chi-sq	Df	Prob.
LOG(RGDP)	0.539300	2	0.7636
ENERGY_DEP	6.883733	2	0.0320
CO2_EMISIONS	1.254693	2	0.5340
All	9.333540	6	0.1557
Dependent variable: CO2_EMISIONS			
Excluded	Chi-sq	Df	Prob.
LOG(RGDP)	0.404751	2	0.8168
ENERGY_DEP	1.123650	2	0.5702
HDI	0.238728	2	0.8875
All	4.841060	6	0.5644

Source: Author's Computation, 2024.

Post-Diagnostic Tests

Table 4.9: VAR Heteroscedasticity Test

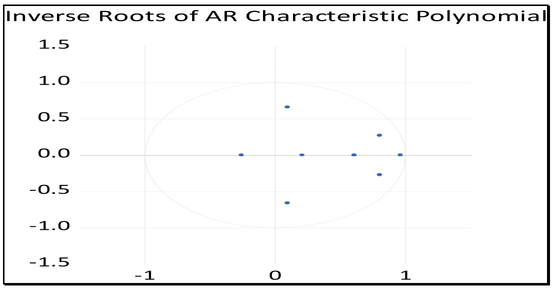
Level and Squares	**Chi.Sq.**	**Df.**	**Prob.**
Joint	**177.0288**	**160**	**0.1693**

Source: Author's Computation, 2024.

Table 4.9 highlights the outcome of the test of unequal variance in the residual term. The findings as indicated by the non-significance of the probability values suggest the absence of heteroscedastic properties in the model.

Model Stability Test

In addition, post diagnostic test of the stability of the model was conducted. The outcome shows that the inverse roots are within the unit circle and not root lies outside the circle. Therefore, the model fulfils the necessary condition for VAR model stability.



Source: Author's Computation, 2024.

5. Conclusion and Policy Recommendation

In the pursuit of economic prosperity, resource rich developing countries focus on what they have on their environment in terms of non-renewable and renewable resources to grow their economies. Hence, for mineral rich countries, the focus is often on the export of mineral resources for foreign exchange. Although, the macroeconomic goal of sustained growth in national output is not out of place, the problem with such an objective in the long run for countries is the prospect of natural resource depletion, especially for fossil-fuel dependent countries.

However, with the rapid pace in innovative non-finite energy resources, it is expected that across the world, natural resource depletion is expected to decline due to decreasing consumption of fossil fuels in the long run. These findings while they in part, point to the influence of the drivers of natural resource depletion; the findings also suggest the need for the country to reduce the depletion of its natural resources by formulating sustainable policies.

A critical challenge for Nigeria is managing its natural resources and evolving new mechanisms to ensure the continued development of the country in the face of the dual challenge of sustaining economic growth and the increasing pressure from its rising population. To this end, the paper suggest that the government should stabilize the macroeconomic environment through the generation of job opportunities for the many unemployed people. This will help reduce the pressure on land and forest resources and the devaluation that is caused by the rise in human activities on natural resources. In addition, the study recommends that policy makers should encourage investment in human capital and reduce public subsidies that encourage conventional fossil fuel production and consumption. Moreover, there is the need to formulate policies that encourage the restructuring of the resource dynamics of the economy, and favour a reduced dependence on non-renewable resources. This would significantly enhance the promotion of renewable energy production and consumption in the country. In addition, such a policy will encourage the preservation of the declining fossil fuel deposits in the country and promote environmental sustainability.

References

1. Amjad, A., Marc, A., & Yannick, R. (2021). Natural resources depletion, renewable energy consumption and environmental degradation: A comparative analysis of developed and developing world. *International Journal of Energy Economics and Policy*, 11 (3), 251 - 260. http://www.doi.10.32479/ijeep.11008.
2. Aquilas, N. A. (2019). Testing the Environmental Kuznets Curve hypothesis for the depletion of natural resources in Sub-Saharan African countries. Ethiopian Economics and Ethiopian Strategy S (ESSP) of, 47.
3. Byaro, M., Nkonoki, J., & Mafwolo, G. (2023). Exploring the nexus between natural resource depletion, renewable energy use, and environmental degradation in sub-Saharan Africa. Environmental Science and Pollution Research, 30(8), 19931-19945.https://www.doi.org/10.1007/s11356-022-23104-7
4. Erdoğan, S., Çakar, N. D., Ulucak, R., Danish, & Kassouri, Y. (2021). The role of natural resources abundance and dependence in achieving environmental sustainability: evidence from resource-based economies. Sustainable Development, 29(1), 143-154.https://www.doi.org/10.1002/sd.2137
5. Khan, H. (2023). Ecological Resources Depletion, Inequality and Poverty.
6. Hussain, H. I., Haseeb, M., Kamarudin, F., Dacko-Pikiewicz, Z., & Szczepańska-Woszczyna, K. (2021). The role of globalization, economic growth and natural resources on the ecological footprint in Thailand: Evidence from nonlinear causal estimations. Processes, 9(7), 1103.https://www.doi.org/10.3390/pr9071103
7. Ibrahim, M. J. (2017). Introductory chapter: Economics, natural resources and sustainable development. Emerging Issues in Economics and Development, 1-4.http://www.doi.10.5772/intechopen.70399.
8. Koirala, B. S., & Pradhan, G. (2020). Determinants of sustainable development: Evidence from 12 Asian countries. Sustainable Development, 28(1), 39-45.https://www.doi.org/10.1002/sd.1963
9. Maya, M.M., & Ayano, S.F. (2021). The impact of population growth on natural resources and farmer's capacity to adapt to climate change in low-income countries. *Earth Syst. Environ*, 5, 271-282. https://www.doi.org/10.1007/s41748-021-00209-6
10. Meadows, D., & Randers, J. (2012). The limits to growth: the 30-year update. Routledge.
11. Moslehpour, M., Firman, A., Lin, C-H., Bilgicli, I., Tran, T. K., & Nguyen, T.T.H (2023). The moderating impact of government support on the relationship between tourism development and growth, natural resources depletion, sociocultural degradation, economic environment and pollution reduction: Case of Indonesian Economy. *Journal of Environmental Science and Pollution Research*, 30, 56863–56878. https://www.doi.org/10.1007/s11356-023-26231-x
12. Musibau, H. O., Shittu, W. O., & Ogunlana, F. O. (2021). The relationship between environmental degradation, energy use and economic growth in Nigeria: new evidence from non-linear ARDL. International Journal of Energy Sector Management, 15(1), 81-100.https://www.10.1108/IJESM-04-2019-0016

13. Nigeria Bureau of Statistics. (2024). Quarterly Statistical Report, 2024.
14. Nigeria Bureau of Statistics. (2023a). Annual Statistical Bulletin, 2023.
15. Ogunwusi, A. A., & Ibrahim, H. D (2019). Industrial development and natural resources depletion in Nigeria. *Journal of Economics and Sustainable Development*, 10(4), 57-79. https://www.doi:10.7176/JESD
16. Oyeranti, O. A., & Obijole, E. O. (2023). Natural Capital Depletion and Sustainable Development: Evidence from Nigeria. International Journal of Social Science and Economic Research, 8(8), 2140-2160. https://doi.org/10.46609/IJSSER.2023.v08i08.004
17. Oyetunji, P. O. (2019). The effects of forests on the economic growth in Nigeria: (1990 -2015). *Worlds News of Natural Science*, 23, 254-265.
18. Pesaran, M. H., and Shin, Y. (1999). An autoregressive distributed lag modelling approach to cointegration. In Strom, S., (Ed.). Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium. Cambridge University Press.
19. Shah, A. (2005). Poverty and Natural Resources: Understanding the Dynamics in the Content of Dryland Regions in Western India. Chronic Poverty Research Centre Working Paper.
20. Sweeney, J. L. (1992). Economic theory of depletable resources: an introduction. North-Holland.
21. Tahir, M., Burki, U., & Hayat, A. (2023). Natural resources and economic growth: evidence from Brunei Darussalam. International Journal of Emerging Markets, 18(10), 4252-4269.https://doi.10.1108/IJOEM-05-2021-0762
22. World Bank (2023). World Development Indicators
23. Xiaoman, W., Majeed, A., Vasbieva, D. G., Yameogo, C. E. W., & Hussain, N. (2021). Natural resources abundance, economic globalization, and carbon emissions: Advancing sustainable development agenda. Sustainable development, 29(5), 1037-1048.https://www.doi.org/10.1002/sd.2192
24. Xu, Y., & Zhao, F. (2023). Impact of energy depletion, human development, and income distribution on natural resource sustainability. Resources Policy, 83, 103531.https://www.doi.org/10.1016/j.resourpol.2023.103531
25. Zallé, O. (2019). Natural resources and economic growth in Africa: The role of institutional quality and human capital. Resources Policy, 62, 616-624.