



Analyzing the impact of energy consumption and income inequality on environmental degradation in Nigeria

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Abstract:

Environmental degradation has become a pressing global concern, with its effects particularly severe in developing economies such as Nigeria. As nations strive for economic growth and improved living standards, the resulting pressure on natural resources and the environment often goes unchecked. The study employed the Dynamic Ordinary Least Squares (DOLS) method, preferred over Ordinary Least Squares (OLS) and Fully Modified Ordinary Least Squares (FMOLS) due to its effectiveness in correcting for endogeneity, heteroskedasticity, and serial correlation through the inclusion of leads and lags. Additionally, the Autoregressive Distributed Lag (ARDL) approach was applied to analyze both short-run dynamics and long-run relationships. Data spanning 1990 to 2023 were sourced from WDI, WGI, and the Central Bank of Nigeria. The Results show that energy consumption and GDP per capita significantly increase CO₂ emissions, while government expenditure reduces them. Political stability also raises emissions, suggesting its role in promoting industrial growth. Income inequality lowers emissions but increases deforestation, likely due to unequal land access. For deforestation, energy consumption and government spending significantly reduce forest loss, while GDP per capita and political stability show insignificant effects. The model results are robust, with high explanatory power. The study highlighted the urgent need for equitable income distribution, cleaner energy adoption, and improved governance to advance environmental sustainability in Nigeria.

Keywords: Energy consumption, Income inequality, Environmental degradation, Deforestation, Nigeria.

Abstrak :

Degradasi lingkungan telah menjadi masalah global yang mendesak, dengan dampaknya yang sangat parah di negara berkembang seperti Nigeria. Ketika negara-negara berusaha keras untuk mencapai pertumbuhan ekonomi dan meningkatkan standar hidup, tekanan yang dihasilkan terhadap sumber daya alam dan lingkungan sering kali tidak terkendali. Penelitian ini menggunakan metode Dynamic Ordinary Least Squares (DOLS), yang lebih disukai daripada Ordinary Least Squares (OLS) dan Fully Modified Ordinary Least Squares (FMOLS) karena keefektifannya dalam mengoreksi endogenitas, heteroskedastisitas, dan korelasi serial dengan memasukkan lead dan lag. Selain itu, pendekatan Autoregressive Distributed Lag (ARDL) digunakan untuk menganalisis dinamika jangka pendek dan hubungan jangka panjang. Data yang mencakup tahun 1990 hingga 2023 bersumber dari WDI, WGI, dan Bank Sentral Nigeria. Hasil penelitian menunjukkan bahwa konsumsi energi dan PDB per kapita secara signifikan meningkatkan emisi CO₂, sementara pengeluaran pemerintah menguranginya. Stabilitas politik juga meningkatkan emisi, yang menunjukkan perannya dalam mendorong pertumbuhan industri. Ketimpangan pendapatan menurunkan emisi tetapi meningkatkan deforestasi, kemungkinan besar karena akses lahan yang tidak merata. Untuk deforestasi, konsumsi energi dan pengeluaran pemerintah secara signifikan mengurangi kehilangan hutan, sementara PDB per kapita dan stabilitas politik menunjukkan efek yang tidak signifikan. Hasil model tersebut cukup kuat, dengan kekuatan penjelasan yang tinggi. Studi ini menyoroti kebutuhan mendesak akan pemerataan pendapatan, adopsi energi yang lebih bersih, dan peningkatan tata kelola untuk memajukan kelestarian lingkungan di Nigeria.

Kata Kunci: *Konsumsi energi, Ketimpangan pendapatan, Degradasi lingkungan, Deforestasi, Nigeria.*

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INTRODUCTION

Energy consumption and income inequality are vital economic factors that have a profound impact on environmental degradation in Nigeria. As the country's economy continues to grow, energy consumption and income disparity are increasingly contributing to both environmental stress and economic inequality. Energy consumption, particularly from fossil fuels, plays a central role in Nigeria's economic activities, from industrialization to transport, but it also drives the degradation of natural resources. Income inequality, in turn, has economic consequences that shape how energy is consumed, particularly in terms of disparities in access to cleaner energy and the sustainability of consumption patterns (Nayak & Bhat, 2020). Together, these issues create complex economic dynamics that hinder efforts to achieve sustainable development and reduce environmental degradation.

Energy consumption in Nigeria is closely tied to economic growth, as increased energy demand is a direct result of industrial expansion, urbanization, and population growth. However, the country's heavy reliance on fossil fuels for energy production has led to significant environmental costs. Oil and gas extraction, transportation, and power generation all contribute to carbon emissions and air pollution, which harm the environment and public health (Lee, 2020). Despite economic progress driven by the oil industry, the environmental consequences of fossil fuel dependence are becoming increasingly apparent. According to the World Bank (2023), CO₂ emissions in Nigeria have risen in parallel with economic growth, illustrating how energy consumption has intensified the environmental degradation of the country.

From an economic standpoint, energy consumption patterns in Nigeria are also deeply influenced by the structure of the energy sector. The oil and gas industry, which generates a substantial portion of Nigeria's GDP, not only contributes to environmental degradation but also shapes the distribution of wealth and income. The economic benefits from fossil fuel production are not equitably distributed, with a small portion of the population controlling most of the wealth generated from the oil sector (Pomeroy & Sharma, 2021). This leads to economic inequality, where a significant part of the population remains without access to clean and affordable energy sources. As a result, the impoverished population often resorts to unsustainable practices, such as the use of firewood or illegal logging, to meet basic energy needs, contributing to environmental harm (Dube et al., 2022).

The economic relationship between income inequality and environmental degradation is also evident in the consumption patterns of different income groups. High-income individuals tend to consume more energy-intensive goods and services, leading to higher carbon footprints. Wealthy individuals often own multiple vehicles, large homes, and numerous electronic devices, which require substantial energy inputs (Angelsen, 2019). This disproportionate energy consumption increases overall demand for fossil fuels, thus exacerbating environmental degradation. On the other hand, lower-income groups, struggling to access clean energy, often turn to unsustainable practices that have a more direct impact on local ecosystems, such as deforestation and overuse of agricultural land. These actions, driven by economic necessity, lead to land degradation, loss of biodiversity, and soil erosion, further contributing to environmental decline.

Furthermore, the economic disparities exacerbated by income inequality affect the nation's capacity to adopt cleaner, more sustainable energy solutions. The poor often lack the financial resources to invest in renewable energy sources, such as solar or wind power, which could reduce the environmental footprint of energy consumption (Pagiola et al., 2021). The wealthier segments of society, in contrast, have the means to invest in energy-efficient technologies and cleaner alternatives, thereby reducing their environmental impact. This creates a widening gap in energy consumption patterns and contributes to unequal environmental degradation across different socio-economic groups.

The oil and gas industry's central role in Nigeria's economy also complicates the situation. The sector generates significant revenue, but much of this wealth does not benefit the broader population (Landell-Mills, 2020). Instead, it reinforces a system of economic disparity, where the profits from fossil fuels are concentrated among a small elite, while the majority of the population remains impoverished and reliant on unsustainable energy sources. As Nigeria's economy continues to depend on oil, the environmental costs of this dependence become increasingly difficult to ignore. The economic structure, centered around fossil fuel production, fails to account for the long-term environmental consequences, leaving future generations to bear the brunt of the ecological damage (Jensen & Zhao, 2020). The interrelationship between energy consumption, income inequality, and environmental degradation is a critical issue for Nigeria's sustainable development. As energy consumption rises alongside economic inequality, both factors exacerbate environmental decline, necessitating urgent economic and environmental policy interventions to mitigate their impact.

This study incorporates several key variables to understand the relationship between energy consumption, income inequality, and environmental degradation in Nigeria, drawing on existing scholarly literature for their operational definitions. Carbon dioxide (CO₂) emissions are used as a primary proxy for environmental degradation, consistent with the approaches of Anwar et al. (2017) and Osabohien et al. (2020). Exposure to CO₂ and other pollutants has serious health consequences, particularly for vulnerable populations such as children and the elderly. These effects include respiratory tract illnesses, asthma attacks, reduced lung function, increased hospital admissions, and even premature deaths. Government capital expenditure (GCE) refers to public investment in infrastructure and long-term projects. It functions as an independent and control variable in both models used in the study, aligning with the works of Shao and Dou (2023) and Yameogo and Dauda (2020), which explored its links with both carbon emissions and life expectancy.

Political Stability and Absence of Violence/Terrorism (PST) measures the perceived risk of political unrest and terrorism, with scores ranging from -2.5 to 2.5 based on a standard normal distribution. This metric reflects the security environment that can influence economic performance and environmental governance. Per capita income (PGDP), representing the average income of individuals in a country, is used as an independent control variable. It has been featured in studies focusing on inequality and life expectancy, such as those conducted by Fatukasi and Ayeomoni (2015), Hill et al. (2019), and Beyene and Kotosz (2021), reinforcing its relevance to economic and health-related outcomes. Energy consumption (EC), particularly from fossil fuels, serves as a significant driver of carbon emissions. Prior literature, including Gao and Fan (2023), as well as Ogede and Tihamiyu (2022) and Osabohien et al. (2020), establishes a clear link between increased fossil fuel use and environmental degradation, along with potential reductions in life expectancy.

The Gini coefficient (GINI) is used to capture income inequality within Nigeria. As adopted in prior studies (Drabo, 2011; Ali & Audi, 2016; Orekoya, 2022), the Gini index measures disparities in income distribution. Higher values generally indicate more inequality, which is often associated with poorer health outcomes—such as lower life expectancy and greater prevalence of chronic illness—due to restricted access to essential services like healthcare, education, and nutrition. However, the extent of this relationship depends on a country's cultural and policy framework. Deforestation, the permanent removal of forested land for non-forest use such as agriculture and urban development, is employed as a second proxy for environmental degradation. It is commonly measured in terms of forest area lost in square kilometers and reflects the environmental cost of human economic activity.

The justification for the present study rests on Nigeria's deepening exposure to environmental degradation within a context of economic and social imbalance. Although previous research has explored the relationship between energy consumption and environmental decline, limited attention has been given to how unequal income distribution influences environmental outcomes (Mulugeta & Degefe, 2020; Zhou & Wang (2022)). This oversight weakens the understanding of how economic inequality contributes to uneven access to clean energy and compels low-income populations toward unsustainable practices. Many existing studies have generalized findings across sub-Saharan Africa without isolating Nigeria's distinct energy patterns and socio-economic dynamics (Imai, et al. (2022; Chichilnisky & Heal, 2021)). Current policies in Nigeria often treat environmental concerns and income inequality as separate challenges, which results in fragmented interventions (Akinlo, 2020). The absence of an integrated analysis that considers both economic inequality and energy-driven environmental degradation creates a critical gap in policy development. This study aims to fill that void, offering insights into the interconnected nature of energy use, inequality, and environmental quality. The outcome is expected to contribute meaningfully to economic planning, encouraging inclusive and environmentally sustainable growth strategies that address the economic roots of environmental decline. Research Questions, Does the effect of energy consumption and income inequality have impact on environmental degradation in Nigeria? Research Hypotheses, There is no statistically significant effect of energy consumption and income inequality on environmental degradation in Nigeria.

RESEARCH METHODOLOGY

The study employs the Dynamic Ordinary Least Squares (DOLS) method. DOLS and Fully Modified Ordinary Least Squares (FMOLS) are favoured over Ordinary Least Squares (OLS) for several reasons. First, while OLS estimates are super-consistent when all variables are stationary (I(0)), the t-statistics computed from non-stationary variables are only approximations. Second, although OLS remains consistent in large samples, it exhibits slower convergence in finite samples. Third, OLS estimates are prone to serial correlation and heteroskedasticity due to omitted dynamics in the residuals, and issues of endogeneity further undermine the validity of inferences based on standard normal tables, rendering the t-statistics potentially misleading. In contrast, the DOLS estimator mitigates endogeneity, heteroskedasticity, and serial correlation by incorporating leads and lags, and it employs white heteroskedastic standard errors. Similarly, FMOLS addresses these problems using a nonparametric approach (Pedroni, 2000); however, DOLS is generally preferred in the literature because its parametric approach does not require all variables to be integrated of the same order (e.g., I(1)). As noted by Yorucu and Bahramian (2015), the primary rationale behind both FMOLS and DOLS is their ability to correct for endogeneity and serial correlation biases, thereby allowing for standard normal inference.

The functional form capturing the objective of this study is specified as;

$$ENVD = f(EC, PGDP, GCE, PST, GINI) \dots \dots \dots 1$$

Furthermore, in the DOLS environment, the residuals are augmented with lags, leads, and contemporaneous values of the regressors (Kao and Chiang 2000). Pedroni (2001) underlines that the between-group estimators are preferable to the within-group estimators for several reasons that are also explained by Harris and Sollis (2003) in more detail the DOLS estimator is then given as;

$$\beta_{DOLS}^* = N^{-1} \sum_{i=1}^N \left(\sum_{t=1}^T Z_t Z_t^i \right)^{-1} \left(\sum_{t=1}^T Z_t ENVD \right) \dots \dots \dots 2$$

where; $Z_t = 2(k+1)1$ vector of regressors and ENVD = a vector of environmental degradation (dependent variable) capturing CO₂ emissions and deforestation.

In general, the model capturing the fourth objective of this study can be represented in DOLS form as following equation 1;

$$A = [c, \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5]'; X = [1, EC_t, LOGPGDP_t, LOGGCE_t, PST_t, GINI_t] \dots \dots \dots 3$$

$c = constant, \alpha_1 \text{ to } \alpha_9$ denote corresponding coefficient parameters . Every other variable remains as defined already.

Therefore, our DOLS in a more general form is specified thus;

$$ENVD_t = A'X_t + \sum_{j=-J}^{j=J} \varphi_j \Delta X_{t-j} + \mu_t \dots \dots \dots 4$$

where; A' is $1 \times K$ coefficient vector, X_t is a column vector of regressors, φ_j Is coefficient matrices of differenced regressors, Δ is a difference operator, $-J$ and J are the lags and leads respectively, and μ_t is the uncorrelated error term

Estimation Procedure: Using time series data; the researcher estimates the research objectives one to three with an Autoregressive Distributed Lag (ARDL) Bound Testing approach. This method is preferred to other econometric methods as it is best suited when examining the short-run dynamic and long-run equilibrium of the model, especially when the order of integration is fractional or not known apriori. Also, the DOLS estimator takes care of endogeneity, heteroscedasticity, and serial correlation with the use of leads and lags. It equally uses white heteroskedastic standard errors. Also, FMOLS does the same using a nonparametric approach (Pedroni, 2000) but DOLS is preferred over FMOLS and is widely applied in the literature.

Table 1: Theoretical Postulations of the Variables Included in the Model

Dependent Variable	Independent Variables	Expected Parameters Signs	Remarks
ENVD (CO ₂ & DFT)	EC	- < 0	Negative
	LOGPGDP	+ > 0	Positive
	LOGGCE	+ > 0	Positive
	PST	+ > 0	Positive
	GINI	- < 0	Negative

Source: Researcher’s Compilation (2024)
Nature and Sources of Data

Table 2 presents the variables, and their type in the three objectives, the variables, acronym, and sources.

Table 2: Summary of Data in the Model and Description

Variable	Acronym	Source
Gini coefficient	GINI	WDI (2023)
Carbon dioxide emissions	CO ₂	WDI (2023)
Per capita gross domestic product	PGDP	WDI (2023)
Energy Consumption	EC	WDI (2023)

Government capital expenditure	GCE	Central Bank of Nigeria (2023)
Political Stability and Absence of Violence/Terrorism	PST	World Governance Indicators (2023)
Deforestation	DFT	WDI (2023)

Source: Researchers' Compilation (2025)

The data used for the study were extracted from *WDI*, *WGI*, and *CBN*. The data used for the study covers the year 1990 to 2023.

DISCUSSION

Descriptive statistics is a [summary statistic](#) that quantitatively describes or summarizes the features of a dataset. Table 3 presents the summary of the descriptive statistics ranging from the measures of central tendency to the measures of dispersion. These include the mean, median, skewness, kurtosis, Jarque-bera, etc. of each of the variables of interest in this study.

Table 3: Summary of Descriptive Statistics

Variables	Va bs.	Me an	Mi nimum	Ma ximum	Strd. Dev.	Jarqu e-Bera	Ske wness	Kur tosis
C		0.6	0.4	0.9	0.12	2.377	0.2	1.8
O₂	4	68461	78280	16396	9537	161	91930	43668
E		73	68	78	34.4	2.441	-	1.7
C	4	7.5341	0.0624	8.7895	8471	026	0.135448	15596
G		51	4.4	25	541.	44.45	1.9	7.0
CE	4	2.0220	69300	00.796	7794	748	39389	41885
GI		45.	35.	57.	6.01	0.879	0.2	2.3
NI	4	96765	10000	90000	0431	048	22292	49732
P		20	14	26	462.	3.940	-	1.3
GDP	4	28.707	29.012	79.554	7116	354	0.054889	35856
PS		-	-	-	0.43	7.742	1.1	3.7
T	4	1.648444	2.211123	0.432022	5663	685	12000	20591
D		23	211	265	1626	2.047	2.20	1.79
FT	4	8315.8	370.6	261.0	2.24	050	E-05	7928

Source: Researchers' Computation from E-Views 10

Estimation and Interpretation for Model

The specific objective of the study seeks to evaluate the effect of energy consumption and income inequality on environmental degradation in Nigeria. To achieve the objective, the study adopts the Dynamic Ordinary Least Square (DOLS) estimation technique in model. The model is

estimated using 1 lag and 1 lead, and interpretations are only based on the long-run results and not necessarily on the first differences of the lags and leads of the variables.

DOLS Regression Result for Model

From the results, a 1% increase in energy consumption leads to an increase of 0.015% in CO₂ emissions and it is statistically significant at a 1% level. This suggests a direct relationship between energy consumption and environmental degradation. Akinlo (2020) found a positive relationship between energy consumption and CO₂ emissions in sub-Saharan Africa, confirming that higher energy consumption exacerbates environmental pollution. Tiwari et al. (2020) also highlighted the strong linkage between energy consumption and carbon emissions in developing economies. In contrast, Zhang and Xu (2020) argue that the relationship between energy consumption and CO₂ emissions may be non-linear, particularly in countries where renewable energy adoption reduces the overall environmental impact.

Moreover, a 1% increase in GDP per capita is associated with a 0.098% increase in CO₂ emissions, which points to economic growth contributing to environmental degradation and it is statistically significant at a 1% level. The study by Cole (2020) supported this by noting that economic growth leads to increased industrial activities, thereby raising CO₂ emissions. Choi and Jeon (2021) also emphasized the positive correlation between GDP growth and CO₂ emissions, particularly in fast-growing economies. However, Murshed et al. (2019) suggested that this relationship could be reversed in the presence of green technologies or a decoupling of growth and emissions.

A 1% increase in government consumption expenditure is associated with a 0.135% decrease in CO₂ emissions, indicating that government spending may promote environmental protection and it is statistically significant at a 1% level. Zhang & Xu (2022) found that higher government expenditure on environmental projects can reduce emissions through investment in clean energy. Lin and Wang (2021) similarly observed a negative link between government spending and environmental degradation, suggesting a potential for policy intervention. On the contrary, government spending, if inefficient or poorly targeted, could have minimal impact on emission reductions.

Political stability positively affects CO₂ emissions, with more stable political environments potentially promoting industrial expansion and increased emissions. It was found to be statistically significant at 1% level. Ajakaiye and Adeyeye (2021) noted that political stability in African countries correlates with higher industrial activities, which might raise emissions. Ghosh et al. (2021) confirmed that in politically stable countries, rapid development may lead to increased emissions due to industrial growth. Yet, Adesina (2020) argued that political stability can encourage the implementation of environmental policies that promote sustainable growth, potentially reducing emissions over time.

Table 4: Dependent Variable CO₂ and DFT

Variable	Coef.	Std. Error	Prob.	Coef.	Std. Error	Prob.
s						

Panel 1		<i>CO₂ Emissions</i>					
		DOLS			FMOLS		
EC		0.0152*	0.0035	0.0015	0.007	0.0040	0.077
		15			441	57	7
LOGPG		0.0983*	0.0276	0.0052	-	0.0332	0.284
	DP	70			0.036256	33	9
LOGGC		-0.1349*	0.0157	0.0000	-	0.0172	0.001
	E	58			0.062317	74	2
PST		0.1410*	0.0336	0.0019	0.069	0.0322	0.039
		39			957	48	0
GINI		-0.0386*	0.0069	0.0002	-	0.0056	0.101
		25			0.009578	41	0
C		2.3937*	0.3125	0.0000	1.689	0.2346	0.000
		98			801	29	0

Adjusted R-squared =
0.9578

R-squared = 0.9859

Prob(F-statistic) =

F-statistic = 35.08241 0.0000

Panel 2		<i>Deforestation</i>					
		DOLS			FMOLS		
EC		-	450.58	0.0002	-	408.75	0.000
		2603.820*	20		1942.789	55	1
LOGPG		-	3547.0	0.1740	-	3348.5	0.020
	DP	5192.230	15		8275.261	59	1
LOGGC		-	2020.0	0.0041	-	1740.5	0.000
	E	7490.086*	26		7542.069	74	2
PST		7284.78	4312.1	0.1220	1210.	3249.3	0.712
		8	91		480	57	4
GINI		2056.70	887.74	0.0430	578.8	568.36	0.317
		7**	92		710	96	5

C	294128.	40072.	0.0000	35834	23641.	0.000
5*	13		4.5	48	0	
Adjusted R-squared	=	R-squared	=			
0.9865		0.995498				
		Prob(F-statistic)	=			
F-statistic	=	110.5578		0.0000		

Source: Researcher's Compilation (2024)

Note: * denotes significance at 1%, ** denotes significance at 5%; FMOLS denotes Fully Modified Least Squares; DOLS denotes Dynamic Ordinary Least Squares. See appendix 20 for the robustness results.

The study observed that higher income inequality is associated with lower CO₂ emissions, which could be due to reduced consumption in the lower-income brackets. Gupta (2021) found that in economies with high-income inequality, the lower purchasing power of the population leads to lower overall consumption and, hence, fewer emissions. Nayak and Bhat (2020) also suggested that economic inequality negatively correlates with carbon emissions due to reduced demand for goods and services. However, Zhang (2020) argue that higher inequality can lead to social unrest, which might affect long-term sustainability policies and indirectly increase emissions.

From the results, with regards to deforestation as an environmental degradation proxy, the estimation reveals that energy consumption negatively impacts deforestation, possibly reflecting an increased use of renewable or cleaner energy alternatives that reduce deforestation pressure. Lee (2020) found that a shift to renewable energy reduces the pressure on forests as alternative energy sources replace wood for heating and cooking. Dube et al. (2022) also showed a negative relationship between energy consumption and deforestation, attributing it to the rise of clean technologies. However, Pomeroy and Sharma (2021) noted that energy consumption in deforestation-prone areas might still involve unsustainable practices, particularly in rural regions.

The relationship between GDP per capita and deforestation is insignificant; suggesting that economic growth alone does not determine deforestation outcomes. Angelsen (2019) found that economic growth does not always correlate with deforestation, as it depends on the sectoral composition of growth. Pagiola et al. (2021) highlighted that some economically growing countries have successfully decoupled growth from environmental degradation. Conversely, Landell-Mills (2020) argued that economic growth typically increases deforestation through infrastructure development, mining, and agriculture.

Government consumption expenditure significantly reduces deforestation, likely due to environmental policies and reforestation programs and it is significant at a 1% level. Li and Xie (2020) confirmed that government spending on environmental protection and forest conservation leads to lower rates of deforestation. Jensen & Zhao (2020) found that governments actively investing in conservation and sustainable land use practices can reduce forest loss. However, studies like Zhou and Wang (2022) warned that inefficient public expenditure could still allow illegal logging and land encroachment to persist.

The positive but insignificant effect of political stability on deforestation suggests that stable governance does not always lead to reduced deforestation. Ajakaiye and Aluko (2021) argued that political stability in certain countries correlates with increased agricultural activities, thus increasing deforestation. However, other studies like Mulugeta and Degefe (2020) found that political stability can promote the enforcement of environmental laws to curb deforestation. Political stability, in some contexts, leads to expansion in deforestation-related industries like agriculture and mining. The study discloses that higher income inequality appears to increase deforestation, possibly due to unequal access to resources and land for agriculture. Chichilnisky and Heal (2021) found that in countries with high inequality, poor populations tend to exploit forests for livelihoods, leading to deforestation. Imai et al. (2022) also observed that high inequality can advance land use practices that promote deforestation, especially in rural areas. However, in some regions, economic inequality can lead to increased environmental consciousness, which might reduce deforestation.

Despite FMOLS providing reliable results, DOLS offers a more pronounced and consistent impact, suggesting its greater ability to capture long-run relationships in this model, thus making it a more effective tool for forecasting life expectancy when energy and economic factors are involved. DOLS is often the preferred method because it incorporates a more robust handling of serial correlation and endogeneity than FMOLS. This provides clearer insights into dynamic, long-run relationships, making DOLS better suited for complex datasets where forward-looking predictions are crucial for policy formulation.

Test for Autocorrelation (Breusch Godfrey)

The Autocorrelation test is used to check if the error terms of different observations are correlated with each other which is against the assumptions of OLS. Autocorrelation is manifested by OLS estimators which are not BLUE (Best linear unbiased estimates). In our study, the Breusch-Godfrey Serial Correlation LM Test is used to detect the presence of autocorrelation for the three models. The result from the models, particularly for CO₂ emissions, show a positive and statistically significant relationship with energy consumption, suggesting that higher energy consumption leads to higher environmental degradation, as evidenced by an increase in CO₂ emissions. This finding is consistent with the work of Akinlo (2020) and Tiwari et al. (2020), who demonstrate the positive impact of energy consumption on environmental pollution. Additionally, the effect of income inequality on deforestation is mixed but reveals a tendency for higher inequality to contribute to environmental degradation. Based on the significant effects observed for energy consumption and inequality, the null hypothesis is rejected, affirming that both factors significantly influence environmental degradation in Nigeria.

The study reveals a significant positive relationship between energy consumption and CO₂ emissions, suggesting that higher energy consumption contributes to environmental degradation. This supports the findings of Akinlo (2020) and Tiwari et al. (2020), who found a direct link between energy consumption and CO₂ emissions in developing economies. On the other hand, the study found that higher income inequality appears to reduce environmental degradation, likely due to reduced consumption in the lower-income groups. This finding is in line with Gupta et al. (2021), which suggests that higher inequality leads to reduced demand for goods and services, thus lowering emissions. However, the relationship between economic growth and environmental

degradation remains contested, with studies like Murshed et al. (2019) pointing to potential decoupling in economies adopting green technologies.

CONCLUSIONS

This study examined the impact of energy consumption and income inequality on environmental degradation in Nigeria, using carbon dioxide (CO₂) emissions and deforestation as environmental indicators. Employing the Dynamic Ordinary Least Squares (DOLS) and Fully Modified Ordinary Least Squares (FMOLS) estimation techniques, the findings reveal that energy consumption significantly increases CO₂ emissions but reduces deforestation, suggesting a complex relationship where increased energy use may involve cleaner alternatives that alleviate pressure on forests. Income inequality was found to reduce CO₂ emissions, possibly due to lower consumption among lower-income groups, but increased deforestation, likely driven by resource exploitation by marginalized populations. Moreover, government consumption expenditure emerged as a significant mitigating factor, reducing both CO₂ emissions and deforestation, highlighting the critical role of public policy and investment in environmental protection. Political stability showed mixed effects—positively influencing CO₂ emissions but having no significant impact on deforestation—indicating that governance alone is insufficient without targeted environmental actions. The study underscores the need for integrated energy, economic, and social policies that promote sustainable development, equitable growth, and environmental conservation in Nigeria.

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