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INTERNATIONAL TRADE AND ENVIRONMENTAL DEGRADATION NEXUS IN NIGERIA

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Abstract

Given the rate of degradation of the natural environment, as well as the continuous increase in international trade, this study seeks to determine the relationship between international trade and environmental degradation in Nigeria from 1982 to 2023. The study was anchored in the framework of the Stochastic Impacts by Regression on the PAT (STIRPAT) model. It adopted the Autoregressive Distributed Lag (ARDL) model to estimate the long-run relationships among indicators of international trade and environmental degradation. The bounds test for cointegration showed the existence of a long-run relationship among international trade, environmental policy, trade policy and environmental degradation for the period reviewed. The findings revealed that trade openness, real GDP and urbanisation had a significant positive impact on environmental degradation in Nigeria, while environmental policy, trade policy and technological advancement had a negative and significant impact on environmental degradation in Nigeria. The study therefore concludes that, in Nigeria, there exists a positive relationship between international trade and environmental degradation and a negative relationship between environmental policies, trade policies and environmental degradation. It therefore recommends that the adoption of cleaner and sustainable technologies in industries through incentives be encouraged while maintaining good environmental regulations.
Keywords: International Trade, Environmental Policy, Trade Policy, Environmental Degradation.
JEL Classification Codes: F18, F43, Q56, Q53, O55

1.0 Introduction

Environmental degradation, defined as the deterioration, depletion, or exhaustion of environmental resources, has emerged as a central concern in contemporary development discourse (Qi et al., 2020). It encompasses the degradation of air, water, and soil resources, ecosystem disruption, and biodiversity loss, with far-reaching consequences including habitat destruction, species extinction, and threats to human well-being (Manasseh et al., 2025; Adelakun, 2024). Recent studies emphasise that these environmental pressures are largely driven by anthropogenic activities such as industrialisation, urbanisation, and unsustainable patterns of production and consumption (Li et al., 2023; United Nations Environment Programme, 2024). Consequently, environmental degradation poses significant threats to ecological sustainability, human health, and long-term economic development.

Although environmental degradation is a global phenomenon, its impacts are more pronounced in resource-dependent developing economies such as Nigeria. In Nigeria, environmental challenges are closely linked to natural resource extraction and trade-related activities. The Niger Delta region, in particular, has experienced extensive environmental damage due to oil exploration and production. Data from the Nigerian Oil Spill Detection and Response Agency (NOSDRA, 2022) indicate that over 9,800 oil spill incidents occurred between 2012 and 2022, leading to severe ecological consequences, including aquatic biodiversity loss, soil contamination, and destruction of livelihoods. In addition, rapid industrialisation and urban expansion in cities such as Lagos, Port Harcourt, Onitsha, and Aba have intensified environmental pollution, further compounding environmental risks.

At the global level, environmental sustainability has been institutionalised through frameworks such as the Sustainable Development Goals (SDGs) established by the United Nations. These goals underscore the importance of climate action, sustainable resource management, biodiversity conservation, and responsible consumption and production (United Nations, 2023). However, achieving these environmental objectives is intricately linked to the dynamics of international trade. Trade influences the scale, composition, and techniques of production, thereby shaping environmental outcomes across countries.

From a theoretical perspective, international trade is grounded in the principle of comparative advantage, which encourages countries to specialize in the production of goods for which they are relatively more efficient. While such specialization enhances global economic efficiency, it also has important environmental implications. Differences in environmental regulations, technological capabilities, and institutional quality across countries often result in asymmetric environmental outcomes. According to the World Trade Organization (2022), international trade can exacerbate environmental degradation through increased resource extraction, higher carbon emissions from transportation, and the relocation of pollution-intensive industries to countries with relatively lax environmental regulations—a phenomenon widely referred to as the pollution haven hypothesis.

In Nigeria, the structure of international trade is heavily skewed toward the export of primary commodities, particularly crude oil. While this has generated substantial foreign exchange earnings, it has also contributed to environmental degradation, especially in oil-producing regions (Oshwofasa et al., 2012). Similarly, the extraction of timber, minerals, and agricultural commodities—driven by both domestic demand and export markets—has contributed to deforestation and ecosystem disruption (Duru, 2014). Deforestation further accelerates climate change through increased carbon emissions and reduced carbon sequestration capacity (Ifeakor, 2023). On the import side, Nigeria's dependence on foreign goods, including machinery and electronic products, has introduced additional environmental concerns. The importation of carbon-intensive goods and the improper management of electronic waste (e-waste) have been identified as significant contributors to environmental pollution and public health risks (Nwokolo et al., 2023).

Notwithstanding these adverse effects, international trade can also serve as a channel for environmental improvement. Trade openness facilitates the diffusion of cleaner technologies, enhances access to environmentally friendly production methods, and promotes innovation (Boleti et al., 2021). This dual role of trade highlights the importance of policy frameworks in shaping the trade–environment nexus. In particular, trade policies and environmental regulations are critical in determining whether trade exacerbates or mitigates environmental degradation.

Despite the growing empirical literature on the relationship between international trade and environmental quality, limited attention has been paid to the role of policy variables in the Nigerian context. Existing studies, such as Aydin et al. (2020), focus on the effects of trade openness and energy intensity on ecological footprints without incorporating policy dimensions. Similarly, Longe et al. (2018) examine the trade–transport–environment nexus but do not explicitly account for trade and environmental policies. This omission represents a significant gap in the literature, given the crucial role of institutional and policy frameworks in mediating environmental outcomes.

Against this backdrop, this study investigates the nexus between international trade and environmental degradation in Nigeria, with particular emphasis on the role of trade and environmental policies. By incorporating policy variables into the analysis, the study provides a more comprehensive understanding of the mechanisms through which trade affects environmental quality. This is particularly relevant in the context of Nigeria's commitment to achieving the SDGs, where balancing economic growth with environmental sustainability remains a critical challenge.

The remainder of the paper is structured as follows. Section 2 reviews the theoretical and empirical literature. Section 3 presents the methodology, including the model specification and data sources. Section 4 discusses the empirical results, while Section 5 concludes with policy implications and recommendations.

2.0 Literature Review

2.1 Trade Openness, Foreign Direct Investment and Environmental Degradation Nexus

The nexus between trade openness, foreign direct investment (FDI), and environmental degradation has attracted significant empirical attention, particularly within the framework of the Environmental Kuznets Curve (EKC) hypothesis. Early contributions, such as Aydin and Turan (2020), revisited the EKC hypothesis for BRICS countries by examining the roles of financial openness, trade openness, and energy intensity on ecological footprint. Their findings indicate that energy intensity is the most significant driver of environmental degradation across BRICS economies, except in Russia. Similarly, Nathaniel and Sarfraz (2020) analysed ASEAN countries (1990–2016) and found a unidirectional causality running from urbanisation to non-renewable energy consumption, highlighting the environmental implications of structural transformation.

In the Nigerian context, Odugbesan and Adebayo (2020) investigated the symmetric and asymmetric effects of FDI and financial development on carbon emissions. Their results revealed that FDI and energy consumption exhibit significant long-run relationships with CO_2 emissions, suggesting that foreign investments contribute to environmental degradation when not properly regulated. Expanding the scope, Doytch (2020) examined 117 countries using a dynamic panel model and found that FDI exerts heterogeneous environmental effects: it contributes to production-based ecological degradation in low- and middle-income countries, while in high-income countries, the impact is largely consumption-driven.

Earlier evidence by Samuel Asumadu Sarkodie and Vladimir Strezov (2019) further supports the pollution haven hypothesis, demonstrating that FDI inflows into developing countries are associated with increased greenhouse gas emissions. Their findings also validate the EKC hypothesis for countries such as China and Indonesia, while a U-shaped relationship was observed for India and South Africa, indicating varying turning points across economies.

More recent empirical studies have deepened the understanding of this nexus. For instance, Usman and Hammar (2021) found that trade openness and FDI significantly increase ecological footprints in developing economies, reinforcing the argument that globalisation can exacerbate environmental degradation in the absence of strong institutional frameworks. Similarly, Awosusi et al. (2022) examined emerging economies and reported that both FDI and trade openness contribute to carbon emissions, although renewable energy adoption can mitigate these adverse effects.

Recent panel studies further emphasize the conditional nature of the trade–FDI–environment relationship. For example, Zhang et al. (2023) found that while trade openness initially increases environmental degradation, it may improve environmental quality in the long run through technology transfer and efficiency gains, thus supporting the EKC hypothesis. In the same vein, Khan et al. (2024) demonstrated that institutional quality and environmental regulations play a crucial moderating role, reducing the negative environmental impacts of FDI inflows. Likewise, Mensah et al. (2025) showed that green innovation and renewable energy adoption significantly offset the environmental damage associated with trade and FDI in Sub-Saharan Africa.

2.2 Economic Growth, Trade Openness and Environmental Degradation Nexus

The relationship between economic growth, trade openness, and environmental degradation has been extensively examined within the Environmental Kuznets Curve (EKC) framework, which posits an inverted U-shaped relationship between income and environmental pressure. However, empirical evidence remains mixed and highly context-specific.

Murshed and Dao (2022) investigated the role of export quality in shaping the relationship between carbon dioxide (CO_2) emissions and income in South Asia. Their findings indicate that the environmental impact of economic growth is conditional on export quality, as evidenced by the statistical significance of the interaction term between income and export sophistication. This suggests that higher-quality, technology-intensive exports may mitigate the environmental costs of growth. Similarly, Nathaniel, Nwulu, and Bekun (2021) examined Latin American and Caribbean countries and found that economic growth and urbanisation significantly increase CO_2 emissions, thereby exacerbating environmental degradation. The study further reported bidirectional causality between economic growth, globalisation, urbanisation, and emissions, highlighting the feedback effects within the growth–environment nexus.

In another related study, Nathaniel, Murshed, and Bassim (2021) assessed the effectiveness of environmental regulations in moderating the relationship between economic growth, energy consumption, trade openness, and ecological footprints. Using advanced panel techniques such as Augmented Mean Group (AMG), Common Correlated Effects Mean Group (CCEMG), and Driscoll–Kraay (DK) estimators, the study found that existing environmental regulations were largely ineffective in reducing ecological footprints. Moreover, increased energy consumption and trade openness were found to significantly worsen environmental quality.

Focusing on Nigeria, Ajayi and Ogunrinola (2020) analysed the dynamic relationship between economic growth, trade openness, and environmental degradation over the period 1960–2017. Their findings reveal that trade openness and population growth exacerbate environmental degradation in the short run, while financial development helps to mitigate environmental damage in both the short and long run. Additionally, real income per capita was found to have a positive and significant effect on environmental degradation across both time horizons, lending support to the upward-sloping phase of the EKC.

Balsalobre-Lorente et al. (2022) found that economic growth and trade openness increase environmental degradation in emerging economies, although renewable energy consumption plays a mitigating role. Similarly, Usman et al. (2023) reported that while economic growth initially leads to higher emissions, technological innovation and human capital development can reverse this trend in the long run, thereby supporting the EKC hypothesis. In a related study, Ahmed et al. (2024) demonstrated that trade openness significantly contributes to carbon emissions in developing countries, particularly where environmental regulations are weak.

African-focused studies also provide important insights. For example, Mensah et al. (2023) found that economic growth and trade openness increase CO_2 emissions in Sub-Saharan Africa, but improvements in institutional quality and environmental governance can significantly reduce these effects. Likewise, Adebayo et al. (2025) showed that economic growth, when combined with fossil fuel dependence and weak regulatory frameworks, intensifies environmental degradation in Nigeria, whereas renewable energy adoption offers a pathway to sustainability.

3.0 Methodology

3.1. Theoretical Framework

The theoretical framework of the study was based on "stochastic, Impacts by Regression on Population, Affluence and Technology (STIRPAT), otherwise known as IPAT model (Dietz & Rosa, 1997)". The IPAT model tied "environmental impact to population, affluence, and technology". Dietz and Rosa (1997) presented a stochastic variant of IPAT to address the problem of strict proportionality of the equation as stated in equation 3.1;

$$I_{it} = \beta_0 P_{it} A_{it} T_{it} e_{it} \quad (3.1)$$

Where, I, P, A, T, and e stand for Impact of human activities on the environment, usually measured in terms of pollutants emission level, population, affluence, technology, and the error term. To explore the international trade & environmental degradation nexus in Nigeria the STIRPAT model is modified as follows:

$$\log I_t = \beta_1 P_t + \beta_2 A_t + \beta_3 T_t + \beta_4 Trop_t + \beta_5 ENP_t + \beta_6 TRP_t + e_t \quad (3.2)$$

Whereas, log represents natural logarithm, t represents period, I represents impact on the environment captured by ecological footprint, P is measured by the urbanization, A is measured in terms of GDP per capita, and T denotes technological advancement, Trop stands for trade openness, ENP represent Environmental policy which was captured by the government expenditure on renewable energy, TRP stands for Trade policy which was captured by the Tariff respectively. However, β_1, β_2, β_3, β_4, β_5 and β_6 indicate the parameters of environmental effect for P, A, T, trade openness, environmental policy and trade policy, respectively.

3.2 Data and Methodology

The data are annual time series data collected from secondary sources spanning from 1982 to 2023 i.e. 41 years. The data was sourced from the Central Bank of Nigeria (CBN) statistical bulletin (2024) and World Bank Indicators (2024). The dependent variable for the research work is environmental degradation ED, proxied by ecological footprint. The independent variables are: urbanisation, GDP, technology, trade openness, environmental policy and trade policy. The study employed the Autoregressive Distributed Lag Model (ARDL) to estimate the long-run mechanism of the indicators of international trade and environmental degradation.

Table 3.1: Variables, Measurements and Sources

Variables	Measurements	Sources
Environmental degradation	Ecological footprint	World Bank Indicator (2024)
Trade openness	TROP(% of GDP)	World Bank Indicator (2024)
Trade Policy (TRP) (Tariff)	TARIF RATE, applied, weighted mean, all products (%)	Central Bank of Nigeria (CBN) Statistical Bulletin (2025)
Environmental policy (ENP) (Government expenditure on renewable energy)	Government expenditure on renewable energy EXREN (In Billion Naira)	Central Bank of Nigeria (CBN) Statistical Bulletin (2024), World Bank Development Indicator (2024)
Real GDP	RGDP (In Billion Naira)	Central Bank of Nigeria (CBN) Statistical Bulletin (2024)
Technology	TECH (Technology achievement index)	Central Bank of Nigeria (CBN) Statistical Bulletin (2024)
Urbanization	(% of total population*)*	World Bank Development Indicator (2023)

Source: Researchers' compilation (2025)

Table 3.1 shows the summary of variables employed in this study, their respective measurements and sources of data.

4.0 Results Presentation and Analysis

4.1 Presentation of Results

4.1.1 Descriptive Statistics

The result obtained indicates that all the variables are normally distributed except trade openness and urbanisation. However, as stated by the central limit theorem, that non normality of empirical data does not prohibit empirical research (Koutsoyiannis, 1977).

Table 4.1 Result of Descriptive Analysis of the Variables

YEAR	LOGED	TROP	TRP	ENP	RGDP	TECH	URBAN
Mean	18.68666	31.60594	19.65262	86.92000	38996.98	0.140056	37.36910
Median	18.73447	33.38961	16.21000	86.23000	28999.80	0.112281	36.08850
Maximum	19.02504	53.27796	91.27000	99.21000	74752.42	0.564540	53.52100
Minimum	18.24348	9.135846	8.220000	80.64000	16211.49	0.000349	22.67100
Std. Dev.	0.276470	12.28486	15.72518	4.577909	21073.79	0.136626	9.142843
Skewness	0.269574	0.246291	3.150050	1.066218	0.524425	1.775963	0.177712
Kurtosis	1.423062	2.169051	3.530544	3.589276	1.632513	5.342634	1.847624
Jarque-Bera	4.860473	1.632947	263.5212	8.565421	5.197657	31.68220	2.545022
Probability	0.028016	0.441988	0.000000	0.013805	0.004361	0.000000	0.280127
Sum	784.8396	1327.450	825.4100	3650.640	1637873.	5.882350	1569.502
Sum Sq. Dev.	3.133867	6187.626	10138.54	859.2474	1.820110	0.881469	3427.255
Observations	42	42	42	42	42	42	42

Source: Researchers' computation using Eviews 12

4.1.2 Multi-Collinearity Test

A multi-collinearity test was conducted to ensure the absence of a linear relationship among the explanatory variables. Table 4.2 shows that the entire pairwise correlation matrix is not greater than 0.8. This implies there is an absence of multicollinearity among the variables in the model, signifying that each independent variable in the model influences the dependent variable differently.

Table 4.2: Result of Correlation Matrix for Multi-Collinearity Test

VARIABLES	LOGED	TROP	TRP	ENP	RGDP	TECH	URBAN
LOGED	1.000000	0.444362	-0.479722	-0.772606	0.778589	-0.090692	0.725934
TROP	0.444362	1.000000	-0.033480	-0.533507	0.103653	-0.032842	0.261334
TRP	-0.479722	-0.033480	1.000000	0.222209	-0.471458	0.549638	-0.414406
ENP	-0.772606	-0.533507	0.222209	1.000000	-0.692529	-0.086042	-0.705831
RGDP	0.778589	0.103653	-0.471458	-0.692529	1.000000	-0.025098	0.768567
TECH	-0.090692	-0.032842	0.549638	-0.086042	-0.025098	1.000000	0.047007
URBAN	0.725934	0.261334	-0.414406	-0.705831	0.768567	0.047007	1.000000

Source: Researchers' computation using Eviews 12

4.1.3 Unit Root Test

The ADF/PP stationarity test results in Table 4.2 showed that at first difference, the value of environmental degradation, trade openness, RGDP, tariff, expenditure on renewable energy, and urbanisation are greater than their critical values at 5% respectively. Therefore, we reject H_0 of ED, TROP, RGDP, TRP, EXREN and URBAN and then conclude that they are stationary at first difference. Also, the value of the ADF test of technology is greater than its critical values at 5%. Therefore, we reject H_0 of TECH and conclude that TECH is stationary at the level form. This implies that the variables of the model are integrated of mixed order (order one and zero).

Table 4.3: Unit root Test; Results of ADF & Philip-Perron Test

Variables	ADF test at level form	PP test at level form	ADF test at 1st Diff.	PP test at 1st Diff.	ADF 5% critical values	PP 5% critical values	Order of integration
LOGED	-1.289622	-1.380822	-6.964472	-6.957553	-3.526609	-3.526609	I(1)
TROP	-2.400375	-2.312959	-4.937328	-13.33665	-3.557759	-3.526609	I(1)
TRP	-3.317816	-3.109441	-6.687085	-13.92004	-3.526609	-3.526609	I(1)
ENP	-1.925633	-1.925633	-5.469832	-5.469832	-3.526609	-3.526609	I(1)
RGDP	-2.295329	-2.305327	-3.586009	-3.586009	-3.526609	-3.526609	I(1)
TECH	-4.596291	-3.804714			-3.526609	-3.523623	I(0)
URBAN	-2.126363	-0.849676	-4.783654	-3.895353	-3.526609	-3.526609	I(1)

Source: Researcher's computation using Eviews 12.

4.1.4 Bound Cointegration Test

Given that the series are integrated of order zero and order one (I(1) and I(0)), the Bound cointegration approach was used to ascertain whether a long-run relationship exists between the variables of the model.

The Bound cointegration approach was employed to estimate the link among the variables. The logic behind the use of this approach is: first, Bound can be applied regardless of whether the series are stationary at level I(0) or after first difference I(1) or a combination of two mutually. Null hypothesis (H_0): there is no cointegration among the variables.

Alternative hypothesis (H_1): there is cointegration among the variables

The result verifies that there is no evidence of cointegration among the variables. This is due to the fact that the F-Statistics value (21.60) is greater than both the lower and upper critical bounds for all the significant levels. This leads to the rejection of null hypothesis of no cointegration. The result is summarized and presented in Table 4.4.

Table 4.4: ARDL Bounds Test		
F-Statistics = 21.60515		
Critical Value Bounds		
Significance levels	**I(0) Bounds**	**I(1) Bounds**
10%	2.12	3.23
5%	2.45	3.61

Source: Researcher's computation using Eviews 12.

Since the bounds test indicated the presence of long run relations among the variables, the study then estimated the long run model to ascertain the long run coefficients of the variables of the model.

4.1.5 ARDL Result

The coefficient of the constant implies that if trade openness, trade policy, environmental policy, real GDP, technology and urbanization are set equals to zero, environmental degradation will increase by about 19.8 percent point. The coefficient of trade openness is 0.010, which implies that with the influence of all other variables held constant, an increase in the trade openness by one percent on the average, will lead to an increase in environmental degradation by about 0.010 Percent point. The coefficient of trade policy is -0.001, this suggest that all things being equal, as trade policy (tariff) increases by one percent on the average, environmental degradation will decrease by about 0.001percent point.

Table 4.5: ARDL Long Run Result

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
TROP	0.010545	0.003914	2.522290	0.0196
TRP	-0.001567	0.000399	-3.779985	0.0050
ENP	-0.002043	0.000701	-2.859047	0.0043
RGDP	0.000046	0.000021	2.246139	0.0058
TECH	-1.614648	0.820778	-1.967215	0.0967
URBAN	0.084459	0.031268	2.760739	0.0288
C	19.856034	1.688344	11.760658	0.0000
CointEq(-1)	-0.327091	-0.327091	-2.810329	0.0202
R^2 = 0.98	Adj. R^2 = 0.88	F-stat = 120.88	Prob. = 0.0000	D.W = 1.97

Source: Researcher's computation using Eviews 12

The coefficient of environmental policy (government expenditure on renewable energy) is -0.002, which implies that with the influence of all other variables held constant, an increase in the environmental policy (government expenditure on renewable energy) by one percent on the average leads to a decrease in environmental degradation by about 0.002 Percent point. The coefficient of real gross domestic product (RGDP) is 0.000046, which implies that with the influence of all other variables held constant, an increase in the real gross domestic product by one percent on the average leads to an increase in environmental degradation by about 0.000046 Percent point. The coefficient of the technology is -1.61, this suggest that all things being equal, as technology increases by one percent on the average, environmental degradation will decrease by about 1.61 percent point. More so, the coefficient of urbanization is given as 0.08, which implies that with the influence of all other variables held constant, an increase in urbanization by one percent on the average, will lead to an increase in environmental degradation by about 0.08 Percent point.

R^2 and Adjusted R^2 From the regression table, it can be observed that multiple coefficient of determination (R^2) is given as 0.98 or 98.0%. This means that about 98.0% of the variation in environmental degradation is explained by changes in trade openness, trade policy, and environmental policy, RGDP, technology and urbanization. The remaining 0.02% is explained by other variables not included in the model. The adjusted R^2 is reported as the multiple coefficient of determination adjusted to take into account the degrees of freedom associated with the sum of squares. The Adjusted R^2 is given as 0.88 or 88.0%. This implies that about 88.0% of the fluctuations in the dependent variable, environmental degradation, are jointly explained by the fluctuations in the explanatory variables.

4.1.6 Test for Autocorrelation:

Empirical results from the Durbin-Watson (D-W) test show that the computed D-W for all models is 1.97. While the result from Durbin-Watson (D-W) tabulated lower case (d_L) is equal to 1.160 and 1.222, Durbin-Watson (D-W) tabulated upper case (d_u) is equal to 1. and 1.726, respectively. We conclude that there is no evidence of autocorrelation or no autocorrelation with a first-order scheme in the specified models.

4.1.7 F-Statistic Test

Since F_{cal} = 120.88 is greater than the $F_{0.05}$ (7, 34) = 5.75 in Table 4.6, we reject H_0. Thus, we conclude that the slope coefficients are not simultaneously equal to zero; hence, there is a joint significance of the variables used in the model, which implies that there is a strong relationship between the regressand (Environmental degradation) and trade openness, trade policy, environmental policy, RGDP, technology and urbanisation.

Table 4.6: Summary of the F-Statistics Test

F-statistics	$F_{0.05}(7,34)$	Decision Rule	Conclusion
120.88	5.75	$F_{cal} > F_{tab}$. Reject H_0	Statistically Significant

Source: Researcher's computation using Eviews 12

4.1.7 Evaluation Based on Economic a Priori Criteria

The results in Table 4.7 revealed that all variables of interest conformed to their a priori expectations.

Table 4.7: Summary of Economic a Priori Criteria

Dependent Variable LOGED

Variables	Expected Signs	Observed Sign
TROP	Positive	Positive
TARIFF	Negative	Negative
EXREN	Negative	Negative
RGDP	Positive	Positive
TECH	Negative	Negative
URBAN	Positive	Positive

Source: Researchers' compilation (2026)

4.1.8 Evaluation Based on Statistical Criteria/Evaluation of Research Hypothesis

Table 4.8 summarises the statistical significance of the variables at 5% level. From the results, we conclude that on the individual significance of the variables included in the model, trade openness, tariff, government expenditure on renewable energy, RGDP, and urbanisation are statistically significant at 5% level of significance.

Table 4.8: Summary of the t-test

Variable(s)	t-statistic	Critical-Value	Decision Rule	Conclusion
C	11.76	2.04	Reject H_0	Statistically Significant
TROP	2.522	2.04	Reject H_0	Statistically significant
TARIFF	-3.779	2.04	Reject H_0	Statistically Significant
EXREN	-2.859	2.04	Reject H_0	Statistically Significant
RGDP	2.246	2.04	Reject H_0	Statistically Significant
TECH	-1.967	2.04	Reject H_0	Statistically Insignificant
URBAN	2.760	2.04	Reject H_0	Statistically Significant

Source: Researcher's computation using Eviews 12

4.1.9 Heteroscedasticity Test

According to Gujaratti (2013), Heteroscedasticity means unequal measures of an observed value of the dependent variable around the regression line. From the result in Table 4.9, since the Obs* R-squared of the probability chi-square is greater than 0.05 i.e. 0.2686, we therefore reject H_0 and conclude that errors in the regression have constant variance.

Table 4.9: Heteroscedasticity Test:

F-statistic	**2.6234**	**Prob. F(31,6)**	**0.1146**
Obs*R-squared	35.389	Prob. Chi-Square(31)	0.2686
Scaled explained SS	1.0643	Prob. Chi-Square(31)	1.000

Source: Researcher's computation using Eviews

4.2 Discussion of Findings

The empirical results indicate that trade openness, tariffs, government expenditure on renewable energy, real GDP, technology, and urbanisation significantly influence environmental degradation in Nigeria, consistent with a priori expectations. The statistical significance of these variables implies that policy actions targeting any of them will have measurable environmental consequences.

Trade openness exhibits a positive and significant relationship with environmental degradation. Specifically, a 1% increase in trade openness leads to approximately a 0.010% increase in environmental degradation, ceteris paribus. This suggests that increased participation in international trade exacerbates environmental pressure in Nigeria. The finding is largely attributed to Nigeria's export structure, which is dominated by primary commodities such as crude oil and raw materials. The extraction and processing of these resources are environmentally intensive, thereby increasing ecological damage. This outcome aligns with the Pollution Haven Hypothesis, which posits that pollution-intensive industries relocate to countries with weaker environmental regulations. The result is also consistent with Ajayi and Ogunrinola (2020), who found that trade openness contributes to environmental degradation in Nigeria.

In contrast, government expenditure on renewable energy shows a negative and significant relationship with environmental degradation. This indicates that increased investment in renewable energy reduces environmental harm. Renewable energy sources such as solar, wind, and hydro generate lower greenhouse gas emissions compared to fossil fuels, thereby reducing pollution and mitigating climate change. Additionally, such investments promote energy efficiency, support the development of green industries, and encourage the adoption of sustainable technologies. Over time, these benefits contribute to environmental sustainability and economic resilience.

Tariffs, as a proxy for trade policy, also demonstrate a negative relationship with environmental degradation. This suggests that higher tariffs may reduce environmental pressure by limiting the volume of trade and, consequently, the scale of environmentally harmful production and consumption. However, while tariffs may reduce environmental degradation in the short run, they can also hinder access to cleaner technologies and reduce the efficiency gains associated with international specialisation. Thus, their environmental impact is context-dependent.

Real Gross Domestic Product (RGDP) is found to have a positive and significant relationship with environmental degradation, implying that economic growth in Nigeria is currently associated with increased environmental harm. This reflects the resource-intensive nature of economic activities, increased energy consumption, and weak enforcement of environmental regulations. The finding supports the early stage of the Environmental Kuznets Curve (EKC) hypothesis, where growth leads to environmental deterioration before eventual improvement at higher income levels.

Technology, on the other hand, exhibits a negative relationship with environmental degradation, indicating that technological advancement contributes to environmental improvement. Innovations in renewable energy, waste management, and resource efficiency reduce pollution and enhance sustainability. Furthermore, advancements in environmental monitoring and data analytics improve environmental governance. However, it is important to note that certain technological activities, such as electronic waste generation, may still pose environmental risks if not properly managed.

Finally, urbanisation shows a positive and significant impact on environmental degradation. Rapid urban growth increases demand for energy, water, and infrastructure, leading to higher resource consumption and pollution levels.

Urbanisation is often accompanied by industrialisation, increased vehicular emissions, and land-use changes such as deforestation, all of which contribute to environmental stress.

Overall, the findings highlight the dual role of economic and trade-related factors in shaping environmental outcomes. While trade openness and economic growth tend to exacerbate environmental degradation, renewable energy investment and technological advancement offer viable pathways for environmental sustainability. This underscores the need for integrated policy frameworks that align economic development with environmental protection in Nigeria.

5.0 Conclusion, Policy Implications and Recommendations

5.1 Conclusion

This study examined the nexus between international trade and environmental degradation in Nigeria, with particular emphasis on the roles of trade openness, tariffs, government expenditure on renewable energy, real GDP, technology, and urbanisation. The findings reveal that trade openness, economic growth, and urbanisation significantly exacerbate environmental degradation, while government expenditure on renewable energy, tariffs, and technological advancement contribute to environmental improvement. These results confirm that economic expansion and integration into global markets, when not properly managed, can intensify environmental pressures. At the same time, targeted policy interventions and technological progress can mitigate these adverse effects.

The positive relationship between trade openness and environmental degradation suggests that Nigeria's export structure—dominated by primary commodities—remains environmentally unsustainable. Similarly, the positive impact of economic growth on environmental degradation indicates that the country is still at the early stage of the Environmental Kuznets Curve (EKC), where growth is accompanied by increased environmental harm. Urbanization further compounds environmental challenges through increased resource consumption, pollution, and land-use changes. Conversely, the negative relationship between renewable energy expenditure and environmental degradation highlights the importance of transitioning to cleaner energy sources. The beneficial role of technology also underscores the importance of innovation in achieving environmental sustainability.

5.2 Policy Implications

The findings of this study have important policy implications. First, they highlight the need for integrating environmental considerations into trade policies. Trade openness, while beneficial for economic growth, must be accompanied by strict environmental regulations to prevent ecological damage. Second, the results emphasise the importance of energy transition policies. Increased government expenditure on renewable energy can significantly reduce environmental degradation and support sustainable development. Third, the role of technology suggests that innovation and technological diffusion should be central to environmental policy frameworks. Finally, the impact of urbanisation calls for improved urban planning and sustainable infrastructure development.

5.3 Recommendations

Achieving environmental sustainability in Nigeria requires a balanced approach that aligns economic growth, trade openness, and environmental protection. By implementing appropriate policies and investing in sustainable technologies, Nigeria can mitigate environmental degradation while maintaining economic development. This can be achieved through the following key recommendations;

1. Strengthen Environmental Regulati ons: The government should enforce stricter environmental standards, especially in export-driven sectors like oil, mining, and agriculture, to reduce environmental degradation.

2. Promote Renewable Energy Invest ment: Greater investment in renewable energy (solar, wind, and hydro) should be prioritised to reduce reliance on fossil fuels and lower emissions.

3. Adopt Green Trade Policies: Trade policies should integrate environmental standards, including incentives for eco-friendly exports and penalties for harmful practices.

4. Enhance Institutional Capacity: Ins titutions responsible for environme ntal monitoring and enforcement should be strengthened to ensure effective implementation of regulations.

5. Encourage Sustainable Urban Plan ning: Urban development should focus on efficient land use, improved public transport, and green infrastructure to reduce environmental pressure.

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