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Research Article

Environmental Taxes and Environmental Degradation in Nigeria: A Nonlinear Approach

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Abstract

The research examines the impact of environmental taxes on environmental degradation in Nigeria. The series of data covered is from 1981 to 2021 which was analysed using a Nonlinear Autoregressive Distributive Lag (N.A.R.D.L) and Diks-Panchenko causality model. The empirical findings reveal that positive and negative change in government tax displayed a negative and positive impact on CO_2 emissions, respectively. Similarly, the positive change in government expenditure enhances environmental degradation. However, the impact of energy consumption (as moderating factor) has a positive relationship with CO_2 emissions and it confirmed it as major causes of anthropogenic CO_2 emission in Nigeria. Furthermore, the nonparametric causality model indicated bidirectional causality between government expenditure and environmental degradation, whereas government tax and environmental degradation, energy consumption and environmental degradation have a unidirectional causality. Thus, the fiscal policy remains essential instruments for promoting environmental quality in Nigeria. This suggests that environmental taxes and government expenditures should be proposed by the Government to mitigate environmental degradation and by enhancing a lower carbon production technology that are environmentally-friendly in Nigeria.

Keywords: *Fiscal Policy; Environmental Degradation; Nonlinear ARDL; Nigeria.*

Introduction

In the economic literature, environmental taxes have been considered as one of the key instruments used to mitigate the negative effects of environmental degradation. Environmental taxes are constraining agents that affect the consumption of fossil fuels such as diesel/petrol. The need for economic growth, fast-growing population, industrialization, transportation, and globalization necessitates the need for exorbitant energy consumption predominantly fossil fuels and other alternative ones in developing economies, thus, raising alarm for environmental degradation due to high level of energy consumption (i.e anthropogenic activities). Although energy is considered an important component in the development agenda, as it is essential for improving human welfare and raising the standard of living (UNDP, 2010). However, the type of energy use in most developing countries, especially Nigeria, is considered to be harmful and hostile to the economic development and ecosystem as a result of greenhouse effects consequences, although Nigeria cannot avoid fossil fuel consumption, but it can minimize it due to the environmental pollution from the use of it (Ogundipe et al., 2020). Fossil Fuels are the main sources of energy consumption, consisting of oil, coal, and natural gas, and their consumption constitute about 19.04 percent of total energy consumed in 2014 in Nigeria, which implies that Nigeria is not free from problems attributable to the use of fossil fuel (Ogundipe *et al.,* 2018). This is the main reason behind the environmental loss. Thus, Global Economies are now facing the mounting effects of environmental challenges caused by the greenhouse effect which is projected to worsen gradually as anthropogenic CO_2 emissions increase.

The World Health Organization (WHO) has estimated that 13.7 million deaths, of which 2.2 million deaths are from the African region, each year have been attributable to unhealthy environmental related diseases, while 8.2 million deaths are due to non-communicable diseases which mostly ascribed to air pollution (WHO, 2016). The report emphasizes that if countries do not take urgent action to make the environment healthy, millions of individuals will continue to become ill and die at a young age. Recently, it has been forecasted that between 2030 and 2050, climate change is expected to cause an additional approximately 250,000 deaths per year and cost about USD 2-4 billion/year by 2030 (WHO, 2021). Whereas, greenhouse CO_2 emission have been increasing annually due to human activities (such as energy consumption) which hurts humanity (Chindo *et al.* 2015).

The challenges facing the global economies and Nigeria in particular, as a result of a tradeoff between economic growth and environmental quality, is a global dilemma (Ullah et al., 2020), and these called for urgent actions, especially from the part of the government, its involvement through effective economic policies like fiscal policy is highly needed. Fiscal policy through government spending and taxation (for example environmental taxes and carbon tax) are used to regulate not only the economic activities but also to protect the environmental quality. Recent literature on environmental dynamics gave more attention to the relationship between economic growth and the environment except very few that investigated on the impact of fiscal policy on the environment in Nigeria, these motivate this study to investigate on the extent to which fiscal instruments-environmental taxes can affect the environmental pollution control in Nigeria.

The article is organized as follows: Section 2 analysed the theoretical and empirical literature; section 3 of the article presented the methodology adopted and used for the study. While section 4 discusses the estimated results and conclusions was presented in section 5 of this article.

Literature Review

This section discusses the theoretical framework and empirical literature reviews as follows:

Theoretical Framework

A Pigouvian tax theory is an economic theory that we adopted to this study as it relates taxation with environmental degradation, in other words negative externalities. Pigou (1932) argued that government should tax the producers for engaging in activities that create negative externalities to society, the cost arising from these negative externalities is not necessarily reflected in the final cost of the products or services, then it should be taxed at a rate equal to the marginal external costs at the efficient level of output (Kagan, 2020). The main purpose of the Pigouvian tax has been using to discourage activities that cause social cost implication which are not reflected in the market price, so this negative implication might be corrected by levying taxes on the producers.

Furthermore, Environmental Kuznets Curve (EKC) hypothesis is an environmental hypothesis that explains the nexus between environmental quality and economic growth. It suggests that the environment worsen at the initial stage of economic development, but after some level of economic growth, the environmental degradation reduces gradually. As Dinda (2004) enumerated that the EKC hypothesis postulates an inverted U-shaped relationship between environmental degradation and economic growth, i.e., environmental degradation increases at early stages of economic development up to a certain point where environmental deterioration decreases as economic growth continues in the long run.

Empirical Literature Review

Morley (2012) used system Generalized Method of Moments (GMM) techniques to investigate the impacts of environmental tax on environmental degradation with annual data from European countries from 1995 to 2006. The study empirically revealed that environmental tax in European countries has negative impact on reducing environmental pollution. Miller and Vela (2013) used 50 countries among international economies and analyzed the effectiveness of environmental taxes by employing panel cross-sectional regression techniques, the outcomes of the study indicated that countries with higher revenues from these environmental taxes exhibit higher reductions in CO_2 emissions and energy consumption. Aydina and Esen (2018) employed Panel data techniques (GMM) to investigate the effect of environmental tax on carbon dioxide (CO_2) emissions on annual data (1995-2013) of EU member states. The findings reveal that the impact of environmentally related taxes on CO_2 emissions is statistically negative.

Moreso, Hashmi and Alam (2019) explore the role of environment-friendly patents and environmental-related taxes in promoting green technology and mitigating CO_2 emissions. It uses GMM and fixed effect techniques of analysis for the estimation, it employed annual data of 29 OECD countries (1990-2014), the outcomes of the study provided that enhancement in environmental tax revenue per capita helped to mitigate the CO_2 emission significantly. Another empirical study conducted by He *et al.* (2019) examined the relationship of the carbon emission and environmental taxes in 35 countries of Organization for Economic Cooperation and Development (OECD) countries and 31 Chinese provinces by employing panel ARDL techniques. The result have shown that from the overall regression results, environmental taxes help to negates CO_2 emissions, both in OECD countries and China.

Furthermore, Hao et al., (2020) investigated on the effect of green growth and environmental tax on CO_2 emissions in G7 countries. It employed CS-ARDL model, from a period of 1991 to 2017. The study shows that both ARDL and NARDL results for green growth reduce CO_2 emissions. Moreover, environmental tax, human capital, and renewable energy use are found to decrease CO_2 emissions as well. Bashir et al., (2020) assessed the environmental tax's impact on CO_2 emissions in OECD countries and other renewable energy and financial development for the period of 1995-2015. The study employed the GMM and quantile regression tecniques. The estimated results endorsed a negative effect of environmental taxes on environmental degradation. Similarly, Thi et al., (2020) conducted a study in Vietnam and examined the influence of environmental tax on CO_2 emissions. The study adopted multivariate regression model to analyses the relationship among various variables, including environmental taxation with CO_2 emissions for the period 2001-2018. The result revealed that the increase in environmental tax collection significantly decreases carbon emissions. Moreover, Ulucak and Kassouri (2020) assessed the non-linear influence of environmental taxes on CO_2 emissions through new mechanics and innovative green technologies. The study employed panel smooth transition regression analysis for the period of 1994 to 2015. The empirical results declared that ERT has a negative effect on CO_2 emissions at the high level of globalization.

Degirmenci and Aydin (2021) have studied the effects of environmental taxes on environmental pollution and unemployment using panel co-integration analysis and AMG estimators for the validity of the double dividend hypothesis on some selected African countries with coverage data of 1994-2017. The findings of this study shows that environmental taxes increased environmental degradation and unemployment in some countries under study while showing environmental restoration and employment in others. Tao et al., (2021) evaluated the dynamic effect of eco-innovation and environmental taxes on the carbon neutrality target in emerging seven (E7) countries from 1995-2018. The study employed panel data techniques (CS-ARDL and AMG estimators) and its finding reveals that eco-innovation and environmental taxes play a major role in carbon abatement and there is the existence of Environmental Kuznet Curve (EKC) in E7 countries. Another research by Safi et al., (2021) investigates the impact of environmental taxes and environmental research and development (R & D) on consumption-based carbon emissions for G-7 countries over a period of 1990 to 2019. The study used the ARDL model for empirical analysis which indicated that both the short-run and long-run, environmental taxes, environmental R & D, and exports vehemently reduce carbon emissions, while GDP and imports significantly enhance carbon emissions.

Wolde-Rufael and Mulat-Weldemeskel (2021) assessed the impact of environmental taxes and stringent environmental policy in reducing CO_2 emissions in a panel of 7 emerging economies over the period 1994–2015. As the research used heterogeneous panel techniques (augmented mean group-AMG estimator). The study indicated a negative relationship between CO_2 emissions and environmental taxes. A recent study conducted by Rafique et al., (2022) has explored the heterogenous impacts of environmental taxes on the environmental footprints of developed economies. Empirically it employed panel ARDL techniques for its analysis. The estimated results revealed that environmental taxes, economic growth, foreign direct investment, energy use, urbanization, renewable energy, and industrialization all have impact on the long-term ecological footprint in OECD countries. Shayanmehr et al. (2023) explore the role of environmental tax on ecological footprint using Panel GMM techniques with robustness of the method of moment quintile regression results. The outcome of the empirical study confirmed that environmental tax reduces environmental degradation.

In Nigeria, Osinusi et al., (2024) conducted an empirical research on the nexus between fiscal policy, Foreign Direct investment and environmental degradation. It's used ARDL techniques and the outcome of the study confirmed that fiscal instruments promote foreign direct investment and mitigate carbon emissions in Nigeria. Similarly, Ademola et al., (2024) investigate the impact of fiscal policy on ecological footprint in Nigeria. They have adopted ARDL techniques of analysis and finally, the results indicate that environmental tax reduces environmental degradation while government expenditure escalates it in Nigeria. For research gaps, having reviewed the available literature on the nexus between fiscal policy and environmental degradation, it is observed that very few studies employed a nonlinear method of analysis (Nonlinear ARDL) on the relationship between fiscal policy and environmental dynamics in the context of Nigeria.

METHODOLOGY

This research employed secondary sources of data from 1981-2021. The secondary data is collected from World Development Indicators, World Bank (2021) and the Statistical Bulletin, CBN (2021). The study used CO_2emissions as dependent variable and for environmental degradation, while the independent variables are Fiscal Policy proxied as government expenditures and total tax revenue, and economic growth (GDP annual growth) to present the overall performance of the economy. The study conducts unit root test using Augmented Dickey-Fuller (ADF), Phillip Perron (PP) test and Kapetanios, Shin and Shell (KSS) nonlinear unit root test. Then the Bound test and Wald test of the nonlinear cointegration test. Causal relationship between the variables was calculated using Diks-Panchenko's (2006) nonlinear Granger causality test.

Model Specification

The research adopts the model of Ullah et al., (2020) for both linear and nonlinear approaches with some modifications. The mathematical Model is specified as:

CO_2= f (GE, TR, EG)…………………………….................................. (3.1_a)

CO_2= f (GE, TR, EG, EC) .... (3.1_b)

Where CO_2 = Carbon dioxide emissions. GE = government expenditure. TR =Total tax revenue, EC= energy consumption and EG=economic growth of Nigeria.

The study used Pesaran et al., (2001) ARDL approach to the error-correction framework and cointegration as:

$$\Delta CO_{2t} = \beta_0 + \sum_{i=1}^{n1} \mu i\, \Delta CO_{2,t=1} + \sum_{i=0}^{n2} \theta i\, \Delta GE_{t=i} + \sum_{t=0}^{n3} \delta 1\, \Delta TR_{t=1} + \sum_{i=0}^{n5} \nu 1\, EG_{t=1} + \beta_1 CO_{2,t-i}$$

$$+\beta_2 GE_{t-i} + \beta_3 TR_{t-i} + \beta_4 EG_{t-i} + \alpha_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (3.3_a)$$

$$\Delta CO_{2t} = \beta_0 + \sum_{i=1}^{n1} \mu i\, \Delta CO_{2,t=1} + \sum_{i=0}^{n2} \theta i\, \Delta GE_{t=i} + \sum_{t=0}^{n3} \delta 1\, \Delta TR_{t=1} + \sum_{i=0}^{n4} \rho 1\, EC_{t=1} + \sum_{i=0}^{n5} \nu 1\, EG_{t=1} + \beta_1 CO_{2,t-i}$$
$$+\beta_2 GE_{t-i} + \beta_3 TR_{t-i} + \beta_4 EC_{t-i} + \beta_5 EG_{t-i} + \alpha_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (3.3_b)$$

Following Shin et al., (2014) nonlinear methodology, we generate partial sum with four new time series that are decomposed as follows:

$GE_t = GE_t^+ \pm GE_t^-$ and $TR_t = TR_t^+ \pm TR_t^-$. The decomposition was further defined as $GE_t^+ = \sum_{n=1}^{t} \Delta\, GE_t^+$, $GE_t^- = \sum_{n=1}^{t} \Delta\, GE_t^-$, $TR_t^+ = \sum_{n=1}^{t} \Delta\, TR_t^+$ *and* $TR_t^- = \sum_{n=i}^{t} \Delta\, TR_t^-$

Therefore, to further construct the asymmetric mathematical equation as our model, we can replace the government expenditure and government revenue with these: $GE_t^+, /TR_t^+$ *and* $GE_t^-, /TR_t^-$ in equation (3) as:

$$\Delta CO_{2,i} = \beta_o + \sum_{i=1}^{n1} \mu i\, \Delta CO_{2,t=1} + \sum_{i=0}^{n2} \theta i\, \Delta GE_{t-i}^+ + \sum_{i=0}^{n3} \nu i\, \Delta GE_{t-i}^- + \sum_{t=0}^{n4} \delta 1\, \Delta TR_{t-i}^+ + \sum_{t=0}^{n5} \phi 1\, \Delta TR_{t-i}^- +$$

$$\sum_{i=0}^{n7} \nu 1\, EG_{t=1} + \beta_1 CO_{2,t-i} + \beta_2 GE_{t-i}^+ + \beta_3 GE_{t-i}^- + \beta_4 TR_{t-i}^+ + \beta_5 TR_{t-i}^- + \beta_6 EG_{t-i} + \alpha_t$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (3.4_a)$$

$$\Delta CO_{2,i} = \beta_o + \sum_{i=1}^{n1} \mu i\, \Delta CO_{2,t=1} + \sum_{i=0}^{n2} \theta i\, \Delta GE_{t-i}^+ + \sum_{i=0}^{n3} \nu i\, \Delta GE_{t-i}^- + \sum_{t=0}^{n4} \delta 1\, \Delta TR_{t-i}^+ + \sum_{t=0}^{n5} \phi 1\, \Delta TR_{t-i}^- +$$
$$\sum_{i=0}^{n6} \rho 1\, EC_{t=1} + \sum_{i=0}^{n7} \nu 1\, EG_{t=1} + \beta_1 CO_{2,t-i} + \beta_2 GE_{t-i}^+ + \beta_3 GE_{t-i}^- + \beta_4 TR_{t-i}^+ + \beta_5 TR_{t-i}^- + \beta_6 EC_{t-i} + \beta_7 EG_{t-i} + \alpha_t$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \; (3.4_b)$$

Where: CO_{2t} = Carbon dioxide emissions, GE_t^+ = positive government expenditure, GE_t^- = negative government expenditure, TR_t^+ =positive total tax revenue, TR_t^- = negative total tax revenue (all represent the positive and negative changes of fiscal policy), EC_t =energy consumption, EG_t =economic growth (GDP growth rate), β_o=constant variables, β_1, β_2, β_3, β_4, β_5, β_6= parameters of the variables and μ_t = error term.

RESULTS WITH DISCUSSION:

Table No. 4.1 Description of Variables

Variables	Symbols	Definition	Data source
Carbon-dioxide emission	CO_2	Carbon-dioxide emission (Kilotons)	World Bank
Government expenditure	GE	Government expenditure (% of GDP)	CBN
Total tax revenue	TTR	Government tax revenue (% of GDP)	CBN
GDP growth	GDP	GDP growth (annual %)	World bank
Energy consumption	EC	Fossil fuel consumption	World bank

Source: Researcher's compilation (2025)

The outcomes of the estimations conducted shows CO_2 emission, government expenditure, total tax revenue and energy consumption are all stationary at first difference of the integration at 1% level of significance while GDP is stationary at level of integration at 1% level of significance for both the method of ADF and PP tests then the variables are characterized as I(0) and I(1).

Table 4.2: Unit Root Test Results

Variable	ADF			PP			KSS (Nonlinear)		
	Level	1st Diff	Dec.	Level	1st Diff	Dec.	Level	1st Diff	Dec.
LCO_2	-5.0297*	-10.069*	I(1)	-4.9764*	-19.999*	I(1)	-2.602**	-5.645*	I(1)
LGE	-0.4032	-7.9700*	I(1)	-0.8287	-7.8482*	I(1)	0.427	-2.356	I(0)
LTTR	-0.1950	-4.6840*	I(1)	-1.4930	-7.9411*	I(1)	0.086	-0.654	I(0)
LGDP	-5.8559*	-4.5503*	I(0)	-5.8503*	-33.446*	I(0)	-2.066	-2.180	I(0)
LEC	-3.2879***	-6.6825*	I(1)	-3.3649***	-8.5101*	I(1)	-2966**	-4.124*	I(1)
Note: *,**,*** donotes significant at 1%, 5% and 10% significance level respectively									

Source: Researcher's estimation using E-views 10 (2025)

While the Table 4.2 also reports the coefficients of Kapetanios, Shin and Shell (KSS) nonlinear unit root tests within the nonlinear framework of ESTAR model, and reveal that LCO_2 and LEC have asymmetric tendencies at level, while the LGDP, LGE and LTTR have pure stationary issues. Therefore, having fulfils the condition of I(0) and I(1) among the variable as shown from the result of KSS nonlinear unit root test, then the study proceed to make use of Nonlinear Autoregressive Distribution Lag (NARDL) bound test for this research analysis.

Table 4.3 provides short-run and long-run results for both linear ARDL and NARDL model A, B and C specifications. The linear ARDL and NARDL short-run model are processed to estimate the short-run of symmetries and asymmetries respectively, as presented in table 4.3. CO_2 is dependent variable. Model A serve as the baseline model that incorporates the main variables of the study (i.e government expenditure (GE), tax revenue (TTR), carbon emissions (CO_2) and economic growth (GDP)). While Model B and Model C, include the moderating factor (i.e energy consumption (EC)) with GE, TTR, GDP and CO_2.

Table 4.3: ARDL and NARDL Coefficient Estimates, CO_2 is the dependent variable

	Short-run Estimates						Long-run Estimates					
Variable	Model A		Model B		Model C		Model A		Model B		Model C	
ARDL Estimates:	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
D(LGE)	--	----	-0.2**	-1.99	-----	----	-0.06	-0.59	-0.02**	-2.30	----	---
D(LTTR)	-0.10	-1.21	-----	----	-0.11***	-1.80	0.02	0.20	-----	--	-0.02	-1.62
D(LEC)	--	---	0.28	0.95	-----	---	----	----	0.77*	2.50	0.53***	1.83
ECM (-1)	-0.81*	-4.06	-0.92*	-6.46	-0.76*	-5.27	-----	----	------	-----	----	----
NARDL Estimates												
D(LGE_POS)	-0.51**	-2.37	-0.79*	-4.11	----	--	0.88**	2.37	0.08	0.46	--	---
D(LGE_NEG)	0.35	0.62	0.47	1.09	-----	--	0.61	1.46	1.07*	2.77	--	--
D(LTTR_POS)	-0.44**	-2.19	----	----	-1.06*	-4.65	-0.57**	-2.11	---	--	0.02	0.22
D(LTTR_NEG)	1.57*	3.01	----	---	-1.06*	-2.77	2.74*	3.59	---	---	-0.20	-0.55
D(LEC_POS)	---	--	1.54*	1.54	1.67**	2.02	---	---	1.84*	2.67	0.80***	1.81
D(LEC_NEG)	---	--	0.10	0.19	---	----	---	---	2.83*	4.97	0.98**	2.51
ECM (-1)	-0.99*	-7.50	-0.79*	-8.62	-0.38*	-5.27						

Source: Researcher's estimation using E-views 10 (2025). *.** and *** indicates 1%, 5% and 10% significance level, respectively. Model A is the baseline model while the moderating models are Model B and C.

In the short-run linear ARDL coefficients, all variables are statistically insignificant in Model A. While the moderating models (Model B and C) reports that government tax is negative and statistically significant at 10% level and this implies that one percentage increase in government tax will reduces CO_2 emission by 0.11%. Government expenditure is negative and significant at 5% level, it means that increase in government expenditure will reduces CO_2 emission by 0.18%.

The speed of adjustment (ECM) for linear ARDL model is negative and statistically significant with 81%, 91% and 76% speed of adjustment for model A, B and C convergence to equilibrium, respectively.

On the other side of the estimates, the NARDL model for short-run estimates, the government expenditure (D(LGE_POS)) is negative and shown statistical significant at 5% and 1% level for the baseline and moderating models respectively, this implies that positive shock in government expenditures have a favourable impact in reducing CO_2 emissions by 0.51% and 0.79% respectively. While the government expenditure (D(LGE_NEG)) is positive and statistically insignificant. Furthermore, the total tax revenue (D(LTTR_POS)) is negative and significant at 5% level, this means positive shocks in total tax revenue is reducing CO_2 emissions by 0.44% at 5% and 1% level for baseline model and moderating models, respectively, in the short-run, it also implies that increasing ratio of taxes by the government to increase revenues have enforces producers to use the production methods that reduces CO_2 emissions. While the total tax revenue (D(LTTR_NEG)) is positive and significant at 1% level, that is the negative shocks of total tax revenue has positive impact on environmental degradation in the short-run for NARDL model A with 1.57%, but statistically negative and significant at 1% level in the moderating model (i.e. model C).

Furthermore, the moderating factor i.e energy consumption (D(LEC_POS)) is positive and statistical significant at 1% and 5% level for both model B and C respectively, which means the positive shocks in energy consumption (EC) has unfavorable impact on co_2 emissions by increasing the environmental pollution with elasticity of 1.54% and 1.67% respectively. While the energy consumption (D(LEC_NEG)) is statistically insignificant. Besides that, error correction mechanism (ECM) shows the speed of adjustment in convergence from short term to long term equilibrium. Then, the sign of the ECM was significantly negative with 0.99%, 0.79% and 0.38% speed of adjustment from short-run to long-run equilibrium annually for both NARDL model A, B and C respectively.

The linear long-run estimates shows that government expenditure (LGE) is negative and statistically significant at 5% level only in moderating model and implies that one percent increase in government expenditure will reduce CO_2 emission by 0.02%.

While the estimate of energy consumption (LEC) is positive and statistically significant at 1% and 10% level for model B and C respectively, it implies that percentage increase in energy consumption will increase CO_2 emissions by 0.77% and 0.53% respectively. However, in the long-run NARDL, government expenditure (LGE_POS) is positive and significant at 5% level in model A and statistically insignificant in the moderating models, it implies that positive shocks in government expenditure will increase CO_2 emissions by 0.88%. This outcome is similar to the findings of Halkos and Paizonas (2016) and Mohammed Saud et al., (2019), who noted that increase in government spending will equally increase environmental degradation and vice versa. Model A reports that total tax revenue (LTTR_POS (-1)) is negative and statistically significant at 5% level, it implies that the positive shocks of tax revenue has decreased pollution by 0.57%. This outcome is similar to the findings of Hasmi and Alam (2019); Hao et al., (2020); Bashir et al., (2020) and Safi et al., (2021), all noted that positive shock in tax revenue is reducing the environmental degradation. But model B and model C report statistically insignificant. While the negative shock in tax revenue (LTTR_NEG (-1)) is positive and significant at 1% level, in model A, it implies that negative shock in tax revenue will decrease CO_2 emissions by 2.74%. But model B and model C report insignificant.

Finally, the positive shock in energy consumption (LEC_POS (-1)) is significantly positive at 1% and 10% level in the moderating models, which means the positive shocks in energy consumption will increase CO_2 emissions by 1.84% and 0.80% respectively. Similarly, the negative shocks in energy consumption (LEC_NEG (-1)) is positive and significant at 1% and 10% level in model B and C respectively, which implies that negative shock in energy consumption have significantly reduce CO_2 emissions with strong elasticity of 2.83% and 0.98% respectively. This outcome is consistent with the findings of Ma et al., (2011); Adebayo et al., (2022), who noted that energy consumption has positive impact on CO_2 emissions.

Diks and Panchenko (2006) Nonlinear Causality Test

In order to test for nonlinear Granger causality among the variables involved, the research study employs Diks and Panchenko (2006) non-parametric and nonlinear Granger causality technique. Table 4.4 provides the results of nonlinear causality. The outcomes suggested that there is bidirectional causality between government expenditure (GE) and environmental degradation (CO_2), this implies that government expenditure have causal effects on environmental degradation in Nigeria and also proved the result of NARDL estimated in the study. While it provide a unidirectional causal relationship between: total tax revenue (TTR) and environmental degradation (CO_2), energy consumption (EC) and total tax revenue (TTR) in Nigeria. It implies that environmental tax has an important role to play in controlling energy consumption for the promoting of environmental quality. And the result reconfirmed a strong impact of taxation in controlling CO_2 emissions in Nigeria.

Table 4.4 Diks and Penchenko (2006) Nonlinear Causality Test Results

Causal Settings		Inferences
LCO_2 doesn't cause LGE -6.298*	LGE doesn't cause LCO_2 -7.794*	Bidirectional
LCO_2 doesn't cause LEC 0.836	LEC doesn't cause LCO_2 0.907	Insignificant
LCO_2 doesn't cause LGDP 0.566	LGDP doesn't cause LCO_2 0.057	Insignificant
LCO_2 doesn't cause LTTR 1.957**	LTTR doesn't cause LCO_2 0.518	Unidirectional
LEC doesn't cause LTTR 0.334	LTTR doesn't cause LEC 1.340***	Unidirectional
LEC doesn't cause LGDP 0.575	LGDP doesn't cause LEC 0.650	Insignificant
LEC doesn't cause LGE 0.570	LGE doesn't cause LEC 0.851	Insignificant
LGDP doesn't cause LGE 1.187	LGE doesn't cause LGDP 1.075	Insignificant
LGDP doesn't cause LTTR 0.486	LTTR doesn't cause LGDP 1.122	Insignificant
LGE doesn't cause LTTR 0.558	LTTR doesn't cause LGE 0.704	Insignificant

Note: The results are obtained through 2 and 3 embedded dimension and bandwidth between 0.30 and 0.70. The number in cells is the corresponding t-statistics with *,** and *** as 1%, 5% and 10% level of significance. Source: Researcher's estimation (2025).

Conclusions

This study investigated the impacts of environmental tax on environmental degradation in Nigeria. The estimated results of the asymmetric ARDL reveals that the positive changes of total tax revenue has a negative impact on CO_2 emission in model A, but has a positive influence on CO_2 emission in model B, that is it has an unfavorable (positive) effects on CO_2 emission in model B. Adversely, the negative shock of total tax revenue exerts favorable (positive) impacts in model A but carries unfavorable (negative) impacts on CO_2 emission in model B. While the positive shock of government expenditure has a positive impact on environmental degradation in model A and model B. However, the adverse changes in government expenditure decrease CO_2 emissions in Nigeria as reported from model B. Furthermore, the positive and negative shock of energy consumption both exerts positive impacts on environmental degradation in Nigeria.

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