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Research Article

An Analytical Assessment on the Impact of Fiscal Policy and Environmental Degradation in Nigeria

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Abstract

This study examines the nexus between fiscal policy and environmental degradation by moderating the effect of energy consumption in Nigeria. The data covered from 1981 until 2021 which was analysed using a Nonlinear Autoregressive Distributive Lag (NARDL) and Diks-Panchenko causality model. The empirical findings reveal that positive and negative shock in government tax has a negative and positive impact on CO_2 emissions, respectively. Similarly, the positive shock in government expenditure enhances environmental degradation. However, the impact of moderating factor (energy consumption) has a positive relationship with CO_2 emissions and it confirmed energy consumption as major causes of anthropogenic CO_2 emission in Nigeria. Moreover, the nonparametric causality model reveals bidirectional causality between government expenditure and environmental degradation, whereas government tax and environmental degradation, energy consumption and environmental degradation has 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 technologies that are environmentally-friendly in Nigeria.

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

Introduction

Global warming and climate change have been one of the debatable and international topics of discussion which focus on the challenges inflicted on the global environment. The causes for the rising temperature of Earth's surface and global atmosphere verified in the last decades has been a subject of controversy among the researchers that are expressing a diverse and conflicting viewpoints in light of the greenhouse effects on the global environment. The mainstream position is that global warming and climate change are due to human action called anthropogenic activities (Esteves & Cukierman, 2012). This point of view is backed by the United Nations' Intergovernmental Panel on Climate Change and supported by most science institutions, while the minority point of view stands that the rising global temperature may be explained by the natural increased solar activity and other natural factors (Esteves & Cukierman, 2012).

The consequences of the greenhouse effect can be harmful to humans and the environment entirely: flooding, storms, desertification of the land, and hurricanes are some of the challenges of climate change, then high air temperatures can also adversely affect people's health like cardiovascular diseases worsen, malaria increases and respiratory organs suffer (Mikhaylov, Moiseev, Aleshin & Burkhardt, 2020). In this respect, World Health Organisation (WHO) has estimated that 13.7 million deaths each year have been attributable to unhealthy environmental-related diseases, of which 2.2 million deaths are from the African region. Whereby, 8.2 million deaths are due to non-communicable diseases which are 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 people will continue to become ill and die at a young age. It's due to these devastating effects on human lives and ecosystems, the International Economies called for control.

International organizations such as the United Nations have made several attempts to cut down the mounting effects of global warming and climate changes through inter-governmental agreements across global economies, as each country of the world has a role to play either as an agent of greenhouse gases emissions or/and part of the movement for mitigation of the anthropogenic CO_2 emissions. For instance, United Nations Framework Convention on Climate Change (UNFCCC), founded in 1992, Kyoto Protocol in 1997, and Paris Agreement in 2016 (Keong, 2020), these are some of the leading international treaties on the global movement to mitigate the adverse effects of environmental degradation. The major goal of these protocols has been highlighted to achieve stabilized and friendly greenhouse gas concentrations in the atmosphere. The fact of combating climate change effects on humans and the ecosystem. Thus, requires active measures from all levels of government, private organizations and civil society. As part of these measures, the role of fiscal policy instruments to promote environmental quality across individual countries (the main aim of this study) is equally paramount.

In Nigeria, according to Ola (1984), there is the existence of environmental protection laws for very long periods since during the colonial era in the form of bye-laws within the country. Environmental policies since the 1900s in relation to the conservation of natural resources and regulating environmental pollution exist. The theoretical basis for using fiscal policy instruments for environmental protection was first proposed by Pigovian tax theory and externality theory of Pigor (1932) which suggests government intervention inform of taxing those producers that engage in the creation of negative externalities to the environment. Thus, fiscal policy is the key element for regulating the economic activities and entire environment. Therefore, this study analysed the impact of government involvement through fiscal policy instruments to play an important role in risk-reducing effects on the cost of environmental degradation.

2 Literature Review
2.1 **Theoretical Literature Review**
A Pigouvian tax theory is an economic theory named after a 1920s British economist- Arthur C. Pigou. 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 product or service, 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 is to discourage activities that impose a social cost which not reflected in the market price, so this adverse effect might be corrected by levying taxes (as main fiscal policy instruments) on the producers.

On the other hand, Environmental Kuznets Curve (EKC) hypothesis is an environmental hypothesis that explains the relationship between environmental quality and economic growth. It suggests that the environment deteriorated at the initial stage of economic development, but after a certain 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.

2.3 **Empirical Literature Review**
Miller and Vela (2013) analyzed the effectiveness of environmental taxes by examining 50 countries from all regions across the globe. It employed panel cross-sectional regression techniques, and the result of the study found that countries with higher revenues from these environmental taxes exhibit higher reductions in CO_2 emissions and energy consumption.

Another study conducted by Rafique, Fareed, Ferraz, Ikram, and Huang (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 empirical results revealed that environmental-related taxes, economic growth, foreign direct investment, energy use, urbanization, renewable energy, and industrialization significantly influence the long-term ecological footprint in OECD countries.

Samah *et al.* (2021) explored the nexus between government expenditure, CO_2 emission, and manufacturing output and employed panel data techniques (GMM estimators) for empirical analysis. The findings conclude the results in Malaysia found that government expenditure is significantly influenced by CO_2 emissions and manufacturing output and vice versa.

Katircioglu and Katircioglu (2017) ascertain the relationship between fiscal policy and CO_2 emissions through testing of the EKC hypothesis in the case of Turkey, the result of the Study showed a negative relationship between fiscal policy and environmental degradation after using conditional Granger causality through the ARDL approach.

Similarly, The Phan *et al.* (2021) investigated the influence of fiscal policy on environmental degradation based on ARDL and the panel data of nine Asian countries. The empirical result indicates that fiscal policy has an asymmetric influence on environmental degradation because a positive change in expenditure minimized CO_2 emissions, while a negative change in expenditure enhance environmental degradation in the long run.

Another research conducted in the Kingdom of Saudi Arabia by Triki, Kahouli, Tissaoui and Tlili (2023), investigate the impact of renewable energy, green Finance, technology innovation and health expenditure on ecological footprint. It uses Linear and Nonlinear ARDL techniques and finally found out that all the variables have an impact on the environmental quality in the country. While Demir (2023), used nonlinear ARDL techniques and analysed the asymmetric impact of fiscal policy on environmental degradation in Turkey. The result of the findings shows that positive shocks of fiscal policy leads to decreasing the level of carbon emissions in the long run, while the negative shocks of the fiscal policy does not have a significant effect on environmental degradation.

Wang, Zhang, Zhou and Zhong (2024) also examined the impact of emission reduction strategies through fiscal policy instruments on environmental quality, it used quasi-natural experiment. Its findings indicated the improvement of environmental quality by emission reduction fiscal policy strategies. Shayanmehr *et al.* (2023) explore the role of environmental tax on ecological footprint using Panel GMM techniques with robustness of the method of moment quantile regression results. The outcome of the empirical study confirmed that envronmental tax reduces environmental degradation. Similarly, a study conducted in G-7 countries by Ozyilmaz and Bayraktar (2023) which adopted System GMM techniques to examine the impact of public expenditure on environmental degradation. Its findings shows public expenditure is significantly reducing environmental pollution.

While Dahmani (2024), empirically examines the effects of environmental fiscal policies, research and technology on promoting environmental sustainability in the G-7 countries. Its uses Cross-Sectionally Augmented ARDL (CS ARDL) and Dynamic Common Correlated Effects techniques to identify the short and long run correlation among the variables of the study. Finally, the outcome of the study confirmed U-shaped Kuznets Curve Hypothesis as well as the effectiveness of environmental taxes on minimizing environmental degradation.

In Nigeria, Osinusi, Ajayi and Sokunbi (2024) conducted an empirical research on the nexus between fiscal policy, Foreign Direct investment and environmental degradation. Its used ARDL techniques and the outcome of the study confirmed that fiscal policy promotes foreign direct investment and mitigate carbon emissions in Nigeria. Similarly, Ademola, Badaru and Wowo (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 envronmental tax reduces ecological footprint while government expenditure escalates the environmental degradation in Nigeria. Lau et al. (2024) investigated the effects of fiscal and monetary policies on environmental quality in five emerging economies (South Africa, China, Russia, India and Brazil) using Panel Modified OLS and Pooled Mean Group ARDL with a data covering 1990 to 2018. The final estimations result confirmed that positive shocks of fiscal and monetary policies significantly improve environmental quality in those countries under study. 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.

3. METHODOLOGY

This research study employed secondary sources of data from the period of 1981-2021. The secondary data is drawn from the World Development Indicators, World Bank (2021) and the Statistical Bulletin, CBN (2021). The study used CO_2 emissions as a dependent variable and proxy 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 by Diks-Panchenko's (2006) nonlinear Granger causality test.

3.1 Model Specification

The research study adopts the model of Ullah, Majeed and Chishti (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:

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

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

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

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 model, we replace the government expenditure and government revenue with $GE_t^+ ,/TR_t^+$ and $GE_t^- ,/TR_t^-$ in equation (3) as:

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

$$\sum_{i=0}^{n7} \nu 1 \, EG_{t=1} \quad + \quad \beta_1 CO_{2,t-i} \quad + \quad \beta_2 GE_{t-i}^+ \quad + \quad \beta_3 GE_{t-i}^- \quad + \quad \beta_4 TR_{t-i}^+ + \beta_5 TR_{t-i}^- + \beta_6 EG_{t-i} \quad + \quad \alpha_t$$
$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.4_a)$$

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

$$\sum_{i=0}^{n6} \rho 1 \, EC_{t=1} + \sum_{i=0}^{n7} \nu 1 \, EG_{t=1} + \beta_1 CO_{2,t-i} + \beta_2 GE_{t-i}^+ + \beta_3 GE_{t-i}^- + \beta_4 TR_{t-i}^+ + \beta_5 TR_{t-i}^- + \beta_6 EC_{t-i} + \beta_7 EG_{t-i} + \alpha_t$$
$$\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (3.4_b)$$

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 shocks of fiscal policy), EC_t =energy consumption, EG_t =economic growth (GDP growth rate), β_o=constant variables, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6$= parameters of the variables and μ_t = error term.

4 RESULTS AND DISCUSSION
Table 4.1 Description of Variables

Variables	Symbol	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 (2024)

The outcomes of the estimation 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 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 (2024)

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

Variable	Short-run Estimates						Long-run Estimates					
	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 (2024). *.** and *** indicates 1%, 5% and 10% significance level, respectively. Model A is the baseline model while the moderating models are Model B and C.

Table 4.3 provides short-run and long-run estimates for both linear and nonlinear ARDL 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 4.2: CO_2 is dependent variable. Model A is 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.

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 hand, the NARDL model for short-run estimates, the government expenditure (D(LGE_POS)) is negative and statistically 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 generate revenues have forces 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 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 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, Ju, Zhang and Li (2011); Adebayo, Oladipupo, Rjoub, Kirikkaleli and Adeshola (2022), who noted that energy consumption has positive impact on CO_2 emissions.

4.5.2 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 results 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	LTTR doesn't cause LCO_2	Unidirectional

1.957**	0.518	
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 (2023).

5.2 Conclusions

This study investigated the nexus between fiscal policy and environmental degradation in Nigeria. Based on the empirical outcomes of the study, it confirmed that fiscal policy and energy consumption have positive and negative impacts on environmental quality in Nigeria.

The outcome of the asymmetric ARDL reveals that 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. The results of the study also reveal that the positive shock 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) impact 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. Furthermore, the positive and negative shock of energy consumption both exerts positive impacts on environmental degradation in Nigeria.

Therefore, this study has the following recommendation:
   i.   Government should design industrial policies and macroeconomic policies in order to support the implementation of low-energy-intensive and lower-carbon production technologies (i.e. Environmental Fiscal Reforms) in Nigeria.
   ii. Government should strictly encourage adherence to the rules and regulations by both external and internal firms on implementing environmental-friendly manufacturing techniques by setting up a special bureau in the Federal Ministry of Environment to supervise such environmental protection's regulations with huge environmental taxes (example carbon tax) to protect the environment.
   iii. Government should increase investment in scientific research and development in areas that innovate and improve low-energy-consumption technologies, and low-carbon production techniques which promote energy saving (green energy) for environmental protection in the economy.

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