The Impact of Economic Openness on Environmental Sustainability in Nigeria

Timothy Ariyo Aiyepeku

Federal University Lokoja, Nigeria

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ABSTRACT

This study seeks to explore the impact of economic openness on environmental sustainability in Nigeria. Using time series data spanning 1981-2021 sourced from World Development Indicators (WDI) and Central Bank of Nigeria Statistical Bulletin, the study employed the Autoregressive Distributed Lag (ARDL) method of regression analysis to analyze the relationship between environmental sustainability (methane as the measure of sustainability or environmental quality) and economic openness (GDP, FDI and Degree of openness), the result indicates that in the long run, the relationship between the dependent variable and the independent variables are positive but statistical insignificant, whereas, the result further reveals that all the variables except FDI have a short run negative impact on the environment but the impacts are statistically insignificant. It was therefore recommended among others that polices that makes investment attractive to investors as well as improve international trade should be encouraged. The novelty of this study lies in the fact that, it is the first single-country study to use CH4 (methane) as a measure of environmental quality for the case of Nigeria.

Keywords: Environmental quality, environmental degradation, economic openness, ARDL

INTRODUCTION

In recent years, there has been a significant increase in international trade between nations, which is crucial for development. This is because trade and investments can lead to the availability of new and better technology, resulting in increased production capacity and expanded market coverage, ultimately leading to higher welfare for trading countries. However, there is often an environmental cost associated with producing, consuming, and transporting goods, which is not factored into the price paid. Although locally sourced products are sometimes considered to be more environmentally friendly, this is not always the case. Rather, trade can help to reduce the negative effects of economic growth by making environmentally-preferable products and technology more easily accessible (Patrick & Ralph, 2009).

The traditional macroeconomic model, which excludes the natural environment and assumes that only businesses engage in production, has been called into question as people realize that economic activity is intertwined with human social institutions, which are inherently connected to the natural environment (Goodwin, Nelson, & Harris, 2008). The impact of economic openness on the environment is exemplified by the deforestation of the Amazon Basin, which is often attributed to the supply of international markets. This serves as an example of externality in the production process, whereby market failures are not accounted for in the commodity price, and are exacerbated by the high levels of production associated with economic openness.

The relationship between trade and the environment came to the forefront in 1991 when Mexico challenged

a US law that banned the importation of tuna from the country. The law prohibited tuna fishing methods that killed dolphins. This led to a major debate over trade and environmental issues that continue to this day. There is an ongoing debate about the connection between open trade and the environment, with many questioning the role of the World Trade Organization in promoting environmentally friendly practices. The concern is that economic openness and trade may cause environmental harm. This was highlighted in the WTO summit in 1999, where environmentalists protested the damage caused by the WTO to the environment. Environmentalists and economists have differing opinions regarding the benefits and costs of international trade and investment. From an economist's viewpoint, economic openness is advantageous as it leads to enhanced production, technological advancements, increased gross domestic product, and better living standards for citizens. However, environmentalists argue that the negative environmental consequences of openness outweigh the benefits, as issues such as global warming, climate change, extinction, and pollution can have severe impacts. It is because of these disputing issues that this research seeks to pinpoint the impact of economic openness as relating to environmental sustainability.

Nigeria is an important participant in this debate, given its increased participation in global trade. The country's role in improving or damaging the environment through its trade policies is significant, and therefore, it has a crucial role to play in promoting environmentally sustainable practices. Like many developing countries, Nigeria faces environmental challenges such as erosion, deforestation, flooding, desertification, and urban deterioration, which stem from human activities aimed at achieving higher levels of development without adequate consideration for environmental protection. Nigeria has responded to these issues with measures such as the establishment of a Federal Ministry of Environment and the Federal Environmental Protection Agency, as well as national conferences and campaigns on environmental sanitation. However, much work still needs to be done to create mechanisms and legal support for reconciling environmental priorities with development objectives.

Theoretical Framework

i. Modern Theory of International trade Heckscher-Ohlin (H.O)

The Heckscher-Ohlin theory, also known as the factor-endowment theory, was developed by Swedish economists Eli Heckscher and Bertil Ohlin in the 1920s and 1930s. The theory explains what determines comparative advantage and what effect international trade has on the earnings of various factors of production in trading nations. The theory maintains that a nation's factor endowments determine its comparative advantage. This means that countries that are rich in capital will export capital-intensive goods, while countries that have much labor will export labor-intensive goods. The theory has relevance to the study of economic openness and environmental sustainability because it explains how trade patterns are determined by factor endowments and how this can affect environmental resources. For example, countries rich in natural resources may have a comparative advantage In exporting these resources, which can lead to unsustainable exploitation of these resources (Sen, 2010).

ii. Environmental Kuznets curve

Environmental Kuznets Curves (EKCs) emerged on the scene in 1991 when Eugene Grossman and Alen Kreuger, two Princeton economists, produced a path breaking working paper that reported a strong statistical relationship between some commonly used measures of environmental quality and per capita income for a cross section of countries. The Environmental Kuznets Curve (EKC) hypothesis proposes an inverse-U shaped relationship between environmental degradation and income per capita, suggesting that environmental pressure increases faster than income at early stages of development and slows down relative to GDP growth at higher income levels. This concept emerged in the early 1990s and has since led to numerous studies on the relationship between environmental quality and economic openness. The EKC provides a possible means for achieving environmental sustainability without significant deviation from

business as usual. However, it also highlights the importance of internalizing externalities and addressing pollution control costs across countries. The idea of sustainable economic development, promoted by the World Commission on Environment and Development, has further emphasized the need to address the relationship between economic growth and environmental sustainability. The EKC hypothesis has been influential in shifting the debate on the impact of economic growth from being a threat to the environment to a potential means for environmental improvement (Grossman & Krueger, 1995).

REVIEW OF EMPIRICAL LITERATURE

(Mojekwu & Ogege, 2012) examined the impact of foreign direct investment on Nigeria economic growth and development. It specifically sought to ascertain or examine the nature, trend and sectorial inflow of Foreign Direct Investment in relation to the economic growth in Nigeria and identify the impact of FDI on some macro-economic indicators. Data for the study was extracted from Central Bank of Nigeria's Statistical Bulletin volume 18, (2009) during the period 1970-2010. The results revealed that there exists a long-run relationship between the dependent and the explanatory variables. The results conformed to the economic a priori expectation. Findings showed that Gross Capital Formation has a positive and significant relationship with the economic growth. Based, on the findings of the research, they therefore, recommended that capital formation encourages economic growth via savings accumulation visa vise, increase in the gross domestic investment.

In a research titled "Estimating the Impact of Foreign Direct Investment in Nigeria" (Anfofum, Gambo, & Suleiman, 2013) used time series data and found out that FDI spurs exports, gross fixed capital formation and economic growth in Nigeria. Thus, FDI is a positive measure of economic growth. The study recommended among others improvement in infrastructural development especially in roads and electricity supply as this will increase the level of development which will in turn attract more inflow of FDI. (Imoughele & Ismaila, 2014) investigated the impact of components of inflow of FDI on the Nigerian economy for the period which spanned between 1986 and 2009. The trend analysis reveals that FDI inflow to the Nigerian economy is dominated by foreign investor from Western Europe which is highly concentrated on the manufacturing sector. The study used co-integration and Error Correction Mechanism (ECM) to determine the relationship between FDI, its components and economic growth. The study found that continuous inflow of foreign direct investment in manning and quarrying, telecommunication, building and construction, trading and business and agricultural sectors have a robust impact on Nigeria's economics growth.

(Idoko, Idachaba, & Agenyi, 2015) carried out a study on the Effects of Foreign Direct Investment on Sustainable Development in Nigeria from 1980-2013. The result of the OLS techniques indicates that FDI is statistically significant and relevant to sustainable development in Nigeria. From the result of the study, it portrayed that for effective economic growth and sustainable development to be achieved in Nigeria, it will be better to focus on the improvement of infrastructural development, human resource, entrepreneurship, and stable macroeconomic framework capable of fostering productive investment that can augment the process of sustainable development.

(Ominyi & Adayi, 2017) in their work titled Foreign Direct Investment and Environmental Sustainability in Nigeria, employed the Ordinary Least Square (OLS) method to analyze the impact of Foreign Direct Investment on environmental sustainability in Nigeria. Data were collected on CO_2 emissions (proxying environmental degradation), FDI, Gross Domestic Product (GDP), and population covering the period 1986 to 2015. The study found out that FDI contributed to CO_2 emissions, hence environmental degradation. This was attributed to the activities of resource extracting industries which cause pollution in Nigeria. In addition, growth in GDP spurs environmental sustainability against a priori expectation due to the low level of Nigeria's industrialization. Furthermore, population growth leads to environmental degradation because

majority of Nigerian citizens are poor and depend on the environment for their livelihood which leads to its depletion. The study therefore concluded that Foreign Direct Investment impedes environmental sustainability, giving credence to the pollution haven hypothesis. It was therefore recommended amongst others that the Nigerian Government should impose stringent laws to protect our environment and regulate the activities of international corporations ensuring that these laws are adhered to.

(Khan & Agha, 2015) researched the direction of the relationship between its chosen variables by using several econometric tests such as Augmented Dickey-Fuller (ADF), Johansen co integration and Granger Causality tests. The results showed that there is no causality between the growth rate of GDP and FDI, growth rate of FDI and CO_2. The only causality found is a uni-directional causality between the growths of GDP and the growth rate of CO_2. The direction is from growth rate of pollution to the growth rate of GDP. The paper concluded that government should make policy that will ensure that transnational companies use equipment's that are environmentally friendly.

(Riti & Kamah, 2015) carried out a study on the contributions of trade liberalization and foreign direct investment inflows on growth in Nigeria and the implications of economic globalization on the Nigerian environment by applying the co-integration and Vector Error Correction Mechanism using data from 1981 to 2013 sourced. The findings indicated that trade openness and FDI inflows have made substantial contributions to economic growth in Nigeria. GDP and trade openness also aided environmental quality in the long run. FDI inflows on the other hand contributed to the worsening of the environment evident in more pollution emission in the long run. Some of the suggested recommendations were that Nigeria must put in place sound environmental policy to ameliorate the globalization effects on the environment particularly in FDI attractions.

Akomolafe, Danladi, and Oseni, (2015) attempted to analyze the relationship between trade openness, economic growth, and environmental pollution in Nigeria. The study introduced urbanization and ruralization as measures of the growth of urban and rural sectors to analyze their contributions to pollution in the country. Using Vector Error Correction Mechanism (VECM) and co-integration techniques, the result confirmed the existence of the Environmental Kuznets curve in Nigeria. Also, there was a positive relationship between ruralization and environmental pollution both in the short and long run. However, there was found a negative relationship between urbanization and environmental pollution in the long run, but positive in the short run. The study concluded with the recommendation that there is a need for policy makers to enact and enforce environmental laws that are aimed at regulating various sources of environmental pollution in the country.

(Holladay, 2015) in the work titled "Exporters and the Environment" he documents a relationship between international trade and environmental performance at the plant level. Using a panel of establishment-level data from 1990-2006, he estimated the relationship between export orientation, import competition and pollution emissions. His findings indicated a robust relationship between international trade and pollution levels. Exporters emit 9-13% less after controlling of output, but there is significant heterogeneity across industries. His work shows that import competition is associated with the exit of the smallest, most pollution intensive plants. The concluding findings was that there was no evidence that this result is caused by polluting firms relocating to countries with low levels of environmental regulation and importing back into the U.S.

Many of the generally acknowledged global environmental problems (greenhouse warming, ozone depletion, soil erosion, chemical management, acidic rain and water pollution, among other things) are directly or indirectly caused by the creation, operation, or disposal of the built environment undertaken by man. If man is responsible for many environmental disasters in which humankind is threatened, can his activities been regulated and conditioned by law? This question poses a view towards what should be the role of regulating authority (government) in environmental sustainability. Question and issues such as these

were what (Oyefara, 2013) in the paper Good Governance and Environmental Sustainability in Lagos State, Nigeria: Can the State Achieve Goal Seven of Millennium Development Goals (MDGs)? tried to give answer to. Results of the study reveal significant impact of good governance on environmental sustainability of the State as evident in various urban forestry, beautification and green Lagos projects. In conclusion, the paper posited that, with good governance, the State can reverse the loss of environmental resources and sustain environmental development.

(Aminu, 2005) examined the impact of environmental policy on location decision, the outflow of "dirty" Foreign Direct Investment (FDI). He also examined the impact of "dirty" FDI in host countries, on annual CO_2 total emission; total emission of known particulate matters; rising temperature; and total energy use. Using disaggregated FDI data, panel data regression, he found that, "dirty" FDI outflow was positively correlated with environmental policy in eleven OECD countries. But FDI inflow was not significant in explaining the level of pollution and energy use in fourteen non-OECD countries. (Ogboru & Anga, 2015) examined the effects of environmental degradation and the risk or threat it poses to sustainable economic development in Nigeria. The paper adopted the theoretical approach in the evaluation of the effects of environmental degradation on Nigeria and its implication for sustainable economic development. The paper posited that a high number of cases of diseases such as cancer, tuberculosis, viral diseases etc. are consequences of environmental pollution which poses great challenge to sustainable economic development among others. Cases of floods, erosions and drastic drop in agricultural output as a result of environmental degradation were also identified.

Wang, (2011) in his study Green GDP and Openness: Evidence from Chinese Provincial Comparable Green GDP, tested the effect of openness to international trade at Chinese provincial level, by applying Comparable Green GDP data from 31 provinces and regions to a variant of Solow growth model. The main finding was: there seems exists a non-linear relationship between green GDP and openness, measured both by volume of trade and foreign directly investment (FDI), at provincial level. Intuitively, openness has an inverted U shape effect: it increases sustainable development at the beginning and decreases sustainable development after a threshold point.

MATERIALS AND METHODS

The research adopts the historical research design. This is done in the hope of arriving at a reliable finding and conclusions. For the purpose of arriving at dependable and unbiased analysis, secondary data were employed. These published materials were obtained from the Central Bank of Nigeria (CBN) Statistical Bulletins, and World Development Indicators. Data obtained were on variables such as Gross Domestic Product (GDP), Import, Export, Foreign Direct Investment (FDI) and Methane Emission (CH_4) for thirty two years (1981 and 2022).

Model Specification

For the purpose of clarity, understanding and effective evaluation of this study, the researcher employed is the Autoregressive distributed lag model (ARDL). The ARDL model in the research basically looks at the possibility impact of economic openness on environmental sustainability. Thus, the hypothetical model to be formulated is written in its functional form as:

CH4= f (GDP, FDI, OPN)……..……. (1)

Where:

GDP = Gross Domestic product

FDI = Foreign Direct Investment

OPEN = Degree of Openness ((Import + Export)/GDP)

CH4 = Methane Emission

In a more explicit form, the models can be written in a log-linear form to transform the variables into the same unit and base. Thus:

$InCH4 = \beta_0 + \beta_1 InGDP + \beta_2 InFDI + In\beta_3 OPEN + \mu$ ..... (2)

Where $\beta_1 > 0$ while $\beta_2, \beta_3 < 0$ from the equations (1) and (2), the conditional ARDL model can be specified as:

$$\Delta \ln CH4_t = \theta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta \ln \text{CH4}_{t-i} + \sum_{j=1}^{q} \beta_{2j} \Delta \ln \text{RGDP}_{t-j} + \sum_{k=1}^{r} \beta_{3k} \Delta \ln \text{FDI}_{t-k} + \sum_{i=1}^{s} \beta_{4i} \Delta \ln \text{OPEN}_{t-i} + \mu \ldots (3)$$

Equation (3) is the short-run equation of the ARDL model without the specification of a long run relationship.

If however a long-run relationship is observed amongst the variables in the time series regression model, a new model would be specified to capture the long-run relationship. The new model is specified as:

$$\Delta \ln CH4_t = \theta_0 + \theta_1 \ln CH4_{t-1} + \theta_2 \ln RGDP_{t-1} + \theta_3 \ln FDI_{t-1} + \theta_4 \ln OPEN_{t-1}$$
$$+ \sum_{i=1}^{p} \beta_{1i} \Delta \ln \text{CH4}_{t-i} + \sum_{j=1}^{q} \beta_{2j} \Delta \ln \text{RGDP}_{t-j} + \sum_{k=1}^{r} \beta_{3k} \Delta \ln \text{FDI}_{t-k} + \sum_{i=1}^{s} \beta_{4i} \Delta \ln \text{OPEN}_{t-i} + \rho \text{ECM}_{t-1} + \mu \ldots\ldots 4$$

Where θ_i are the long run multipliers and β_0 is the drift, βi are the short run parameters, ECM is the error correction term that reconciles short run dynamics to the long run and μ_t is the error term.

DATA ANALYSIS AND DISCUSSION OF FINDINGS

Descriptive statistics

The descriptive analysis of the variables use for econometrics analysis by the researcher is presented in table 1. The table is but a summary of the result of the analysis done using the EViews 12.0 econometric software. The original and complete result as produced by EViews in provided in the appendix section of the research.

Table 1: Descriptive Analysis of Variables table

	CH4	RGDP	FDI	OPEN
Mean	76434.91	1.47E+11	1.94E+09	6.385328
Median	82757.30	1.31E+11	1.00E+09	0.378458
Maximum	102391.0	4.04E+11	8.84E+09	34.02000
Minimum	5276.500	-1.794253	0.049718	0.265359
Std. Dev.	18272.95	1.13E+11	2.60E+09	11.71508

Observations	41	41	41	41

Source: Researchers' Summary of E-Views 12.0 Econometric Package output (2023).

Table 1 shows the mean value of methane emission (CH4) in the period to be 76434.91, and that of gross domestic trade (RGDP) was 1.47E+11 the range for RGDP was -1.794253 to 4.04E+11 with a standard deviation of 1.13E+11. Also, foreign direct investment (FDI) ranges from 0.049718 to 8.84E+09 with a mean and standard deviation of 1.94E+09 and 2.60E+09 respectively. More so, the value of trade openness (OPEN) has the minimum value of 0.265359 with a maximum of value of 34.02000.

Unit roots Tests

Unit roots are major sources of non-stationarity. The time series behavior of each of the variables is presented in Tables 2 and 3, using the Augmented Dickey-Fuller ADF and Phillips-Perron P–P tests at both level and first difference of the series.

Table 2: Augmented Dickey-Fuller unit root test

DIFFERENCE	**Without Trend**	**With Trend**	**Without Trend**	**With Trend**
	LEVEL		**FIRST DIFFERENCE**	
CH4	(0.2940) -1.980085	(0.0002) -5.604117	(0.0000) -7.162234	(0.0000) -7.065487
RGDP	(0.9995) 1.744553	(0.7524) -1.642132	(0.0033) -4.118743	(0.0025) -4.88043
FDI	(0.9322) -0.169540	(0.0041) -4.657212	(0.0000) -11.19353	(0.0000) -11.09929
OPEN	(0.0011) -4.522978	(0.0033) -4.739380	(0.0000) -6.025863	(0.0001) -6.111586

Table 3: Phillip Perron Unit root test

DIFFERENCE	**Without Trend**	**With Trend**	**Without Trend**	**With Trend**
	LEVEL		**FIRST DIFFERENCE**	
CH4	(0.0021) -4.190441	(0.0002) -5.614155	(0.0000) -7.12629	(0.0000) -8.852209
RGDP	(0.9992) 1.586550	(0.7569) -1.631305	(0.0034) -4.104913	(0.0027) -4.845205

FDI	(0.7765) -0.894575	(0.0037) -4.696378	(0.0000) -11.20316	(0.0000) -11.34983
OPEN	(0.0011) -4.522978	(0.0022) -4.916065	(0.0000) -9.246526	(0.0000) -18.20816

Source: Researchers' Summary of E-Views 12.0 Econometric Package output (2023).

Key: The figures in parentheses () indicate the probability values.

Those without parentheses () are the T-statistics values

The unit root test results for ADF and PP revealed that the group time series variables used in the model are I (0) and I (1) variables but none is I (2). The relevant critical value bounds used in the research are based on case II with restricted intercept and no trend (Narayan & Smith, 2005) this also conforms to the work of Usman & Manap (2010). Such model does not conform to that used by Merican et al (2007), Riti & Kamah, (2015) and Inedu, (2015) who used the critical value for case III with unrestricted intercept and no trend from Pesaran (2001). Case II was however chosen purposefully because, theory suggests that even at zero level of economic activities, there will be certain level of CH_4 pollution which does not ensue from anthropogenic sources (i.e., by nature) (Adam & Manap, 2010).

Estimating the Autoregressive Distributed Lag (ARDL) Model

The Vector Auto Regression criteria for the Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ) were employed to obtain the optimum level of time lag and ensure the reliability of the models. The results are presented in the table below:

Table 4: VAR lag order selection criteria

1	**FPE**	**AIC**	**SC**	**HQ**
0	7.50e+41	104.9346	105.0638	104.9806
1	2.75e+40	101.6253	102.1425*	101.8093
2	3.64e+40	101.8976	102.8025	102.2196
3	1.81e+40*	101.1744*	102.4672	101.6344*

Note: * indicates lag order selected by the criteria.

The selection criteria result shows that the whole criteria selected lag 3. The likelihood ratio, the final prediction error, the Akaike information, and Hannan criteria selected lag 3 as shown by the asterisk at 5% level of significance.

Bounds test cointegration result

The bounds test of cointegration was conducted to check for the existence of cointegration. This conforms to the research of Usman & Manap (2010). The bounds test was conducted in place of the Johansen cointegration test because the series were stationary at order I (0) and I (1) respectively.

Table 5: Bounds test cointegration result

DEPENDENT	F-STATISTICS	BOUNDS TEST VALUES		COINTEGRATION	WHAT NEXT
		I(0)	I(1)		
CH4	12.13845	2.79	3.67	Yes	Estimate ARDL

Source: Researchers' Summary of E-Views 12.0 Econometric Package output (2023).

The result of the bounds Test of cointegration shows that the F-statistics value of 12.13845 is greater Than 2.79 the I (0) bound value at 5% level of significance. The decision rule for the bound test of cointegration is that if the value of F-Statistics is below the value of I (0) bound we cannot reject the null hypothesis of no cointegration that is there is no long-run relationship between the variables in the model. If however F-Statistics is greater than the value of I (1) bounds we can reject the null hypothesis of no cointegration. The result of the Bounds test as computed by the researcher using the EViews 12.0 econometrics software package found a long-run relationship between the variable used as a measure of environmental degradation (methane CH_4) and the variables used as measure of economic openness (GDP, FDI & Degree of openness). The result, therefore, gives impetus to carry out the short-run and long-run dynamics of the ARDL model.

Table 6: Estimating the long run Autoregressive Distributed Lag

Dependent Variable: CH4

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	54381.50	9003.923	6.039756	0.0000
RGDP	6.77E-08	7.80E-08	0.868539	0.3907
FDI	2.19E-06	2.71E-06	0.809443	0.4234
OPEN	1230.827	354.4129	3.472861	0.0013
R-squared	0.487155	F-stats		11.71550
Adj. R-Squared	0.445573	Prob(F-stats)		0.000015

Source: Researchers' Summary of E-Views 12.0 Econometric Package output (2023)

The results presented in Table 6 show that real gross domestic product (RGDP) has an insignificant but positive effect on environmental sustainability in the long run. The resulting consequence implies that economic growth in Nigeria will lead to an increase in environmental sustainability and vice versa. The result also revealed that foreign direct investment has an insignificant positive effect on environmental sustainability in the long run. This implies that a unit increase in the foreign direct investment will lead to a 2.19 percent increase in environmental sustainability. Trade openness on the other hand, exerted a positive and significant impact on environmental sustainability in the long run. The findings agree with that of Usman & Manap, (2010) who observed a long-run relationship between the variables of interest used in their research work.

Estimating the short run Autoregressive Distributed Lag (ARDL) model

The ARDL model is estimated using the ordinary least square method of estimation. The appropriate number of lags for the model was derived in the lag selection stage and in that stage all the criteria selected lag 3 as the appropriate lag for the model. The researcher therefore inputted the short run model command

with 3 lags in EViews to derive the coefficient, standard error, t-statistic and probability values of the regression model. The result of the short run dynamic is presented below:

Table 7: Short-run dynamic CH_4 = f (GDP, FDI, OPN)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CH4(-1))	-0.468366	0.066062	-7.089795	0.0000
D(CH4(-2))	-0.336316	0.074655	-4.504957	0.0002
D(CH4(-3))	-0.124107	0.066062	-1.878631	0.0736
D(RGDP)	-2.40E-08	2.78E-08	-0.864948	0.3964
D(RGDP(-1))	-6.66E-08	2.19E-08	-3.045505	0.0059
D(RGDP(-2))	-3.37E-08	1.84E-08	-1.830404	0.0808
D(FDI)	1.05E-07	7.80E-07	0.134521	0.8942
D(FDI(-1))	3.06E-06	9.49E-07	3.222687	0.0039
D(FDI(-2))	2.18E-06	8.37E-07	2.604331	0.0162
D(OPEN)	-267.0380	288.6566	-0.925106	0.3649
CointEq(-1)*	-0.302549	0.032208	-9.393657	0.0000

R-squared = 0.8659 DW = 1.633626 Adj. R-squared = 0.814373 AIC = -19.58991

Source: Researchers' Summary of E-Views 12.0 Econometric Package output (2022).

The result denotes that Methane emission (CH4) have no implication on environmental sustainability in the current year, but had a negative and significant impact on environmental sustainability in the first lag, second lag and third lag period. Similarly, economic growth (RGDP) in the current year, first lag period and second lag period had a negative and insignificant impact on environmental sustainability in the short run. However, the current year, first lag and second lag of foreign direct investment had a positive but insignificant effect on environmental sustainability except for the first lag period. Thus, an additional increase in foreign direct investment from the last three years results in a positive impact on environmental sustainability in the base year and in the long run. Finally, trade openness has a negative and insignificant on environmental sustainability in the current year such that an additional increase in the trade openness would cause the environmental sustainability to begin to decline. The ECM result shows that a 30% percent deviation from the equilibrium needs to be corrected each year. The negative and significant result of the error term confirms the ARDL bound relationship among the variables.

ARDL Model Diagnostic Tests

To test how good and fit the Autoregressive distributed lag model is the researcher conducted the following econometrics test.

Table 8: Result of diagnostic test conducted

Diagnostic	Statistic	Conclusion
Ramsey Reset Test	F–statistic = 0.425825 (0.7381) Log-likelihood= 2.832546 (0.0687)	Equation is correctly specified
Breusch-Godfrey-Serial correlation LM Test	F–statistic= 0.076720 (0.9714) Obs*R-squared = 0.526933 (0.9129)	No serial correlation

Multivariate Normality	Jack-Bera test = 1.608381 p-value = 0.447450	Residuals are normal
Heteroskedasticity Test: Breusch-Pagan-Godfrey	F-statistic = 0.580264 (0.8263) Obs*R-squared = 8.877075 (0.7134)	No Heteroskedasticity

Source: Researchers' Summary of E-Views 12.0 Econometric Package output (2022).

The result of the serial correlation test using Breusch-Godfrey Serial Correlation LM test method shows that the null hypothesis of no serial correlation cannot be rejected. This mean the research model is good and does not suffer from serial correlation. The Ramsey rest test, multivariate normality test and the heteroskedasticity test were also conducted as guides to determine how good the research model is and if it could be used for real economic decisions. The results of the tests are summarized in table 8. The result in table 4.8 shows that the model is correctly specified, no serial correlation, the residuals are normal and there is no heteroskedasticity. That is the model suffers none of any aforementioned econometric problem.

CONCLUSION AND RECOMMENDATION

From the stated hypothesis, findings reveals that the aside from trade openness, the joint variables of economic openness exerted an insignificant but positive impact on environmental sustainability in the long run. This means that an increasing rate of openness would have no adverse effect on the environment if methane is used as the measure of environmental quality this could partly be due to the fact that methane is used as a source of energy and its emission doesn't linger as long in the atmosphere as carbon dioxide. Further evidence from the short run result revealed that only foreign direct investments had a positive but insignificant impact on environmental sustainability in the short run whereas that methane emission, economic growth and trade openness collective had a negative and insignificant impact on environmental sustainability in their current year, first lag, second lag and third lag period. Implying that an additional increase in chosen variables from the last three years results in a negative impact on environmental sustainability in the base year and in the short run. Thus, this research concludes that economic openness negatively affects environment sustainability in the short run and in the long run positively impacted on environment sustainability when methane emission is used as a measure of environmental sustainability.

Based on finding of the study, the following recommendations have been given:

1. Government should develop policies that prioritize the reduction of short term negative environmental impact of economic openness.
2. Improvement and promotion of sustainable economic growth that preserves and protect the environment.
3. Government should also provide an enabling environment in the area of security so that foreign investors would be encouraged to invest more and local investors will not relocate to neighboring countries.

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