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The Effects of CO_2 and NO_2 Emissions on Economic Growth in Nigeria

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Abstract:
This paper examined the relationship between carbon emissions and Nigeria's economic growth from 1985 to 2021. ARDL approach was adopted in analyzing the data. Gross domestic product (GDP) was used as a proxy for economic growth in Nigeria, while carbon dioxide ($C0_2$) emission, nitrous oxide ($N0_2$), and gross fixed capital formation (GFCF) were used as the independent variables. The findings revealed that Gross fixed capital formation had a significant positive influence on GDP in the short-run but a significant negative influence on GDP in the long-run. While nitrous oxide (($N0_2$) emissions and carbon dioxide ($C0_2$) emissions follow the Kuznets curve of Grossman and Krueger (1995) of positive and negative impacts on GDP in the short-term and long-term, respectively. To have a carbon economy, it is recommended that the Nigerian government should both conceptualize and implement favourable policies and incentives (granting of tax credits to carbon-neutral corporations) from the government as a foundational catalyst for the development of green infrastructure and significant investments in renewable energy technology are immediately needed to keep pace with the country's growing population.

Keywords: *CO_2 and NO_2 emission, economic growth, Nigeria*

1. Introduction

Comprehensive and effective health policies and the occasional carbon economy may both require a healthy atmosphere to thrive. Safety nets and health infrastructure are essential in developed nations in response to environmental challenges. As a result, developed countries put out great efforts in maintaining a clean environment, and they spend millions of dollars doing so. This strategy does not exclude Africa, but most African governments lack sufficient financial resources and institutional capacity to implement it effectively (Zaman et al., 2016). Emission-related illnesses claim the lives of an estimated 12.6 million people per year (WHO, 2016). These include stroke and cardiovascular disease, as well as chronic conditions and cancer. Health-harmful emissions pollutants are linked to climate change, and lowering emission pollution will save lives and reduce the pace of near-term global warming. It is becoming increasingly difficult to maintain a healthy lifestyle while the global environment deteriorates at an ever-increasing rate (Balan, 2016). Pollution is causing more premature deaths in Africa than either unsafe water or malnutrition in children, and it will soon become a health and climatic disaster. An estimated 712,000 people are killed each year because of pollution, as opposed to 542,000 from unsafe drinking water, 275,000 from malnutrition, and 391,000 from unsanitary sewage systems (Dhrifi, 2018).

Nigeria is a developing economy, and economic growth is one of the macroeconomic goals that cannot be compromised. Economic growth requires an increase in the country's overall energy consumption. Transport contributed to 47.76 percent of Nigeria's CO_2 emissions between 2000 and 2014, an important statistic to keep in mind (IEA, 2020). The usage of fossil fuels remains a major contributor to CO_2 emissions, which have been linked to global warming (Alege et al., 2017).

For many years, West African countries have attempted to grow their economies by gradually transitioning from a farm-based economy to an industrialized one. Historically, industrialization has been the cornerstone of economic growth, carbonic acid gas (CO_2), the primary gas in the middle of the discourse, is a byproduct of economic growth (Adu & Denkyirah, 2018). West Africa has become a 'pollution haven' because of weak environmental laws and policies in the sub-region, making it an attractive location for multinational corporations to build factories (Odusanya et al., 2014).

No doubt, the carbon economy has been the subject of some studies (Adu & Denkyirah, 2018; Dhrifi, 2018; Matthew et al., 2018; Munawer, 2018; Nkalu & Edeme, 2019; Zaidi & Saidi, 2018;) which mainly concentrated on developed countries but there is a dearth of such studies on developing countries, especially Africa and visa-vis Nigeria. Against this backdrop, this study shall examine the effects of carbon dioxide emission (CO_2), nitrous oxide (NO_2), and gross fixed capital formation impact on Nigeria's economic growth from 1985 to 2021.

2. Literature Review

2.1. Conceptual Review on Carbon Emissions

The burning of fossil fuels and the production of cement are both included in the World Bank's definition of carbon emission (CO_2). Consumption of solid, liquid, and gaseous fuels and gas flares creates carbon dioxide. Each year's CO_2 measurements are only slightly different from the previous years. There are many causes that contribute to climate change, both natural and man-made. The biggest threat to the atmosphere comes from emissions of gaseous pollutants caused by humans, which have a terrible impact on the environment. This is an international environmental crisis as enormous amounts of greenhouse gases are generated from industries and power plants; for instance, two-thirds of the worldwide rise of 3.1 percent in 2007 in anthropogenic carbon dioxide emissions have been attributed to China (IEA, 2009; Yan &Yang, 2010).

2.1.1. Economic Growth

DfID (2008) described economic growth as a key tool for reducing poverty and improving living conditions in developing countries like Nigeria. Growth may lead to prosperity and opportunities. Environmental sustainability must be a part of any growth that is planned. Developing countries like Nigeria and industrialized nations must work together to advance low-carbon technology. However, this is not the situation in Nigeria where the rate of economic expansion and the rate of carbon emissions are growing in opposite directions. Sustainable low-carbon growth in underdeveloped nations is a subject in need of fresh attention. Social and economic research, together with collaboration with the corporate sector and the government, is required for this. Nigeria needs to improve and implement international standards and agreements on the mitigation of activities affecting the ecosystem and carbon trading. Adaptation and dissemination of new technological advancements in an emerging nation like Nigeria require specific strategies.

2.2. Theoretical Review

2.2.1. Endogenous Growth Theory

Mesagan and Ekundayo (2015) opine that economic expansion has a direct impact on carbon emissions. According to the endogenous growth hypothesis (Solow, 1956; Swan, 1956), growth occurs over the long-term because of economic activities that produce new technological knowledge and skill set. They also claim that the notion of endogenous growth is based on the economy's own self-development. Their conclusion is that endogenous growth is a long-term economic growth determined by forces internal to the economic system, particularly those forces governing opportunities and incentives to create technological knowledge; that is, it exists in direct opposition to the Solow-Swan exogenous model of growth, which stresses that growth is influenced by external economic variables. While Aghion and Howit (1992) opine that economic growth is measured by an increase in output per person and is ultimately determined by growth in total factor productivity (TFP) which in turn is dictated by technical advancement.

2.2.2. Externalities Theory

Economic progress and FDI in Nigeria contributed greatly to pollution (Odusanya et al., 2014), even if the trade is beneficial in the long and short term. Both Henry Sidgwick (1838–1900) and Arthur Pigou (1877–1959), two British economists, are credited for first expressing and then formalizing the notion of externalities, or spillover effects. Externalities are costs or benefits of an economic activity encountered by an unrelated third party. According to Saez and Berkeley (2010), externalities occur when one economic actor's activities make another economic agent worse off or better off. However, the first agent does not suffer the costs or benefits of doing so. A producer or consumer's activities might have unanticipated external or indirect impacts on other producers and/or consumers (Sankar, 2004), which may be either positive or negative (Uur, 2011). For example, if a landlord purchased smoke alarms, the likelihood of a fire spreading to neighboring properties is reduced, which benefits everyone in the neighborhood. Sankar (2004) lists technological spillover as another beneficial externality (such as foreign direct investment, trade, information technology, etc.). This happens when a company's invention helps the company but also enters the pool of technological knowledge and benefits the society. As a result, when externalities are present, the costs and benefits for the public and the private sectors diverge.

2.3. Empirical Review

Global warming regarding climate change has become a central issue, as CO_2 is one of the leading concerns of most countries (Fernandes & Paunov, 2012). The EKC (Environmental Kuznets curve EKC - developed by Kuznets in 1955), the growth–CO_2 nexus, and the influence of institutional quality are the focus of this empirical investigation. Le and Ozturk (2020) looked at how carbon emission affects economic growth in 47 emerging markets and developing economies (EMDEs). Their findings confirmed that the EKC indeed exists. Similarly, Le and Nguyen (2020) used the panel-corrected standard errors (PSCE) to analyze the impact of environmental pollution on the economic prosperity of 95 nations and revealed the presence of the EKC. Moreover, this is in line with the findings of Elsalih (2020), who used the dynamic SYS-GMM estimate for environmental degradation in 28 oil-producing countries. Godil (2020) observed that the EKC might be found in Pakistan using the quartile autoregressive distributive lag approach (QADL). Haldar and Sethi (2021) examined the connection between pollution and economic growth in 39 developing countries and came to the same results. Using the spatial econometric framework, Lv and Li (2021) found that the environmental Kuznets curve (EKC) exists in relation to economic development and environmental degradation in 97 countries, including South Africa. According to Egbetokun et al. (2020), CO_2 emission has a significant influence on economic growth in Nigeria. The EKC was not found in additional studies, contrary to what was originally claimed. According to Lise (2006), a study in Turkey examined the link between carbon dioxide emissions and household income. The analysis discovered a linear rather than a quadratic relationship between the variables and concluded that the data did not support the EKC hypothesis. When it comes to environmental quality and economic growth, research by Omojolaibi (2010) looked at many nations in west Africa, including Nigeria, to determine whether an EKC existed. While the pooled OLS results agreed with the EKC, the fixed effects results were not. Using the Autoregressive Distributed Lag (ARDL) with data spanning from 1960 to 2008, Akpan and Chuku (2011) studied Nigeria's economic growth and environmental deterioration. It was found that the EKC theory did not hold up under scrutiny. Akpan and Abang (2014) also discovered that the association between economic growth and environmental quality has an N-shaped curve rather than a U-shaped curve based on a global panel of data spanning 47 nations. Adams et al. (2020) studied the influence of economic growth on environmental pollution in 19 Sub-Saharan African countries. The EKC was shown to be baseless. Economic growth has been shown to have no effect on environmental pollution in a study of 83 economies by Acheampong et al. (2020). Olubusoye and Musa (2020) studied the link between carbon emissions and economic growth in Africa. From 1980 to 2016, 43 African nations were separated into three income categories, and the EKC hypothesis was tested using the ARDL model, Mean Group (MG), and Pooling Mean Group (PMG) models. According to the study, just 21% of the countries in the sample agreed with the EKC hypothesis, compared to 70% of the countries in the whole sample. According to the report, most African countries would see an increase in emissions because of economic growth. Similarly, Coondoo and Dinda (2002) used Granger causality tests to investigate the link between CO_2 emissions and economic growth in a panel analysis of 88 nations from the Americas, Europe, Asia, and Africa. The results show that in developed nations in North America, Eastern Europe, and Western Europe, emissions are linked to income. In contrast, for nations such as Japan, Oceania, and Central and South America, the causal chain goes from income to emissions. Causality, however, is proven to be two-way for countries in Asia and Africa. Similarly, Richmond and Kaufmann (2006) used panel research to examine the association between economic growth and carbon emissions in OECD and non-OECD nations, utilizing factors such as the ratio of fuel mix supplied by energy suppliers, income, and CO_2 emission. Economic growth and carbon emissions were shown to be negatively linked in OECD nations but positively linked in non-OECD countries. Soytas and Sari (2009) employed the Granger causality test to investigate energy consumption, economic growth, and carbon emissions in Turkey, adjusting for gross fixed capital creation and labor. According to the findings, unidirectional causality extends from carbon emissions to energy use without feedback. From 1995 to 2012, Kasperowicz (2015) used the ECM method to analyze the economic growth impact of carbon emissions in Poland. The results indicate a substantial correlation between economic growth and CO_2 emissions using variables such as GDP, carbon dioxide emissions (CO_2), energy consumption, capital stock, and overall employment. Unlike Richmond and Kaufmann (2006), whose findings were insignificant, their findings are significant. Menyah and Wolde-Rufael (2010) evaluated the long-term and causative link between energy use, pollution, and economic growth in South Africa from 1965 to 2006. Using the ARDL bound test for long-term relationships and the ECM approach for short-term dynamics, the researchers discovered a single line of causation connecting emissions with economic growth. Another similar study by Menyah and Wolde-Rufael (2010) found a single-direction cause-and-effect link between nuclear energy and carbon dioxide emissions in the United States from 1960 to 2007, analyzing the relationship between CO_2 emissions, nuclear energy, and renewable energy sources. Renewable energy and CO_2 emissions were shown to be unrelated in the study. Zaidi and Ferhi (2019) used a dynamic simultaneous equation model to study the relationship between energy consumption, economic growth, and CO_2 emissions between 2002 and 2012. They discovered that there is a two-way relationship between energy consumption and electricity use using the study's variables, which included GDP a proxy for energy use, and CO_2 emissions. Furthermore, Danish (2020) used FMOLS and DK regression techniques to examine the relationship between environmental pollution and institutional quality in 18 Asia–Pacific countries. In the study, it was shown that the quality of institutions has an impact on the environment. Sarkodie and Adams (2018) investigated the influence of institutional quality on CO_2 emissions using several assessment methodologies for South African data, including the ARDL methodology. He found that higher levels of institutional quality might contribute to lower levels of carbon dioxide emissions.

Joshi and Beck (2018) used the Arellano-Bover/Blundell-Bond Generalized Method of Moments (GMM) to analyze the relationship between democracy (political and economic freedom) and carbon dioxide emissions in a sample of OECD and non-OECD nations. OECD and non-OECD nations' emissions are shown to be positively correlated with a country's degree of political and economic freedom. Wawrzyniak and Dory (2020) also used GMM to examine the link between economic growth and CO_2 emissions in 93 developing and rising nations. Despite the study's findings that government efficacy has an impact on the connection between economic growth and emissions, it did not prove that corruption control has a moderating effect.

Egbichi et al. (2018) adopted a symmetrical ARDL model to examine the influence of energy consumption on the growth of African countries between 1986 and 2016. The symmetrical ARDL result showed that growth in African countries has not registered any major improvement due to continual oscillations in the electricity provision. They find that gas consumption in Nigeria has a significant negative impact on the country's economy because of gas flaring and other environmental pollutants in some of the country's most important oil-producing states in the Niger Delta. However, petroleum consumption has a significant impact on economic growth in Nigeria.

Using an auto-regressive distributive lag (ARDL) model with Pakistani yearly data spanning the years 1995–2017, Wang, Asghar, Zaidi, and Wang (2019) investigate the dynamic links between CO_2 emissions, health expenditures, and economic growth in the presence of gross fixed capital formation and per capita trade. According to their empirical findings, Pakistan's health spending, CO_2 emissions, and economic growth have a strong long-term and short-term causal link. The Granger causality between health expenditures and CO_2 emissions is bidirectional, and the Granger causality between health expenditures and economic growth is also bidirectional. There is a direct, short-term link between the amount of carbon emitted and the amount spent on health care. Both carbon dioxide emissions and gross fixed capital formation are examined for a bidirectional causal link, and then, policy solutions to reduce CO_2 emissions and healthcare costs without sacrificing economic growth are offered.

3. Methodology

3.1. Sources of Data

This study used secondary time series data from the year 1985 to 2021. Gross Domestic Product (GDP) was obtained from Central Bank of Nigeria (CBN) statistical bulletin, while Nitrous oxide emission (NO_2), Carbon dioxide emission (CO_2), and Gross Fixed Capital Formation (GFCF) were obtained from World Development Indicator (WDI).

3.2. Model Specification

Nigeria's economic growth and environmental sustainability are linked under the ARDL model. The following is a mathematical representation of the relationship:

$$LGDPP = CO_2 + GFCF + NO_2 + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots . (3.1)$$

Where:
LGDPP = Log of Gross Domestic Product
CO_2 = Carbon dioxide emissions
GFCF = Gross Fixed Capital Formation
NO_2 = Nitrous Oxide
ε = Error term
Specifying equation (1) in the ARDL equation yields:

Specifying equation (3.1) in the ARDL equation yields:

$$\Delta LGDP = b_0 + \sum_{j=0}^{r} b_1 \Delta CO2_{t-j} + \sum_{k=0}^{s} b_2 \Delta GFCF_{t-k} + \sum_{l=0}^{v} b_3 \Delta NO2_{t-l} + \varphi_1 LGDP_{t-1} + \varphi_2 CO2_{t-1} +$$

$$\varphi_3 GFCF_{t-1} + \varphi_4 NO2_{t-1} + e_2 \qquad (3.2)$$

Equation (3.2) depicts the short-run variables, while the long-run process is depicted by the lag factors in the second half of the equation. The word used to identify the stochastic term is e_2. bi (I = 1,2,3) and φi (i = 1,2,3,4) are the long- and short-run parameters of the variables. The optimal lag period will be estimated based on Akaike knowledge-collecting criterion. This is how equation (3.3) is represented when it has been corrected for errors.

$$\Delta LGDP = b_0 + \sum_{j=0}^{r} b_1 \Delta CO2_{t-j} + \sum_{k=0}^{s} b_2 \Delta GFCF_{t-k} + \sum_{l=0}^{v} b_3 \Delta NO2_{t-l} + b_5 ECM2_{t-1} + e_{22} \qquad (3.3)$$

Where $ECM2_{t-1}$ is the error correction term.

4. Empirical Results and Discussions

4.1. The Descriptive Statistics of the Variables

Table 1 below summarizes the descriptive statistics for the variables and shows the analysis results. All the variables' standard deviations are centered on their average values (less than the mean value). From the table, GDP is more stable and predictable over the years than any of the other variables. Looking at the results, it is easily discernable, albeit intuitively, that the variable GFCG will have the strongest impact on GDP given its highest standard deviation value amongst the variables as well as its huge range value of: 40.77954 (53.94827 – 13.16873). NO_2 is also expected to have a significant impact on GDP following the same intuitive observation of a mild standard deviation value of 3.27% and a range value of: 6.888675 (8.571291 – 1.682616), which indicates that the majority of the values are above the mean value because the range value (6.888675) is greater than its mean value (4.410528), that is 6.888675>4.410528. However, for CO_2, we do not expect it to have a significant impact on GDP since its range value of: 20.73124 (53.46346 – 32.73222) is less than its mean value (44.40217) that is 20.73124<44.40217. However, we cannot foretell the signage of the significant impact if it would be positive or negative, which is one of the limitations of descriptive statistics.

Variables	Observation	Mean	Standardd Deviation	Minimumm Value	Maximum Value
LogGDP	36	10.33529	0.20814	10.05782	10.66678
CO_2	36	44.40217	4.881158	32.73222	53.46346
NO_2	36	4.410528	3.272558	1.682616	8.571291
GFCF	36	32.73692	12.50445	13.16873	53.94827

Table 1: Results of Descriptive Statistics
Source: Authors' (2022) Computations

4.2. Augmented Dickey-Fuller Unit Root Test

According to the ADF's unit root test results presented in table 2 below, GDP is stationary at level. At levels, the test statistic surpasses the 5% threshold value in absolute terms. However, the independent variables are not stationary. There is a statistically significant difference between the current level of test statistics and the critical threshold of 5%. The null hypothesis of unit root existence is not rejected for all the independent variables. These variables were first differenced and became stationary at the first difference at 5 percent level. The ADF test at the first difference is more significant in absolute terms than the 5 percent critical value. The independent variables are integrated into order 1 using the ADF unit root measure, whereas the log of GDP is integrated into order 0.

Variables	ADF Results		Model	Lag Order	~I(d)
	Level	1st Difference			
LogGDP	-3.1310*	-	Drift	2	I(0)
CO_2	-1.735	-4.8790*	Drift	2	I(1)
NO_2	1.038	-3.5870*	Drift	2	I(1)
GFCF	-1.553	-4.2470*	Drift	2	I(1)

"* Designates a 5 percent significance level and the non-acceptance of the null hypothesis of the existence of unit root's, Akaike's Final Prediction Error (FPE) and Akaike's knowledge criterion were used to determine the best lag lengths". "At levels, the ADF 5 percent critical value is -1.706, and at the first difference, it is -1.708". "A drift model is included in the Augmented Dickey-Fuller's unit root estimated".

Table 2: The ADF Unit Root Test
Source: Authors' Computation, 2022

4.3. The Link between Emission and Economic Growth in Nigeria

ECM (equation 3.3) was used to investigate the link between Nigerian economic growth and carbon emissions. It should be noted that the variables' level-form connection in equation (3.2) was first tested to validate the presence of a level influence on the variables (cointegration).

"Critical Values (0.1-0.01), F-statistic, Case 3"							
90%		95%		97.50%		99%	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
1.72	2.77	2.23	4.24	3.24	4.67	3.45	5.21
90%		95%		97.50%		99%	
Critical Values (0.1-0.01), t-statistic, Case 3							
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
-1.57	-2.46	-1.86	-3.67	-2.13	-4.04	-2.43	-4.55
K	3						
F	6.6340						
t	- 3.8730						

Table 3: Bounds Test Result for Level Form Relationship (Level Effect) of the Variables in the ARDL Equation (3.2)
Source: Authors' Computation 2022

According to the F-test, the test statistic exceeded the critical upper Bounds value of 4.01 at the 5 percent level. Either I(0), I(1), or joint cointegration do not matter to the null hypothesis of no level relationship for the variables in equation (3.6) because it is rejected at 5 percent. Similar to the t-statistic, the critical value of 5 percent is below the critical upper bounds value. According to the t-statistic, the hypothesis that there is no relationship between the two variables is invalidated. Given this conclusion, we can conclude that the I(0) and I(1) variables are cointegrated. Variables in the ARDL model have a long-run (level-form) relationship. Deterministic regressors likewise have a level of influence on the long-term relationship.

4.3.1. The ARDL Model Error Correction

The ECM described in equations (3.3) has been estimated. To calculate the model's optimum lag time, the Akaike Information Criterion (AIC) was utilized automatically. A combination of the I(0) and I(1) series, without the I(2) series, is ideal for this study. Neither of the variables is affected by structural breaks I(2). There is no requirement for a structural break variable to be included in the model. Using the ARDL model of equation (3.3), the long-run and short-run coefficients of error correction estimates are shown in table 3.

The dependent variable is GDP - log of Gross Domestic Product				
LogGDP	coefficients	Standard Errors	t-Statistics	P-value
Adjustment	-0.521575	0.1030777	-3.88	0.001
Long-Run				
NO_2	-0.0153404	0.0058778	-3.54	0.028
CO_2	-0.0030066	0.0025538	-1.13	0.360
GFCF	-0.0138762	0.0006836	-17.84	0.000
Short-Run				
NO_2	0.4809926	0.1933453	2.49	0.023
CO_2	0.0008574	0.0008833	0.87	0.435
GFCF	0.0018858	0.0009251	2.18	0.046
Constant	4.922877	1.2418880	3.96	0.001
R2		0.8540		
Adjusted R2		0.8167		
F-stat		5.62(.00270)		
D-statistic		(11, 29) 2.197530		
Breusch-Godfrey LM Chi-square Statistics 0.813 (.33940)				

Table 4: Estimates of the ARDL Model's Error Correction - (Equation 3.3)
Source: Authors' (2022) Computations using E-views 8.0

The adjustment coefficient is significant and has a negative sign, and is between the usual ranges of zero and one. It is estimated that the system automatically corrects 52.15 percent of all errors in succeeding years at an annual rate of -0.5215750. Equation (3.3) changes to equilibrium at the rate of 52.15 percent per year in the long run. Convergence is a common occurrence.

The results in table 4 above indicate that in the long-run, NO_2 has a significant negative influence on GDP, such that a 1% change in NO_2 will cause 1.53% contraction in GDP. However, the short-run impact of NO_2 on GDP is so significant to suggest that Nigeria's economic growth is heavily dependent on NO_2 emissions, which, as a result, shows that a 1% change (increase) in NO_2 will cause a 48.10% increase in GDP. These results seem to be confirming the Grossman and Krueger (1995) hypothesis that shows that the long-term coefficient is negatively signed while short–term coefficient is positively signed. Our findings here imply that the Kuznets curve exists in Nigeria, and this is consistent with the findings of Lv and Li (2021) – a study of 47 emerging economies, Le and Ozturk (2020) – a study of 97 countries, including South Africa, and Egbetokun et al.'s (2020) study of the significant influence of emissions on Nigeria's economic growth. The significant impact of NO2 on GDP, both in the long-term and short-term, confirms our postulations during analysis of the results from the descriptive statistics.

CO_2 emissions also exhibited a negative long-run coefficient of about 0.00300660 with a t-value of -1.13. This suggests that CO_2 emissions have a long-run detrimental impact on the economy. Over the long-term, a 1% increase in emissions of CO_2 reduces GDP by around 0.3 percent. There is no long-run influence of CO_2 on GDP since it has a t-value of -1.13, which is less than 2 in absolute terms. An even more conclusive indication of the impact's insignificance is that the probability value of 0.360 is higher than the critical value of 5 percent (0.05). The short-run t-value is 0.870 and the likelihood value of 0.435, carbon dioxide emissions have no immediate impact on Nigeria's GDP. This confirms our postulations during analysis of the results from the descriptive statistics. Notwithstanding the insignificant impact of CO_2 on GDP, the signage of both the long-term and short-term coefficients of negative and positive, respectively, also confirms the existence of Kuznets curve in Nigeria.

Our results in table 4 show that the long-term coefficient of gross fixed capital formation had a significant negative impact on GDP, with a coefficient value of -0.011387620 and a t-value of 17.840. In the long run, a 1% increase in gross fixed capital formation will result in a 1.38% decrease in GDP. According to the coefficient (0.00188580), the t-value (2.2180), as well as the probabilities (0.046), implies a positive influence of gross fixed capital formation on GDP in the short run. A 1% percent rise in gross fixed capital formation leads to a 0.19 percent rise in GDP in the short run, and it is statistically significant at the 5% level. This statistical significant influence of gross fixed capital formation on GDP, both in the long-term and short-term, confirms our earlier assertion during analysis of the results from the descriptive statistics that this would be the outcome.

According to the R^2 value of 0.8540, the variables explained 85% of the variation in Nigeria's GDP. The remaining 14.60 percent of GDP fluctuation is accounted for by variables not included in equation (3.3). The F-statistics value of 5.62 is found to be significant. That the variables have no influence on GDP is thus rejected as a null hypothesis. According to the.00270 significant probability value, the null hypothesis's rejection is an insignificant error. A significant influence on Nigeria's GDP is therefore caused by these variables. The Durbin-Watson statistic value of 2.197530 indicates the absence of autocorrelation. Further validation is provided by the Breusch-Godfrey LM Chi-square Statistics of 0.813 with a probability value of.33940, which indicates that no serial association's null hypothesis should be accepted.

5. Conclusions and Recommendations

In this study, the link between carbon emissions and Nigeria's economic growth was examined. This relationship was analyzed using the ARDL method. Nigeria's economic growth in the short-run is positively impacted by gross fixed capital formation, but in the long-run gross fixed capital formation caused a decrease (negative impact) on Nigeria's economic growth. Nitrous oxide (NO_2) emissions have a significant negative influence on Nigeria's economic growth in the long-term but a significant positive impact on GDP in the short-term, while carbon dioxide (CO_2) emissions caused insignificant positive and negative increase and decrease to Nigeria's economic growth both in the short-run and long-run respectively. These findings show that NO_2 and CO_2 in Nigeria's economic growth follow the Kuznets curve of Grossman and Krueger (1995).

Nigeria's environmental and industrial policies require overhauling to engender the pursuit of sustainable economic growth both in the short-term and long-term from the supply of energy infrastructure (Ugwoke et al., 2020). Since the country's carbon emissions are primarily from energy production, transportation, and consumption (Gershon & Patricia, 2019), favourable policies and incentives (granting tax credits to carbon-neutral corporations) from the government as a foundational catalyst for the development of green infrastructure and significant investments in renewable energy technology are immediately needed to keep pace with the country's growing population (Akinyemi et al., 2021). The proposition of taxes on CO_2 by Areo et al. (2020) may seem plausible, but without a government-sponsored cheaper alternatives, the taxes may be passed to the consumers and may cause no real change to bring about a carbon economy.

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