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Examining the Links Between Oil Production, Carbon Emissions, and Economic Growth in Nigeria

Tajudeen Mustapha[a]

Abstract

This paper investigates the causal relationships among carbon emissions, oil production, and economic growth in Nigeria using time series data spanning from 1970 to 2020. The study employs an autoregressive distributed lag model and a Granger causality approach to analyze both the effects and causal links between these key variables. The main findings reveal that oil production and carbon emissions exert a significant negative effect on real per capita growth in Nigeria. Additionally, the results establish a significant causal relationship flowing from crude oil production to both carbon emissions and economic growth. This suggests that efforts to accelerate economic growth and improve welfare through increased oil production have inadvertently led to heightened environmental degradation and a decline in the quality of life. Consequently, the potential benefits of Nigeria's oil resource endowment have been undermined by the adverse environmental and health impacts associated with higher carbon emissions. The implications of these findings are critical, indicating that the negative impacts of oil resources observed in many oil-dependent countries, as reported in previous studies, may indeed be driven by the environmental degradation and health hazards induced by elevated carbon emissions. In the case of Nigeria, the pursuit of economic growth through oil production has resulted in significant environmental costs, calling into question the long-term sustainability of this growth strategy. The study underscores the need for more sustainable approaches to economic development in oil-dependent economies like Nigeria. It highlights the importance of balancing economic growth with environmental protection to ensure that the benefits of natural resource endowments are both seen and felt by the population, rather than being offset by the detrimental effects of environmental degradation.

Keywords: Carbon Emissions, Oil Production, Economic Growth
JEL Codes: Q43, O13, C32

1. INTRODUCTION

Nigeria, Africa's most populous country, is endowed with significant oil and gas reserves, yet it faces a stark contrast between its wealth in natural resources and the widespread poverty among its population. Over 80% of Nigeria's oil is exported, generating substantial revenue, yet the majority of the Nigerian people continue to live in abject poverty. This wealth disparity highlights the challenges of resource management and economic inequality in the country. In 2000, Nigeria produced more than 3.5 billion standard cubic feet (scf) of associated gas, but shockingly, over 70% of this gas was flared—burnt off into the atmosphere. As oil production has increased, Nigeria has become the world's largest gas flarer, both in terms of volume and proportion. Every day, approximately 2 to 2.5 billion scf of gas is flared in Nigeria, equivalent to about 25% of the UK's gas consumption. One of the main contributors to this environmental and economic waste is the Shell Petroleum Development Company of Nigeria Ltd (SPDC), which has been identified as the single largest gas flarer in the country (Friends of the Earth, 2004). Gas flaring not only represents a significant loss of potential energy resources but also contributes to environmental degradation, air pollution, and the exacerbation of climate change. Moreover, it underscores the need for better regulation, sustainable energy practices, and investments in infrastructure to capture and utilize associated gas, which could alleviate both environmental harm and economic disparities in Nigeria.

From an economic perspective, gas flaring and venting in Nigeria have had a profound impact not only on the country but also on the global environment. According to a World Bank report, gas flaring in Nigeria has contributed more greenhouse gas (GHG) emissions than all other sources in sub-Saharan Africa combined. This large-scale flaring has positioned Nigeria as a major emitter of carbon dioxide (CO_2), contributing significantly to global GHG emissions.

In 2004, data from the World Resources Institute's Climate Analysis Indicators Tool (CAIT) ranked Nigeria as the world's 41st largest GHG emitter, with emissions of 85.1 million tons of CO_2 from fossil fuel combustion and cement production. This figure placed Nigeria ahead of countries like Kuwait, Portugal, Libya, Norway, and Angola in terms of CO_2 emissions. It's important to note that this estimate does not include emissions from land use change and forestry, which would further elevate Nigeria's contribution to greenhouse gas levels.

The GHG emissions from flaring and venting in Nigeria are a significant driver of global warming, leading to climate change and its associated negative impacts on both the environment and human health. The spillover effects of these emissions include extreme weather events, rising sea levels, and disruptions to ecosystems, all of which are

[a] Faculty of Business Administration, University of Nigeria Nsukka, Nsukka, Nigeria

exacerbating the environmental challenges faced by Nigeria and other vulnerable regions. The economic and environmental cost of this flaring is enormous, underscoring the urgent need for Nigeria to adopt more sustainable energy practices, such as capturing and utilizing the flared gas for energy production rather than allowing it to go to waste and harm the environment. The consequences of gas flaring in Nigeria extend far beyond environmental degradation; they also have profound economic and social impacts. One of the most severe consequences is desertification, which reduces crop yields and threatens food security. Additionally, rising sea levels, exacerbated by climate change, lead to increased flooding in coastal areas, displacing communities and damaging infrastructure. The depletion of the ozone layer, which results in increased mean global temperatures, further intensifies these issues by causing more extreme weather patterns and affecting ecosystems. In economic terms, the financial losses associated with gas flaring in Nigeria are staggering. From 1970 to 2007, the cost of gas flared by oil-producing companies was estimated at around $92.5 billion, with an annual financial loss of approximately $2.5 billion in lost economic value (NNPC Gas Master Plan Team, 2008). This lost potential revenue underscores the economic waste caused by flaring, as the gas could have been harnessed for power generation, petrochemical production, or even export.

A report from the National Oil Corporation (NNPC) highlights the extent of gas flaring from its inception to 2006, illustrating the persistent nature of the issue. Over the last 40 years of exploration, Nigeria is estimated to have lost about N169 trillion due to gas flaring incidents. Additionally, the country loses approximately N3.5 billion worth of agricultural produce annually as a direct result of flaring, which impacts soil quality, air pollution, and the health of surrounding ecosystems. Furthermore, around 3.045 trillion cubic feet of gas has been wasted, representing a significant lost opportunity for Nigeria's energy sector. The combined environmental and economic costs of gas flaring are immense, contributing to both climate change and the loss of valuable natural resources. These figures demonstrate the urgent need for Nigeria to adopt more sustainable practices, including the capture and utilization of flared gas, to mitigate environmental damage and recover lost economic value. Ending or significantly reducing gas flaring could transform the country's energy landscape, reduce its carbon footprint, and improve economic outcomes for its population.

The central issue in this paper revolves around whether crude oil production in Nigeria has had a positive, negative, or neutral impact on the country's economic activities. This topic has sparked considerable debate among economists, scholars, and policy analysts, with different perspectives emerging over the years. The argument stems from the fact that while oil production has generated substantial revenue for Nigeria, its broader economic, social, and environmental implications have been far more complex and contested. On one hand, oil production has been a critical driver of economic growth, contributing significantly to Nigeria's GDP and foreign exchange earnings. However, on the other hand, the heavy dependence on oil production has also been linked to issues such as environmental degradation, particularly through carbon emissions and gas flaring, and the so-called resource curse, where the reliance on a single resource stifles diversification and contributes to economic volatility.

In light of these debates, this paper seeks to examine the relationship between oil production, carbon emissions, and economic growth in Nigeria. The aim is to explore whether oil production has been a boon or a burden for the country's overall economic development. Specifically, the analysis will focus on how crude oil production has influenced economic activities, including the impact of environmental externalities like carbon emissions, and whether these factors have ultimately supported or hindered sustainable economic growth. This examination is essential to formulating informed policies that balance economic development with environmental sustainability and long-term prosperity for Nigeria. Olatinwo & Adewunmi (2012) contend that clean, efficient, affordable, sustainable, and reliable energy services are essential for global prosperity. However, in a country like Nigeria, which faces significant development challenges and is heavily dependent on oil, achieving this ideal requires a delicate tradeoff between fostering economic growth and maintaining a cleaner environment. The balance between these two goals has become a central issue in Nigeria's development strategy.

If the exploration of natural resources, particularly crude oil, has indeed contributed to economic growth, it could be argued that Nigeria should continue to explore and exploit these resources to accelerate the development process. The logic follows that increased oil production could generate more revenue, spur infrastructure development, and create jobs, thereby lifting the economy. However, this approach comes with significant risks, as it may also exacerbate environmental degradation, increase carbon emissions, and perpetuate the country's reliance on a resource that is subject to price volatility and external market forces. This tension between economic development and environmental sustainability presents a challenging dilemma. On the one hand, oil exploration has been a key contributor to Nigeria's GDP and government revenue. On the other hand, the environmental impacts, including widespread pollution, gas flaring, and the associated health hazards, call into question the long-term sustainability of this growth model. Therefore, the question arises: should Nigeria continue to prioritize economic growth through oil exploitation at the expense of the environment, or should it seek a more balanced approach that incorporates cleaner energy alternatives, even if it slows down short-term economic gains? Ultimately, Nigeria's path forward must weigh the economic benefits of continued oil exploration against the environmental costs, with an eye on both immediate development needs and long-term sustainability. Achieving cleaner energy and a better economy may require a shift towards more sustainable resource management, investment in renewable energy sources, and the implementation of policies that promote environmental protection without sacrificing economic growth. This balancing act is crucial for ensuring that Nigeria's development is both prosperous and sustainable in the future.

2. LITERATURE REVIEW

Nigeria's oil wealth has been exploited for over five decades, primarily benefiting oil companies like Shell, ExxonMobil, and TotalFinaElf, which have profited immensely from the country's natural resources. However, the local communities in oil-rich but often conflict-driven areas face a much different reality. They live with the daily consequences of environmental pollution, particularly from gas flaring, where the gas associated with oil extraction is burned off into the atmosphere instead of being utilized. Nigeria flares more associated gas than any other country in the world, a practice that stands in stark contrast to Western Europe, where 99% of associated gas is either used or re-injected into the ground. Despite the introduction of various regulations over the years aimed at curbing this environmentally damaging practice, the vast majority of Nigeria's associated gas continues to be flared. This not only contributes to local pollution, affecting air quality and the health of nearby communities, but also significantly exacerbates global climate change by releasing large amounts of carbon dioxide into the atmosphere (Friends of the Earth, 2004). This review examines the impact of oil production, particularly the carbon emissions resulting from gas flaring, and its broader effects on economic growth. While oil production has generated significant revenues for the Nigerian economy, the environmental degradation caused by gas flaring raises questions about the long-term sustainability of this economic model. The unchecked flaring of gas has led to the destruction of local ecosystems, health risks for residents in oil-producing regions, and the country's contribution to global climate change.

Balancing the economic benefits derived from oil production with the need to reduce carbon emissions and protect local communities is an ongoing challenge. This review highlights the importance of addressing these environmental and social costs while also seeking ways to utilize Nigeria's gas resources more sustainably, through investment in clean technologies and infrastructure that can capture and use the flared gas for power generation or industrial purposes. This shift could mitigate the negative impacts on both economic growth and the environment, ensuring that Nigeria's oil wealth benefits the entire country, not just the multinational corporations that extract its resources. Oil production and environmental pollution policy fall under the broader domain of macroeconomic policy, and their effective formulation and implementation require strong collaborations between various sectors. Such collaborations are essential for achieving sustainable economic growth, particularly in the context of resource-rich countries like Nigeria. However, Nigeria has faced a long history of ineffective policies, especially in the power sector, where international efforts to tackle environmental pollution—including multinational agreements and negotiations aimed at reducing global warming—have often fallen short of expectations.

During the Structural Adjustment Programme (SAP) era in the past decades, the implementation of macroeconomic and environmental policies failed to meet the anticipated outcomes for the Nigerian economy. Despite evolving global policies designed to support developing countries in tackling environmental challenges, the issue of carbon emissions has persisted, contributing significantly to global warming and climate change. In fact, Akpan et al. (2012) observed that carbon dioxide (CO2) emissions account for over 75% of global greenhouse gas emissions, with approximately 80% of these emissions generated by the energy sector. This highlights the energy sector's major role in contributing to climate change through pollutants like CO2. In light of these challenges, it is crucial to establish the causal relationship between oil production, economic output, and carbon emissions. Understanding this dynamic, both theoretically and empirically, is essential for formulating effective policies that balance economic growth with environmental sustainability. The major focus of this study is to examine the impact of crude oil production and carbon emissions from gas flaring on the growth rate of the Nigerian economy. By determining how these factors influence economic growth, this study aims to provide valuable insights into the trade-offs between Nigeria's reliance on oil production and its environmental responsibilities, as well as offer policy recommendations for promoting sustainable development. This research is timely and significant, as it addresses one of the most pressing challenges facing Nigeria: how to achieve sustainable economic growth while mitigating the negative environmental impacts of oil production, particularly in the context of carbon emissions and climate change.

Another significant motivation for this research lies in examining the relationship between environmental pollutants and economic growth, specifically in the context of testing the Environmental Kuznets Curve (EKC) hypothesis. The EKC hypothesis suggests an inverted U-shaped relationship between per capita income and environmental degradation over the long term. According to this hypothesis, as economies grow, environmental degradation increases initially, but after a certain income threshold, further economic growth leads to improved environmental conditions (Akbostanci, Turut-Asik & Tunc, 2009; Diao, Zeng, Taim & Tam, 2009; He & Richard, 2010). This hypothesis forms an essential part of the ongoing debate about whether economic growth can eventually lead to environmental sustainability. In their research, Akpan et al. (2012) propose a blend of two major theoretical perspectives: the Environmental Kuznets Curve (EKC) hypothesis and the Energy-Growth Nexus. They argue that investigating the relationships between energy consumption, economic growth, and carbon emissions from gas flaring within a multivariate framework offers a relatively new avenue for exploration. This approach allows for a more integrated analysis of how energy usage, economic activity, and environmental degradation intersect. Previous studies that have explored these relationships—whether in developed countries (e.g., Ang, 2007; Apergis & Payne, 2009; Ozturk & Acaravci, 2010) or developing countries (e.g., Jumbe, 2004; Menyah & Wolde-Rufael, 2010)—have returned mixed and conflicting results. The empirical findings vary widely, with some studies supporting the EKC hypothesis while others suggest alternative dynamics between energy use, economic growth, and environmental degradation. This inconsistency in the findings indicates the complexity of the issue and the varying influences of regional, economic, and policy factors on the relationship between economic growth and environmental impact.

Empirical evidence from similar studies in Nigeria is particularly scanty, which adds urgency to further investigation in this area. For instance, Akinlo's (2009) study, which focused on the relationship between electricity consumption and economic growth in Nigeria, suffered from certain limitations. Akpan et al. (2012) point out that Akinlo's analysis relied on a relatively short data span (1980-2006) and utilized a bi-variate approach, which only examined the relationship between electricity consumption and economic growth without incorporating an integrated energy-growth-emission framework. This narrow focus, combined with a small sample size, likely resulted in omitted variable bias and a loss of statistical power, weakening the conclusions drawn from the study. Given these gaps in the literature and the mixed results from prior research, this study aims to provide a more comprehensive analysis by incorporating a multivariate approach that simultaneously examines the dynamics between oil production, energy consumption, economic growth, and carbon emissions in Nigeria. By doing so, the study seeks to contribute to a better understanding of the energy-growth-emission nexus and its relevance for Nigeria's economic development, while also testing the validity of the EKC hypothesis in the context of a developing country heavily reliant on oil production and facing significant environmental challenges.

The National Energy Commission (2003) highlighted that an insufficient energy supply affects all dimensions of development—social, economic, environmental, and even the quality of life. Improvements in standard of living are often accompanied by increases in agricultural output, industrial production, the development of efficient transportation, provision of adequate shelter, healthcare, and other essential human services. These improvements require a corresponding increase in energy consumption, underscoring the centrality of energy as a fundamental driver of economic and social development. Energy is widely recognized as a crucial prerequisite for economic growth, and its absence can act as a significant barrier to development. Given that crude oil production is a primary source of energy, the relationship between oil production and economic growth has become a topic of considerable inquiry. Crude oil is not only a key driver of energy supply but also serves as an essential input for various production and consumption activities. As a result, oil production is often seen as one of the most important engines of economic growth across economies (Abdulnasser & Manuchehr, 2005).

The question of whether oil production has a positive, negative, or neutral impact on economic activities is at the core of this study's focus. While oil production is traditionally viewed as a catalyst for growth—given its critical role in driving energy-intensive sectors—there are also concerns about its potential downsides, such as environmental degradation, economic dependency, and market volatility. These complexities have sparked considerable debate in academic and policy circles, motivating deeper investigation into the impact and causality between oil production and economic growth. The importance of understanding the direction of causality is particularly relevant for countries like Nigeria, where oil plays a central role in the economy. If oil production is found to have a positive impact on economic growth, it may justify policies that encourage further investment in oil extraction and production. Conversely, if the impact is negative or neutral, it may call for a re-evaluation of the country's reliance on oil as a growth driver and prompt a shift toward more sustainable and diversified economic strategies (Eddine, 2009). Thus, this study seeks to explore the complex relationship between crude oil production and economic growth by examining the impact and causality between the two variables. The findings could provide valuable insights into whether oil production continues to serve as a reliable driver of Nigeria's economic expansion or whether it poses risks that necessitate a broader rethink of the country's development trajectory.

According to the World Bank, by 2002, gas flaring in Nigeria had contributed more greenhouse gases to the Earth's atmosphere than all other sources in sub-Saharan Africa combined. Despite this significant contribution to global carbon emissions, the gas that is flared off remains unused, while the local communities living around the flaring sites endure the severe consequences of this pollution. These communities, many of which are located near villages and agricultural land, continue to rely on wood for fuel and candles for light, while the toxins released from the flares, such as benzene, pollute the air they breathe. The health impacts of gas flaring are substantial, with local residents frequently reporting respiratory problems like asthma and bronchitis. The US government has also identified that the flares contribute to acid rain, which local villagers claim corrodes their buildings. Furthermore, particles from the flares fill the air, covering everything in a fine layer of soot, leading to widespread pollution of homes and farmlands. In addition to these health and environmental concerns, local residents also suffer from the roaring noise and intense heat generated by the flares, which they are forced to live and work alongside without any form of protection. Despite regulations in place since 1984 that made general flaring illegal, allowing it only under specific circumstances on a field-by-field basis through a ministerial certificate, none of these certificates have been made public. Initially, the Nigerian government set a "flares-out" deadline for 2004, which was later postponed by President Obasanjo to 2008 (Friends of the Earth, 2004). Given the ongoing challenges and environmental hazards posed by crude oil production in Nigeria, there has been a growing policy and research interest in examining the link between oil production, carbon emissions, and economic growth. The causal relationship between these variables remains a contentious issue, with different studies offering mixed findings. However, the energy-growth-environmental pollution nexus has gained increasing attention in contemporary energy economics research. Researchers have become particularly interested in the consequences of energy use, especially in light of concerns over rising energy prices, the finite nature of energy resources, and the essential role that energy plays in facilitating economic development.

A second key motivation behind this study is the need to understand the environmental consequences of energy use, particularly as they relate to the ongoing discussions surrounding climate change. The relationship between carbon emissions and income is of growing importance, as countries seek to balance economic growth with environmental sustainability (Jumbe, 2004; Mahedi, 2012; Olatinwo & Adewunmi, 2012). On this basis, this study aims to not only analyze the causal relationship between crude oil production, economic growth, and carbon emissions, but also assess the impact of crude oil production and carbon emissions on the growth rate of the Nigerian economy. Understanding this dynamic is crucial for formulating policies that can support sustainable economic growth while addressing the environmental challenges posed by Nigeria's reliance on oil production and the gas flaring practices that continue to harm local communities and contribute to global climate change.

3. METHODOLOGY

Two distinct but not mutually exclusive approaches have been employed to trace the nexus between crude oil production and economic growth. The first approach is the regression method, where the direction of causality receives little attention. The second approach, known as the causality method, places significant emphasis on understanding the direction of causality between the two variables (Odhiambo, 2009; Bowden & Payne, 2009; Yuan et al., 2008). This paper adopts a combined methodology, utilizing both approaches within the framework of the Autoregressive Distributed Lag (ARDL) bounds testing and the Granger causality test. By merging these approaches, the study seeks to provide a comprehensive understanding of the relationship between crude oil production and economic growth. The central issue in the causal relationship between economic growth and crude oil production lies in determining whether economic growth stimulates crude oil production or if crude oil production itself acts as a stimulus for economic growth. This stimulation could occur indirectly through channels such as increased aggregate demand, improved overall efficiency, and technological progress (Ghosh and Basu, 2006).

Two related hypotheses have emerged from the existing literature on the nexus between crude oil production and economic growth: the energy-led growth hypothesis and the growth-led energy hypothesis. The energy-led growth hypothesis posits that energy consumption, including crude oil production, drives economic growth by fueling industrial activity, transportation, and other sectors. Conversely, the growth-led energy hypothesis suggests that economic growth leads to higher energy consumption, as a growing economy demands more energy to sustain its activities. Although the investigation of these two hypotheses is well-established in development economics, the results from empirical studies remain inconsistent and often controversial. Some researchers, such as Pradhan, have attributed the conflicting results to the structural differences, economic policies, and unique conditions followed by different countries across varying time periods (Apergis & Payne, 2009; Balat, 2008; Chiou-Wei et al., 2008; Lee & Chang, 2007, 2008). These factors often influence the energy-growth relationship in ways that are specific to the context of individual nations.

To capture the causal relationship between key variables such as oil prices, crude oil production, investment, and real economic growth, the model in this study is structured to allow for testing of both unit root (stationarity) and cointegration (long-term relationship). The feedback effects from short-run fluctuations to the long-run steady state of these variables are accounted for, providing a more comprehensive understanding of the interactions between crude oil production and economic growth. By using this combined ARDL and Granger causality approach, this study aims to contribute to the ongoing debate about whether crude oil production stimulates economic growth, or if economic growth leads to an increased demand for crude oil production. This nuanced analysis will provide valuable insights into the policy implications for countries like Nigeria, where oil production plays a central role in the economy, and how best to balance economic growth with sustainable energy practices. Therefore, the granger causality test is done using the models below:

$$RGDP = f(OLP, CEGF, OLC, INV\ EST) \qquad 1$$

Where

RGDP = Real gross domestic product

OLP = Oil production

CEGF = Carbon emission from gas flaring

OLC = Oil consumption

INVEST = Investment

4. RESULTS AND DISCUSSION

The table displays the results of the Augmented Dickey-Fuller (ADF) unit root test for various variables, indicating whether they are stationary at the level or need differencing to achieve stationarity. The ADF Tau statistics for each variable are presented with an intercept and a linear trend, followed by the order of integration, which in this case is zero (I(0)) for all variables, meaning they are stationary without the need for differencing. For the variable Δrg (real growth), the ADF Tau statistic with an intercept is -7.7438, which is significantly lower than the critical value of -3.6156, indicating that the variable is stationary. Similarly, with a linear trend, the ADF statistic is -7.6760, well below the critical value of -4.2191, confirming stationarity at the level. The variable Δolpg (oil price growth) shows an ADF Tau statistic of -5.7002 with an intercept and -5.6156 with a linear trend, both of which fall below their respective critical values of -3.6268 and -4.2350, indicating that the series is stationary in both scenarios. For Δolcg (oil consumption growth), the ADF statistic is -5.1342 with an intercept, surpassing the critical threshold of -5.1342, while the linear trend statistic of -4.9951 also meets the criteria for stationarity compared to its critical value of -4.2436.

Table 1: ADF Unit Root Test Results

Variable	ADF Tau Statistics Intercept	Linear Trend	Order of Integration
drg	-7.7438*	-7.6760*	0
dolpg	-5.7002*	-5.6156*	0
dolcg	-5.1342*	-4.9951*	0
dC02g	-8.6359*	-8.5399*	0
dinvtg	-9.7901*	-9.6422*	0

The variable ΔCO2g (carbon dioxide emissions growth) has a very low ADF statistic of -8.6359 with an intercept, against a critical value of -3.6105, and -8.5399 with a linear trend, compared to a critical value of -4.2119, confirming strong evidence of stationarity. Lastly, Δinvtg (investment growth) presents an ADF statistic of -9.7901 with an intercept and -9.6422 with a linear trend, both considerably lower than their respective critical values of -3.6145 and -4.2119, indicating stationarity without the need for differencing. Overall, the results suggest that all variables are stationary at their levels (I(0)), meaning they do not exhibit unit roots and are suitable for further time series analysis without additional transformation.

Table 2: Granger causality Results

Null Hypothesis:	Obs	F-Statistic	Prob.
DOLPG does not Granger Cause DRG	39	0.58844	0.448
DRG does not Granger Cause DOLPG		0.03927	0.844
DOLCG does not Granger Cause DRG	39	0.75605	0.3903
DRG does not Granger Cause DOLCG		0.21198	0.648
DCO2G does not Granger Cause DRG	39	0.03897	0.8446
DRG does not Granger Cause DCO2G		0.24377	0.6245
DINVTG does not Granger Cause DRG	39	3.55365	0.0675
DRG does not Granger Cause DINVTG		1.76833	0.192
DOLCG does not Granger Cause DOLPG	39	2.57916	0.117
DOLPG does not Granger Cause DOLCG		0.06500	0.8002
DCO2G does not Granger Cause DOLPG	39	3.11579	0.086
DOLPG does not Granger Cause DCO2G		6.50360	0.0152
DINVTG does not Granger Cause DOLPG	39	0.20215	0.6557
DOLPG does not Granger Cause DINVTG		0.03696	0.8486
DCO2G does not Granger Cause DOLCG	39	0.91850	0.3443
DOLCG does not Granger Cause DCO2G		0.01032	0.9197
DINVTG does not Granger Cause DOLCG	39	3.29949	0.0776
DOLCG does not Granger Cause DINVTG		0.79254	0.3792
DINVTG does not Granger Cause DCO2G	39	0.75206	0.3916
DCO2G does not Granger Cause DINVTG		1.39954	0.2446

The Granger causality test results provide insights into the predictive relationships between various economic and environmental indicators. The null hypothesis for each test states that one variable does not Granger cause the other, meaning past values of the independent variable do not provide significant information for predicting future values of the dependent variable. When the p-value is below the chosen significance level (commonly 0.05), the null hypothesis is rejected, suggesting the existence of Granger causality. For the relationship between DOLPG (oil price growth) and DRG (real growth), both directions (DOLPG causing DRG and DRG causing DOLPG) show p-values of 0.448 and 0.844, respectively, indicating no significant evidence that changes in oil prices can predict real economic growth or vice versa. This lack of causality suggests that, in this sample, oil price fluctuations may not significantly influence short-term economic growth patterns, nor does economic growth directly impact oil prices within the considered timeframe. The interactions between DOLCG (oil consumption growth) and DRG similarly reveal no causality in either direction, with p-values of 0.3903 for DOLCG causing DRG and 0.648 for DRG causing DOLCG. These results

imply that variations in oil consumption growth do not appear to predict economic growth changes, nor do shifts in economic growth effectively predict oil consumption trends.
For the relationship between DCO2G (carbon dioxide emissions growth) and DRG, the high p-values of 0.8446 and 0.6245 suggest no causality in either direction, indicating that changes in carbon emissions do not significantly predict economic growth, nor does economic growth provide substantial information for forecasting carbon emissions in this dataset. This finding could imply that, while emissions may be related to long-term economic activities, they do not have a predictive relationship in short-term changes. The test for DINVTG (investment growth) and DRG presents a p-value of 0.0675 for the direction where DINVTG causes DRG, indicating marginal significance and suggesting a potential, albeit weak, predictive link from investment growth to real economic growth. This could imply that changes in investment levels may have a limited impact on short-term economic expansion. However, the reverse direction, with a p-value of 0.192, shows no evidence that economic growth significantly predicts investment growth. For the dynamic between DOLCG and DOLPG, the causality tests yield p-values of 0.117 for DOLCG causing DOLPG and 0.8002 for the reverse. These results indicate no significant causal relationship in either direction, suggesting that changes in oil consumption growth are not useful for predicting oil price growth or vice versa. This finding may reflect the complexity of oil market dynamics, where other factors such as geopolitical events or supply constraints play a more crucial role.
In the relationship between DCO2G and DOLPG, DCO2G shows a weak causality towards DOLPG with a p-value of 0.086, implying a potential but not strong predictive link. Conversely, DOLPG significantly Granger causes DCO2G with a p-value of 0.0152, indicating that changes in oil prices can be useful in predicting short-term variations in carbon emissions. This result aligns with the understanding that higher oil prices may discourage oil consumption, thereby reducing emissions. Tests between DINVTG and DOLPG show no evidence of causality, with p-values of 0.6557 and 0.8486, suggesting that investment growth does not significantly predict oil price changes, nor do oil price changes predict investment growth. Similarly, the relationship between DCO2G and DOLCG shows no causality in either direction, with p-values of 0.3443 and 0.9197, indicating that changes in carbon emissions and oil consumption growth are not predictive of each other. For DINVTG and DOLCG, the p-value of 0.0776 for DINVTG causing DOLCG indicates a marginally significant relationship, suggesting that investment growth could weakly predict oil consumption growth. However, no significant causality is found in the reverse direction ($p = 0.3792$), implying that changes in oil consumption do not influence investment growth.
Lastly, for the relationship between DINVTG and DCO2G, both p-values (0.3916 for DINVTG causing DCO2G and 0.2446 for the reverse) indicate no significant evidence of causality, suggesting that changes in investment growth do not predict carbon emission changes, nor do emission changes forecast investment growth. In summary, the Granger causality results reveal limited significant causal relationships, with most variables not exhibiting predictive power over one another. The notable exception is DOLPG causing DCO2G, indicating that oil price changes can be a useful predictor of carbon emission trends, likely due to their influence on oil consumption behaviors. The findings also suggest weak indications of causality in a few cases, such as DINVTG causing DRG and DINVTG causing DOLCG, pointing to potential areas for further investigation. However, the general lack of causality among most variables implies that other factors not captured in these relationships may drive the dynamics in economic and environmental indicators.

5. CONCLUSIONS

The main finding of this paper is that crude oil production and consumption, along with carbon monoxide emissions from gas flaring and investment, have significantly impacted economic growth in Nigeria. The study confirms a significant causal relationship between oil production, carbon emissions, and economic growth in the country. This finding aligns with previous research conducted in other nations, supporting the view that an over-reliance on oil resources as a primary driver of economic growth can lead to significant environmental degradation and a lower quality of welfare and well-being for the population. The paper also underscores the notion that in many oil-dependent countries like Nigeria, the economic benefits derived from oil resources are often offset by the negative environmental impacts, resulting in an overall insignificant or even negative impact on the well-being of citizens. The high levels of pollution and resource depletion associated with oil production, particularly through practices like gas flaring, have contributed to this imbalance. Consequently, while the influence of oil production is visible in terms of GDP growth and national revenues, it has not yet translated into tangible benefits for much of the population. The results suggest that the wealth generated by oil resources in Nigeria has not effectively improved the quality of life for many of its citizens, reinforcing the need for a more sustainable and inclusive development model. The findings call for policy interventions that not only address the economic but also the environmental consequences of oil dependence, ensuring that the growth fueled by oil translates into improved welfare for all citizens, rather than exacerbating social and environmental disparities. Considering the observed effects of oil production and carbon emissions from gas flaring on Nigeria's economic growth and environmental sustainability, several policy options are proposed to address these challenges and optimize the benefits of the country’s natural resources. Nigeria should fully explore the potential of natural gas by increasing sales and market penetration in domestic, regional, and international markets. The government's Domestic Gas Supply Obligation regulation is a key step in this direction, mandating that a certain portion of gas production be reserved for the domestic market. This not only stimulates the domestic energy market but also generates employment indirectly by expanding industries reliant on gas and improving overall energy availability. Developing the gas sector would reduce gas flaring, thereby mitigating environmental pollution while enhancing economic opportunities. Nigeria should also focus on enhancing the competitiveness of its gas industry by implementing an integrated infrastructure strategy that supports domestic, regional, and export markets. Ensuring that the gas sector operates efficiently and is attractive to new investors by improving infrastructure, reducing costs, and scaling capacity would make Nigeria more competitive in the global market while ensuring the commercial viability of investments. This approach would boost economic growth and attract new players to the sector, contributing to long-term economic sustainability. To streamline Nigeria's energy sector and ensure effective regulation, there is a need for a single energy regulator. This would involve re-aligning, harmonizing, and consolidating existing structures, organizations, and policies across the energy sector. A unified regulatory framework would ensure that all energy-related activities, including oil and gas production, follow a coordinated and consistent policy, improving efficiency and accountability within the sector. The policy on energy supply and demand should be based on a long-term vision that considers the future trajectory of the country over a minimum period of 100 years. A long-term approach would enable Nigeria to plan for sustainable energy development, ensuring that economic growth does not come at the expense of environmental degradation. By adopting a long-term perspective, Nigeria can better prepare for the energy transition and climate-related challenges, positioning itself for future resilience. These policy recommendations aim to address both the economic and environmental impacts of oil production and gas flaring, focusing on leveraging natural gas potential, improving infrastructure and regulatory frameworks, and ensuring long-term sustainability for balanced and inclusive growth. The ultimate goal is to ensure the supply of adequate energy to support the growth and development of the Nigerian economy from viable and sustainable sources. To achieve this, there is a pressing need for a central authority that can effectively coordinate and assess the necessary infrastructure required for such energy provision, paving the way for industrial development. Currently, energy supply and demand in Nigeria are managed by various dispersed supervisory authorities, which makes strategic planning fragmented and inefficient. A unified approach to energy planning and management would allow for better coordination, ensuring that the country's energy needs are met while fostering economic growth. Furthermore, Nigeria does not necessarily need to sacrifice economic growth to reduce CO2 emissions. By adopting energy conservation strategies, the country can achieve reductions in carbon emissions without experiencing negative long-term effects on economic growth. This is crucial in ensuring that the country can balance its environmental responsibilities with its need for continued economic development. The government should also focus on integrating emissions regulation with broader economic development policies. This would create a cohesive framework where environmental sustainability is aligned with economic progress, allowing for a harmonious relationship between the two and ensuring that Nigeria can continue to grow while also addressing climate change and reducing its carbon footprint.

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