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Environmental Pollution, Energy Resource Import, Economic Growth and Financial Development: Theoretical Exploration and Empirical Evidence from Nigeria

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Abstract

The complications in the sustainable development notion which have resulted into unending arguments and empirical analyses on energy-output-emission nexus have been extended to the exploration of the individual and joint effects of trade and finance on the nexus This study therefore extends the literature by reviewing the theoretical links among economic growth, carbon emission, energy resource import and financial development with empirical evidence from Nigeria during 1981 and 2019. Based on the mixed integration order, autoregressive distributed lag (ARDL) bounds test revealed cointegrating (long-run) relationship among the selected variables with and without structural break. Further analysis was conducted using the standard linear and non-linear bivariate Granger causality methods with and without structural breaks. With the inclusion of structural break in the causality model, the results improved. The results indicated that a significant unidirectional causality runs from real output (GDP) per capita to financial development (domestic credit to the private sector). Similarly, a significant one-way causality moves from environmental pollution (carbon emission) to financial development (both domestic credit and broad money supply). Further, there is a significant unidirectional causality running from energy resource import (fuel import) to financial development (broad money supply). Moreover, a significant feedback effect exists between financial development and energy resource import. These findings inform some policy implications which were well articulated in the conclusion.

Keywords: Energy resource import; Aggregate output growth; Carbon emission; Financial development; Linear and non-linear causality; Nigeria

Introduction

The debates on the complexity of the sustainable development concept which have led to many empirical studies on energy-output-emission nexus have been extended to the exploration of the individual and joint effects of trade and finance on the nexus [1-3]. The need to promote sustainable development globally has led to the articulation of sustainable development goals (SDGs) with emphasis on the various aspects of energy-output-emission nexus. Thus, some SDGs (1, 2, 7, 8, 12 and 13) explicitly cover pro-poor growth and development, sustainable energy and climate change. The imperative for the simultaneous achievement of the three pillars of the SDGs was reiterated in a recent special report on Global Warming by the Intergovernmental Panel on Climatic Change (IPCC 2018).

Although trade and finance are not part of the main SDGs, they are important in the realisation of the goals. These key elements are categorised under the means of implementing (MOI) SDGs and financing for sustainable development (FFSD). The idea behind the recognition of trade in the 2030 Agenda is that it contributes to growth and sustainable development when effectively managed [4]. Trade related SDG targets and commitments include making concrete efforts to double the exports of Least Developed Countries (LDCs), execution of duty-free quota-free and the new agreement on trade facilitation, and provision of market access for LDCs exports. They also extend to issues on the use of regional trade integration (with appropriate safeguards) to foster inclusive growth and removal of trade restrictions that cause overcapacity, over-fishing and inefficient energy use. Moreover, they cover promotion of market access to enhance productivity and income of small scale producers and the integration of developing countries into global value chains to facilitate sustainable development [4]. In particular, the Sustainable Development Goal 7 which is

on ''sustainable energy'' stresses the need to promote access to affordable energy and cooperation in the area of technology to facilitate the attainment of sustainable development goals. Trade is crucial in the achievement of this goal because most developing countries depend on imported energy products, and technological diffusion from developed nations.

Building infrastructure to facilitate economic activities of small scale producers and promoting their access to production inputs require innovative financing. Public-private partnership is essential in the financing of the attainment of the SDGs. Private sector investment can be encouraged via climate finance that minimises risks associated with private finance. Innovative financing and insurance schemes are important given the fact that inadequate access to affordable credit and high risk factors inherent in the business environment are hindering micro, small and medium scale enterprises from embarking on investment in climate-resilient technologies and practices [5].

For the purpose of empirical analysis of the linkages among the variables being studied, we use a case study (Nigeria). Nigeria, like other developing countries, is battling with the challenges of sustainable development. In the country, real gross domestic product per capita was relatively higher during 2000-2015 than the proceeding period (World Bank, on-line)[1]. Also, a considerable share of refined fuel utilised in the country is imported[2]. In Nigeria import of fuel was higher in 2000-2015 than the previous period[3]. Fuel import exceeded domestic fuel output in the country by about 225% in 2009, though fell to about 78% in 2012 (US Energy Information Administration: USEIA, on-line). Moreover, fuel imports in Nigeria stood at 20% of total merchandise imports in 2012-2015. Contrary to the observed upward trends in GDP per capita and fuel import per capita, carbon emissions per capita fell marginally from 10.36 metric tons in 1984 to 9.15 metric tons in 2015, while the domestic credit to the private sector (% of total credit) and broad money (% of GDP) in Nigeria ranged 9-19% and 16-27%. Therefore, the interactions among energy resource import, finance development, output and emission require theoretical and empirical analyses.

The questions that arise from the foregoing include:

a) Can we link the trends of carbon emissions and output in Nigeria to energy resource import and financial development?

b) Does the link of financial development with the energy, output and emission depend on the focus of policies (financial access or depth)?

c) Does structural change (break) mediate theses links?

d) Can we broaden the understanding of the theoretical links among the variables?

Despite the importance of these questions, little or no study has addressed them over time[4,5].

The motivations for this study are discussed in the following. Although some past studies have covered diverse combinations of the four variables (energy import, output, emission and financial development), however, the few studies that covered all of them provided findings that are largely mixed and inconclusive across countries and regions. This probably reflect the differences in the level of economic and financial development of the economies studied, and diverse methodological approaches as well as theoretical basis (which is absent in most studies). Besides, previous analyses ignore the case of Sub-Saharan Africa especially the relatively large and industrial economies in the Continent including Nigeria. Also, despite the fact that fossil fuel consumption in these economies, which is a major driver of growth and environmental quality, are imported, little or no study has captured the link between this imported energy resource and economic growth, carbon emission and financial development. Moreover, it should be stated that, the use of an indicator of financial development in the previous studies may be questionable given various dimensions of the concept. It should also be noted that, the focus of the previous studies is on energy consumption and trade or trade openness (but not energy resource import). These are the gaps filled by this study which examines the links among energy resource import, output, emission and financial development.

[1]World Development indicators,

[2]Some oil-rich economies including Nigeria where the refinery facilities are either inadequate or underutilised, crude oil is being exported to earn foreign exchange, part of which is also used to finance import of refined petroleum products to bridge the domestic energy gap and obtain the required energy to propel economic activities

[3]Due to malfunctioning of refineries and increased energy requirement in the economy (Tajudeen, 2015; and Adewuyi, 2016)

[4]https://www.thisdaylive.com/index.php/2019/05/30/green-financing-in-nigeria/: In Nigeria a number of financial innovations have occurred in the financial sector including the use of Automated Teller Machine (ATM), Point of Sale terminals (POS), Web/Internet payment (WEBP) and Mobile pay (MBP). It has been shown that the use of four innovation channels mutually rose at a mean of 296.47% in and 112.63% in value and volume terms respectively during 2009-2018 (Okafor, 2019). In Nigeria, the initial green bond was issued in 2017 (N10.69 Billion Sovereign Green Bonds) to finance three green projects (Energizing Education Project-EEP, Rural Electrification Project-REP and the Afforestation Project-AP. with a number of conditions including investment in renewable and sustainable energy, clean transportation, sustainable water management, climate change adaptation, energy efficiency, sustainable waste management, sustainable land use, biodiversity conservation, green buildings.

[5]https://www.lexology.com/library/detail.aspx?g=c402f0e6-471b-41b8-b161-40feabf01804: In the same vein, North South Power Company Limited issued the N8.5 Billion Green Guaranteed Infrastructure Bond (GGIB) to finance its sustainable energy provision programmes. Similarly, in the banking sector, Access Bank gained the approval of the Securities & Exchange Commission (SEC) to issue N15 Billion Green Bond.

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Literature Review

This study examines the interactions among economic growth, energy resource import, carbon emission and financial development. Some previous studies have covered various combinations of these four variables. For instance, some works have been done on the links among energy consumption, economic growth and financial development [6-8], while some studies have also covered carbon emission, energy consumption and financial development [9-14]. There are researches on financial development, carbon emission and economic growth [15,16]. Studies have also been conducted on the link between ffinancial development and carbon emission [17] as well as between energy consumption and financial development [18,19].

The interest of this review is on the studies that considered all four variables in the same framework. Thus, adopting a panel simultaneous equation model estimated with generalized method of moments, Abdouli & Hammami [20] established the feedback causality between carbon emissions (and energy consumption) and growth among Middle East Countries from 1980 to 2014. Their results further suggest unidirectional causality running from financial development and energy consumption to carbon emission. Further, among APEC Countries, Zaidi et al. [21] showed evidence of bidirectional causality between carbon emissions and financial development, as well as energy intensity during 1990-2016. They further found a unidirectional causality running from carbon emission and energy intensity to economic growth, and energy intensity to financial development. Granger causality analysis of Ozturk & Acaravci [22] could not provide evidence of a strong link among growth, energy, environment and financial development, but only found one-way Granger causality running from energy consumption and economic growth to financial development in Turkey between 1960 and 2007.

Moreover, Salahuddin et al. [23] adopted panel VECM-based Granger causality to analyse the case of the Gulf Cooperation Council countries, and reported a bidirectional causal relationship between energy consumption and environmental pollution and a unidirectional movement from financial development (economic growth) to energy consumption (carbon emission). In Indonesia, Shahbaz et al. [1] used similar method to show evidence of bidirectional causality between financial development and environmental pollution, while revealing bidirectional link between output as well as energy consumption, and carbon emissions. For the case of Kuwait, Salahuddin et al. [2] presented unidirectional causal link from electricity consumption, carbon emissions and financial development to economic growth during 1980-2013. Mugableh [24] also provided evidence of unidirectional Granger causality from financial development to energy and growth in Jordan, as well as feedback causal link between carbon emissions and growth. Abdouli & Hammami [25] and Bekhet et al. [26] however showed mixed findings across 17 MENA countries and GCC countries respectively, while no link is established between financial development and environmental quality by Shahbaz et al. [27] in South Africa.

As stated earlier, some past studies have covered diverse mix of these four variables (energy import output emission and financial development). However, the few studies that covered all of them provided findings that are largely mixed and inconclusive across countries and regions, reflecting the differences in the level of development of each economy and the financial sectors. Besides, analysis ignores the case of Sub-Saharan Africa especially the relatively large and industrial economies in the continent including Nigeria. Besides, despite the fact that fossil fuel consumption in these economies, which is a major driver of growth and environmental quality, are imported, little or no study has captured the link between this imported energy resource and economic growth, carbon emission and financial development, which is the focus of this study with empirical evidence from Nigeria Moreover, it should be stated that ,the use of an indicator of financial development in the previous studies may be questionable given various dimensions of the concept. It should also be noted that, the focus of the previous studies is on energy consumption and trade or trade openness (but not energy resource import). These are the gaps filled by this study.

Theory and Methodology

Theoretical linkages between the variables

Finance-growth nexus

The debates about the finance-growth nexus started with the Schumpeter [28] notion that the growth and development of the real sector is propelled by the growth and development of the financial sector (finance-driven growth hypothesis). The expansion in the real sector would engender demand for increased and improved financial services by all categories of enterprises (small, medium and large), resulting into financial development. Subsequently, the endogenous growth model emphasizes the role of stocks of capital and knowledge in long-run growth [29]. Thus, sustainable long-run growth is driven by enlargement of the capital and the knowledge stocks which require investment financing. Thus, financial development is imperative for sustainable long-run growth. However, an alternative argument came on board when Robinson [30] stated that economic growth is also central for financial development. Thus, strict exogeneity of financial development in an endogenous growth model may not hold. This idea is widely known as the ''demand-following hypothesis'', implying that economic growth is a prospective driver of financial development.

Finance-energy import nexus

Access to finance enhances the standard of living of citizens and fosters human activities that raise energy use (Shahbaz et al. 2017a). In the same vein, energy is required for the functioning of the financial infrastructure (usage of ICT and other equipment as well as provision of conducive environment for personnel, transportation, etc) and performance of financial services. Trade

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finance implies borrowing by firms from financial institutions including banks to facilitate international trade activities. Diverse arguments have been made on the finance-trade nexus. For instance, financial condition has been introduced as part of endowment in the Heckscher-Ohlin trade model [31]. According to Kletzer & Bardhan [31], in a world where countries have the same technology or endowments, comparative advantage may diverge depending on the credit market conditions and credit contract enforcement status. Thus, an import dependent economy (with imperfections: moral hazard in foreign credit markets) may need to rely on a strong or highly developed local financial sector for trade and growth. The financial sector needs to provide access to affordable foreign exchange required for imports. Importers also require other financial services such as trade finance instruments and infrastructure.

Local finance provision is important for developing countries due to low level of income and creditworthiness rating, lack of internationally acceptable collateral and poor credit contract enforcement that deters foreign funding. However, Do & Levchenko [32] gives alternative argument that financial development is influenced by trade patterns. They pointed out the endogeneity of financial development as it is driven by the demand for foreign finance in individual countries: When comparative advantage in trade influences a country's consumption patterns, then countries importing goods (including energy) that require more finance will have a high demand for foreign trade finance which will enhance financial development.

Energy (import)-growth nexus

The standard energy economic literature suggests four hypotheses [33,34]. The growth hypothesis entails a unidirectional causality running from energy consumption to economic growth. Since energy is a crucial intermediate input in production, therefore it plays a crucial role in promoting economic growth. However, the conservation hypothesis states that economic growth requires energy consumption. The hypothesis shows that a unidirectional causality moves from economic growth to energy consumption. Increased aggregate demand following a rise in the real income per capita in turns induces production expansion which necessitates high energy use. Nevertheless, technological development can shorten energy use per output such that economic growth generates a reducing effect on energy consumption. Moreover, the feedback hypothesis reflects a bi-directional causality between energy consumption and economic growth. This implies that there is a direct positive correlation and complementarities between the two variables. Further, the neutrality hypothesis portrays absence of causal link between economic growth and energy consumption as the influence of the variable on each other is relatively small or negligible. It is also important to discuss the trade (export and import) -lead growth and growth-led trade hypotheses. Import-led growth is about the role of import benefits and opportunities (import- induced access to affordable commodities and inputs including energy) in growth. These opportunities and benefits lead to expansion of domestic consumption and growth. In the same vein, income (growth)-led import concerns the role of income in consumption including import [35].

Energy (import) - environmental quality nexus

Energy economic literature shows that energy is a critical input in production [34,36]. According to Fare et al. [37], production inputs including energy generate both good output (commodities) and bad output (carbon emissions and wastes). Also, the quest to improve environmental quality (reduce carbon emissions) induces the reduction of energy use and choice of energy type consumed. The trade-environment nexus has been summarized under the Pollution-Haven and Pollution-Halo hypotheses [38]. Trade is associated with major environment effects either adverse effect (pollution haven) or favourable effect (pollution hallo) depending on the host country environmental laws and enforcement of compliance with such laws in most developing host countries over time [38,39].

Growth- environmental quality nexus

The growth-emission nexus is usually described by the well-known Environmental Kuznets Curve (EKC) hypothesis, which illustrates the causal link between environmental pollution and economic growth. The hypothesis shows that environmental pollution tends to go up at low level of per capita income, but as per capita income increases (which lead to improved living standard) and reaches a point pollution decreases [40]. Good environmental quality promotes output growth via policies that reduce human health risks (such as respiratory and contaminated diseases) and minimise physical risks (such as oil-spillage, earthquake), which constrains growth.

Finance-environmental quality nexus

Environmental quality (CO_2 emission) is influenced by financial development in some means. Adequate financial intermediations make consumers have easy access to affordable credit which them improve their living standard by acquiring household appliances, refrigerators and automobiles that discharges CO_2 [17]. Also, financial development via effective financial intermediaries enables firms to intensify the use of existing business assets such as land and building, equipment, automobiles that directly or indirectly generate carbon emission or launch new projects which implementation results in increased carbon emission. Further, financial developments may induce inflows of foreign direct investment with positive impact on economic growth which engenders CO_2 emission [15,16]. Financial development can also improve environmental quality (via better environmental management practices) by enhancing corporate governance induced by special green-projects financing and monitoring role of financiers of business projects. Financial development may promote inflow foreign investments with enlarged R&D activities that lead to better environmental conditions [41]. In the reverse, the quest to tackle environmental pollution problem can also drive financial innovations. Thus, solution to environmental pollution

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problem (carbon emission) may be in terms of designing financial innovation programmes such as climate or green-financing schemes. These include promotion of equity investments in environment-oriented firms and projects, as well as financial products such as eco-leases, climate mortgages and green lending [42].

Methodology

Following the foregoing, this study adopts the ARDL bounds test cointegration and the VECM based Granger causality techniques to analyse the link among the variables. The ARDL bounds test, developed by Pesaran and Shin (1999) and Pesaran et al. (2001), allows for variables of different orders (I (0) or I (1)) or mix order of integration, endogenous and with different optimal lags. Thus, the possibility of unit root in the selected variables is tested in order to satisfy the underlying assumptions of the ARDL bounds testing approach. The existence of long-run relationship among GDP per capita (GDP), energy resource import per capita (ERIMP), carbon emissions (CO_2) per capita, and financial development variables (domestic credit -CR, and broad money-BM) may be specified as follows:

$$\Delta GDP_t = \alpha_1 + \theta_1 GDPC_{t-1} + \theta_2 ERIMP_{t_1} + \theta_3 CO2_t + \theta_4 CR_t + \theta_5 BM + \sum_{i=0}^{m}\beta_i \Delta GDPC_{t-i} + \sum_{i=0}^{m}\beta_i \Delta ERIMP_{t-i} + \sum_{i=0}^{m}\beta_i \Delta CO2_{t-i} + \sum_{i=0}^{m}\beta_i \Delta CR_{t-i} + \sum_{i=0}^{m}\beta_i \Delta BM_{t-i} + \pi_{1t} \quad \text{.....(1)}$$

$$\Delta GDP_t = \alpha_1 + \theta_1 GDPC_{t-1} + \theta_2 ERIMP_t + \theta_3 CO2_t + \theta_4 CR_t + \theta_5 BM + \theta_6 CR\_B_t + \theta_7 GDP\_B_t + \theta_8 ERIMP\_B_t + \sum_{i=0}^{m}\beta_i \Delta GDPC_{t-i} + \sum_{i=0}^{m}\beta_i \Delta ERIMP_{t-i} + \sum_{i=0}^{m}\beta_i \Delta CO2_{t-i} + \sum_{i=0}^{m}\beta_i \Delta CR_{t-i} + \sum_{i=0}^{m}\beta_i \Delta BM_{t-i} + \sum_{i=0}^{m}\beta_i \Delta CR\_B_{t-i} + \sum_{i=0}^{m}\beta_i \Delta GDP\_B_{t-i} + \sum_{i=0}^{m}\beta_i \Delta ERIMP\_B_{t-i} + \pi_{1t} \quad \text{.....(2)}$$

Where equation 1 is the model without structural break and equation 2 is the model with structural break. π_{1t} and Δ represent the error term and the first difference operator respectively. CR_B, GDP_B and ERIMP_B are structural break in domestic credit, GDP and energy resource import respectively. This approach tests the null hypothesis of no cointegration. If the calculated F-statistics is greater than the upper band level, the null is rejected, indicating cointegration. If the calculated F-statistics however lies below the lower critical value, we cannot reject the null hypothesis of no cointegration. Decision is inconclusive if it lies between the bounds.

In order to examine the causal relationship among the selected variables, Granger (1988) causality analysis is conducted using the VECM model depending on the cointegrating relationship among the variables. The augmented Granger causality test is formulated as a bivariate *pth* order VECM in the following forms:

$$\begin{bmatrix}\Delta GDP_t\\ \Delta CO2_t\\ \Delta ERIMP_t\\ \Delta CR_t\\ \Delta BM_t\end{bmatrix} = \begin{bmatrix}k_1\\ k_2\\ k_3\\ k_4\\ k_5\end{bmatrix} + \sum_{i=1}^{p}\begin{bmatrix}d_{11}(L)d_{12}(L)d_{13}(L)d_{14}(L)d_{15}(L)\\ d_{21}(L)d_{22}(L)d_{23}(L)d_{24}(L)d_{25}(L)\\ d_{31}(L)d_{32}(L)d_{33}(L)d_{34}(L)d_{35}(L)\\ d_{41}(L)d_{42}(L)d_{43}(L)d_{44}(L)d_{45}(L)\\ d_{51}(L)d_{52}(L)d_{53}(L)d_{54}(L)d_{55}(L)\end{bmatrix}\begin{bmatrix}\Delta GDP_{t-1}\\ \Delta CO2_{t-1}\\ \Delta ERIMP_{t-1}\\ \Delta CR_{t-1}\\ \Delta BM_{t-1}\end{bmatrix} + \begin{bmatrix}\lambda_1 ECT_{t-1}\\ \lambda_2 ECT_{t-1}\\ \lambda_3 ECT_{t-1}\\ \lambda_4 ECT_{t-1}\\ \lambda_5 ECT_{t-1}\end{bmatrix} + \begin{bmatrix}C_1\\ C_2\\ C_3\\ C_4\\ C_5\end{bmatrix} + \begin{bmatrix}\pi_1\\ \pi_2\\ \pi_3\\ \pi_4\\ \pi_5\end{bmatrix} \quad \text{.....(3)}$$

$$\begin{bmatrix}\Delta GDP_t\\ \Delta CO2_t\\ \Delta ERIMP_t\\ \Delta CR_t\\ \Delta BM_t\\ \Delta Z_t\end{bmatrix} = \begin{bmatrix}k_1\\ k_2\\ k_3\\ k_4\\ k_5\\ k_6\end{bmatrix} + \sum_{i=1}^{p}\begin{bmatrix}d_{11}(L)d_{12}(L)d_{13}(L)d_{14}(L)d_{15}(L)d_{16}(L)\\ d_{21}(L)d_{22}(L)d_{23}(L)d_{24}(L)d_{25}(L)d_{26}(L)\\ d_{31}(L)d_{32}(L)d_{33}(L)d_{34}(L)d_{35}(L)d_{36}(L)\\ d_{41}(L)d_{42}(L)d_{43}(L)d_{44}(L)d_{45}(L)d_{46}(L)\\ d_{51}(L)d_{52}(L)d_{53}(L)d_{54}(L)d_{55}(L)d_{56}(L)\\ d_{61}(L)d_{62}(L)d_{63}(L)d_{64}(L)d_{65}(L)d_{66}(L)\end{bmatrix}\begin{bmatrix}\Delta GDP_{t-1}\\ \Delta CO2_{t-1}\\ \Delta ERIMP_{t-1}\\ \Delta CR_{t-1}\\ \Delta BM_{t-1}\\ \Delta Z_{t-1}\end{bmatrix} + \begin{bmatrix}\lambda_1 ECT_{t-1}\\ \lambda_2 ECT_{t-1}\\ \lambda_3 ECT_{t-1}\\ \lambda_4 ECT_{t-1}\\ \lambda_5 ECT_{t-1}\\ \lambda_6 ECT_{t-1}\end{bmatrix} + \begin{bmatrix}C_1\\ C_2\\ C_3\\ C_4\\ C_5\\ C_6\end{bmatrix} + \begin{bmatrix}\pi_1\\ \pi_2\\ \pi_3\\ \pi_4\\ \pi_5\\ \pi_6\end{bmatrix} \quad \text{.....(4)}$$

Where ECT represents the error-correction term, C_i (i=1....6) are constants; and π_5 (i=1...6) are serially uncorrelated random error terms with zero mean. Equations 3 and 4 are models without structural break and with break respectively. Z_t are the structural break variables. The variables utilized in this study, which cover the period 1981 to 2019, are described in Table 1. The period of the data sets is dictated by availability.

Empirical Results and Discussion

Preliminary analysis

The summary statistics of all series utilized in the causality analysis is presented in Table 2[6]. The statistics show that the average real GDP per capita in Nigeria is US$1774.7 with a maximum level of US$2563.9. Also, fuel import per capita in Nigeria averaged USD0.04 with a maximum of USD0.615. Moreover, average carbon emission per capita is 0.629 metric tons in Nigeria, while domestic credit (CR) and broad money (BM) range from an average of 9% and16% to a maximum of 19% and 27% in Nigeria respectively. In terms of the variability, output appears more volatile than the other variables in Nigeria, while CO_2 and energy resource import (ERIMP) are least dispersed.

The stationarity properties of the series are determined using both Augmented Dickey Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. In addition, in order to account for the possible structural change, ADF unit root test with structural break is conducted. While ADF tests the null hypothesis of presence of unit root, KPSS tests the null hypothesis that the series are stationary, allowing a reliable decision to be made. ADF and PP results suggest that all the series are stationary at level (Table 3). The results of the ADF unit root test with structural break indicate that all the series are stationary at level, except CO_2 (Table 4).

The Brock, Dechert and Scheinkman (1987) [43] (BDS) non-linearity test is conducted on all variables with dimension (m) running from 2 to 8 and distance of 0.7. The BDS tests the null hypothesis of independently and identically distributed (iid) series against an alternative hypothesis that the selected series are non-linear or non iid. Results of the BDS tests do not reject the null hypothesis for almost all the variables (Table 5). Thus,

[6]Aggregate output, fuel import, and carbon emissions are measured in per capita terms.

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except broad money, all variables of interest are linear. Further, cointegration analysis is conducted using the ARDL bounds testing approach, and results are reported in Table 6. Cointegrating relationship exists among the selected variables in Nigeria with and without the structural break. Thus, long-run (cointegration) relationship is found among the variables in the country.

Table 1: Variable Description and Data Sources.

Variable	Description	Measurement	Data Sources
GDPPC	Aggregate Output	GDP Per Capita (constant 2005 US$)	World Bank, World Development Indicators, 2020
ERIMP	Energy resource Import	Fuel imports per capita (constant 2010 US$)	World Bank, World Development Indicators, 2020
CO2	Carbon emission	CO2 emissions (metric tons per capita)	World Bank, World Development Indicators, 2020
FD(CR)	Domestic Credit	Domestic credit to private sector (% of GDP)	World Bank, World Development Indicators, 2020
FD(BM)	Broad Money	Broad money (% of GDP)	World Bank, World Development Indicators, 2020

Source: Author's compilation.

Table 2: Summary Statistics.

	FD(BM)	CO2	FD(CR)	ERIMP	GDP
Nigeria					
Mean	16.13778	0.629406	9.192353	0.129742	1774.713
Median	13.39988	0.688179	8.168808	0.027404	1581.562
Maximum	27.37879	0.874309	19.6256	0.615486	2563.9
Minimum	9.063329	0.312014	4.957522	0.03648	1324.297
Std. Dev.	5.770074	0.174644	3.547854	0.191361	445.5466
Observations	39	39	39	39	39

Source: Computed.

Table 3: Unit root Tests.

Variable	Augmented Dickey Fuller (ADF) Levels				Kwiatkowski-Phillips-Schmidt-Shin (KPSS)				Decision
	Intercept		Trend and Intercept		Intercept		Trend and Intercept		
	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference	
FD(BM)	-1.563	1.092	-0.265	0.948	0.32	0.322	0.095	0.153**	I(0)
CO2	-1.794	-5.433*	-1.758	-5.294*	0.119	0.138	0.125	0.133	I(0)
FD(CR)	-0.953	-2.102	0.701	-2.301	0.423	0.377	0.133	0.147**	I(0)
ERIMP	-1.473	-10.686*	-3.812**	-10.542*	0.527**	0.034	0.139	0.033	I(0)
GDP	-1.17	3.123	1.544	3.333	0.13	0.344	0.123	0.152**	I(0)

Note: * and ** indicate that the variable is stationary at 1% and 5% respectively. I(0) represents stationarity at level while I(1) denotes stationarity at first difference. Source: Author; Data from WDI.

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Table 4: ADF Unit root with Structural Break.

Variables	Break Date	T-statistics	Break Date	T-statistics	Decision
	Level		First Difference		
FD(BM)	2006	-6.575*	2012	-5.307*	I(0)
CO2	1999	-2.791	2000	-8.053*	I(1)
FD(CR)	2006	-4.823*	2007	-6.051*	I(0)
ERIMP	2013	-5.617*	2007	-13.346*	I(0)
GDP	2001	-4.884*	2002	-4.345***	I(0)

Note: * and ** indicate that the variable is stationary at 1% and 5% respectively. I(0) represents stationarity at level while I(1) denotes stationarity at first difference. Source: Author; Data from WDI.

Table 5: BDS Non-Linearity Test.

	GDP	(FD)BM	CO2	(FD)CR	ERIMP
Nigeria					
2	-0.011(0.012)	-0.006(0.013)	-0.003(0.018)	-0.004(0.012)	-0.002(0.019)
3	-0.015(0.019)	-0.044(0.021)**	0.022(0.029)	-0.038(0.019)**	-0.050(0.030)***
4	-0.017(0.023)	-0.029(0.026)	0.017(0.035)	-0.027(0.023)	-0.051(0.037)
5	-0.018(0.024)	-0.084(0.027)*	0.014(0.037)	-0.012(0.025)	-0.034(0.040)
6	-0.020(0.024)	-0.073(0.027)*	-0.009(0.036)	-0.003(0.024)	-0.016(0.039)
7	-0.018(0.022)	-0.061(0.025)*	-0.018(0.034)	0.012(0.023)	0.002(0.037)
8	-0.005(0.020)	-0.041(0.023)***	-0.022(0.031)	0.014(0.021)	0.024(0.034)

Source: Computed; Note: *, ** and *** represent significance levels at 1%, 5% and 10% respectively.

Standard errors are in parenthesis.

Table 6: Bounds test.

Country	F-Statistics	K	90%		95%		99%		Decision
			I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
Without Structural	4.477	7	2.03	3.13	2.32	3.5	2.96	4.26	Cointegrated
With Structural Break	6.432	7	2.03	3.13	2.32	3.5	2.96	4.26	Cointegrated

Source: Computed.

Granger causality between financial development, resource import, output and carbon emissions

Both linear and non-linear bivariate Granger causality tests were conducted. However, only the results of the linear Granger causality between the variables of interest are reported in Table 7, while those of the non-linear were kept in the appendix (Table A & B) due to their insignificance. Results with structural breaks (Panel B) are better than those without structural breaks (Panel A). The results indicate that a significant unidirectional causality runs from real output (GDP) per capita to financial development (domestic credit to the private sector). This result is consistent with the Robinson [30] position that economic growth is important for financial development. This idea is widely referred to as the "demand-following hypothesis". The result is also in line with the finding of Ozturk & Acaravci [22] for Turkey. Similarly, a significant unidirectional causality also moves from environmental pollution (carbon emission) to financial development (both domestic credit and broad money supply). As stated earlier, pursuance of solution to environmental pollution problem may lead to the design of financial innovation programmes such as climate or green-financing schemes that are elements of financial development. This finding is inconsistent with that of Abdouli & Hammami [20], Zaidi et al. [21] and Shahbaz et al [1,6] for Middle East, Asia Pacific Economic Cooperation countries Indonesia and China respectively.

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Table 7: Bivariate Linear Granger causality.

	GDP	BM	CO2	CR	ERIMP	CR_B	GDP_B	ERIMP_B
A. Without Structural Breaks								
GDP	-	3.87	0.072	0.583	1.051	-	-	-
BM	4.520***	-	0.774	8.661*	0.892	-	-	-
CO2	0.012	0.072	-	0.128	0.377	-	-	-
CR	1.379	1.484	1.517	-	2.781	-	-	-
ERIMP	3.687	0.774	9.202	0.936	-	-	-	-
ECT_{t-1}	123.467*	98.850*	19.784	80.418*	11.153	-	-	-

B. With Structural Breaks								
	GDP	**BM**	**CO2**	**CR**	**ERIMP**	**CR_B**	**GDP_B**	**ERIMP_B**
GDP	-	3.938	0.451	7.497**	3.703	0.490	0.445	0.599
BM	2.553	-	0.859	3.35	0.391	0.867	0.795	1.507
CO2	0.279	5.187***	-	21.971*	2.298	0.684	6.811**	0.198
CR	0.086	2.769	1.84	-	6.017**	1.860	0.199	0.369*
ERIMP	0.498	8.669*	0.183	41.400*	-	0.704	0.760	24.517
CR_B	1.575	3.212	0.381	11.133*	20.565*	-	0.494	10.774*
GDP_B	5.111***	5.910**	0.183	12.900*	0.1648	0.084	-	0.252
ERIMP_B	0.727	3.733	0.238	30.202*	48.020*	2.185	0.636	-
ECT_{t-1}	14.771	29.874*	3.404	68.368*	86.491*	6.686	10.777	38.404*

Note: *, ** and *** represent significance levels at 1%, 5% and 10% respectively. Standard errors are in parenthesis.

Further, there is a significant unidirectional causality running from energy resource import (fuel import) to financial development (broad money supply). Moreover, a significant feedback effect exists between financial development and energy resource import (fuel import). This result is in line with the arguments of both Kletzer & Bardhan [31] and Do & Levchenko [32]. Financial development may be a source of comparative advantage in trade. The financial sector needs to provide access to affordable foreign exchange required for imports. Importers also require other financial services such as trade finance instruments and infrastructure. However, financial development could be engendered by trade patterns. A country's consumption patterns could influence comparative advantage in trade such that countries importing goods (including energy) that need more finance will have a high demand for foreign trade finance, thus stimulating financial development level. The results contrast those of Salahuddin et al. [2] and Mugableh [24] for Kuwait and Jordan respectively. The links financial development, energy resource import, economic growth and environmental quality are further presented in Figure 1. The results further show evidence of a long-run causal link running from per capita economic growth, carbon emissions and energy resource import to financial development (both credit access and financial depth). In the same vein, long-run causality is found to run from economic growth, financial development and carbon emissions to energy resource import. This indicates that the link among these variables could play key role in determining the level of financial development and energy import in the long term [44].

Summary, Conclusion and Policy Recommendations

This study investigates the links among financial development, resource import, economic growth and carbon emission in Nigeria between 1981and 2019. The long-run relationship was tested using the autoregressive distributed lag (ARDL) model. The links among the variables were examined using the standard linear and non-linear bivariate Granger causality methods with structural breaks. Financial development is measured using both domestic credit and broad money as a percentage of GDP to account for the role of credit access and financial depth.

The results of the ADF unit root test with structural break indicate that all the series are stationary at level, except CO_2 emission. Also, results of the BDS tests reveal that except broad money, all variables of interest are linear. Further, the ARDL bounds testing approach indicates that cointegrating (long-run) relationship exists among the selected variables with and without structural break. Moreover, the Granger causality results indicate that a significant unidirectional causality running from real output (GDP) per capita to financial development (domestic credit to the private sector). Similarly, a significant unidirectional causality moves from environmental pollution (carbon emission)

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to financial development (both domestic credit and broad money supply). Further, there is a significant unidirectional causality running from energy resource import (fuel import) to financial development (broad money supply). Moreover, a significant feedback effect exists between financial development and energy resource import (fuel import).

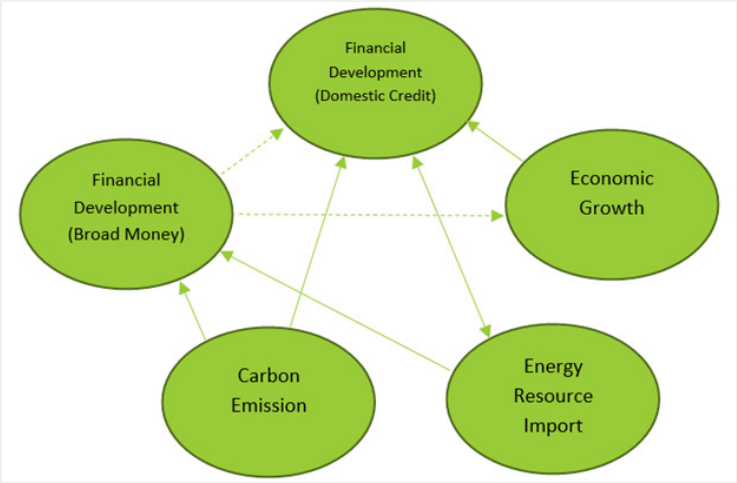

Figure 1: Finance-Growth-Resource Import-Emission Links in Nigeria.

Note: The unbroken lines show the results of the model with structural break, while broken ones represent results of the model without structural break.

A number of policy implications can be drawn from the foregoing findings. It is clear from the results that the level of economic development of an economy drives financial development. Therefore, stakeholders in Nigeria's economic development should ensure the growth and structural transformation of the economy from primary production to secondary and tertiary production which are the first two elements of economic development. Therefore, government should intensify diversification efforts to promote sustained growth which will in turn enhance financial development in the country especially credit to the private sector. There should also be technological and institutional transformations in terms of acquisition of technical knowledge, creativity and innovation as well as changes in values and attitudes so as to cope with the rapid wave of globalisation. Since energy is a critical input in production, foreign exchange and credit should be made available and affordable for importers of petroleum products. The policy makers should note that finance stimulates production which in turns fosters the development of the financial sector. Efforts should be increased in the pursuance of pollution-induced financial innovation schemes such as green- and climate-loans and stocks so as to reduce environmental pollution and also promote financial development. This should also be complemented with public awareness and campaigns. The various agricultural and climatic programmes being implemented by the Federal government (via the Central Bank) and the State governments should be vigorously promoted.

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Appendix

Table A: Bivariate Non-Linear Granger causality without structural break.

	GDP	ERIMP	CO2	FD(CR)	FD(BM)
GDP	-	0.098	0.1	1.569	1.236
ERIMP	0.212	-	1.192	0.457	0.137
CO2	0.556	0.144	-	0.381	0.015
FD(CR)	0.338	0.004	0.971	-	0.502
FD(BM)	0.015	0.42	0.714	0.053	-

Source: Computed.

Table B: Bivariate Non-Linear Granger causality with structural breaks.

	GDP	BM	CO2	CR	ERIMP	CR_B	GDP_B	ERIMP_B
GDP	-	0.596	0.17	1.129	0.053	0.266	0.54	1.179
BM	0.437	-	0.154	0.814	0.043	0.103	0.211	0.030
CO2	0.086	0.332	-	0.177	0.336	0.547	0.142	0.178
CR	0.368	0.388	0.127	-	1.249	0.155	0.205	0.748
ERIMP	1.026	0.505	0.178	0.01	-	2.516	0.499	2.460
CR_B	0.05	0.031	0.110	0.235	1.286	-	0.005	1.287
GDP_B	0.126	0.027	0.136	0.549	0.311	0.0997	-	1.277
ERIMP_B	0.18	0.117	0.425	0.972	0.184	2.448	0.757	-

Source: Computed.

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