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Article

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Green Growth and Environmental Sustainability in Nigeria

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ABSTRACT

The purpose of this paper is to examine the long-run equilibrium between green growth and some environmental variables like deforestation, energy depletion and carbon dioxide (CO_2) emissions in Nigeria from 1980 to 2015. To examine these long-run linkages, the study adopted the autoregressive distributive lag bound testing approach to cointegration. The bound testing approach shows an evidence of a negative long-run relationship between carbon dioxide emission and environmental depletion and renewable energy which stand as the proxy for green growth variable. Inversely, a positive long-run relationship exists between green growth variable and deforestation. Generally, this paper submits that efficient investment in green growth technologies and policies in Nigeria will assist to ensure a sustainable environment.

Keywords: Green Growth, Sustainable Environment, Carbon Emission, Energy Depletion, Nigeria
JEL Classifications: Q56, Q58

1. INTRODUCTION

The environment is a source of sustenance for more than 50% of the economically active high and increasing population of the African race and other developing economies as they largely get their source of livelihood from agriculture, animal husbandry, fishing, hunting, foraging and forestry. The need to get the source of livelihood and still maintain a quality environment directly explains the relevance of the seventh goal target of the Millennium development Goal which is to "ensure environmental sustainability" (Todaro and Smith, 2015). A review of these items in the MDG connotes that the attempt to ensure economic growth and development in these developing countries affects the quality of the environment and vice versa. Meanwhile, the environmental cost relating to economic activities has raised plethora of arguments among several economists. Although, development economists are of the view that a high consideration should be awarded to the environment as part of policy initiatives, but the development economists have also failed to integrate environmental cost in the calculation of growth national index. The continued utilisation of unsustainable methods of production will have an unending damage to soil, water supply and forest with a slow rate of replenishment compared to the rate of harvest. Therefore, the government should always consider the need to sustain a quality environment in their policy formulations and implementations (Todaro and Smith, 2015).

The quest to sustainable development and emergence of green growth economy has continued to dominate the central issue of economic development policy and the need to find a long-lasting solution to environmental issues emanating from the need to grow and develop the economies. Most countries of the world have witnessed a severe economic downturn, high rate of unemployment, growing environmental hazard and increasing rate of health related problems, despite the huge resource endowments of these countries.

Green growth economy became the focus of policymakers not only because most industrialised and resource oriented nations like United Arab Emirate, Korea, Japan, and China have adopted a transition away from the quantitative to qualitative growth path and has become the world leader in green growth export through the creation of industries using wind, solar and bio-fuels (Bowen, 2012). While developing nations like Nigeria, Haiti and South Africa have topped the chart of all standard measure of environmental and negative hardship caused as a result of exploration, extraction, manufacturing and production of economic activities which is an old path of growth.

Green growth has its origin in Asia and Pacific regions at a conference held in Seol in the year 2005 when it was decided that there is a need to move from the then present economic growth to a sustainable green growth path with its overall aim of reducing poverty level and environmental sustainability. As at the commencement in 2005, it was a regional based policy, but later received a global attention most especially among the developing nations with assistance from several international agencies like the World Bank, UNESCAP, and OECD in 2012 (Omilola, 2014).

Green growth is a policy framework that combines environment and the economy, it is aimed at increasing the level of economic growth through income and investment so as to reduce poverty through the provision of green and clean jobs and improved wellbeing of its citizen and also to develop a management policy to checkmate, control activities carried out within an environment. Fay (2012) is of the view that green growth is the only vital strategy that can set developing countries on the path of sustainable development through poverty alleviation and increased public awareness on environmental issues. All the importance accruable from the proper adoption of green growth. Adequate adoption of green growth can be activated by ensuring the needed level of innovativeness in these African countries and removing the bottlenecks to proper diffusion of green growth products or technologies.

Although there exists no universal definition of green growth, but World bank refers to green growth as an inclusive growth that is efficient in its use of natural resources, as it minimises pollution and environmental impacts, also resilient in that it accounts for natural hazards and the role of environmental management and natural capital in preventing physical disaster (World Bank, 2012). OECD (2011b) refers to green growth as a strategy of ensuring economic growth and development without a resultant impact on the ecosystem but a sustainable effect on the social welfare. In a bid to actualizing these goals, green investment and innovations should be given a full recognition as they are key determinants of sustainable growth and development. Also, Bowen (2012) saw the framework as a complete economic progress that creates an enabling and sustainable environment through reduction in carbon emission and other forms of pollution, which is targeted at creating a more business friendly environment to boost productivity and improve the people's welfare.

1.1. Statement of the Problems

As all the countries in the world are aiming towards achieving economic growth and development, the ever increasing population of the world has led to increased adoption of high technological machine, establishment of big firms and technologies, accumulation of vehicles are increasing the accumulation of CO_2 in the atmosphere. This accumulation of CO_2 emission in the atmosphere is posing a serious challenge to the environment as it is tending towards a level that will make it difficult to maintain an acceptable global mean temperature below 2°C over the preindustrial level. Despite, the record of increasing irreversible environmental changes consistent with increasing temperature, carbon dioxide is also posing serious effect on the world oceans. There is the possibility of a significant harm reef ecosystem owing to the commitment to high probabilities of coral bleaching and mortality recorded in the late twentieth century as a result of global warming in different part of the world (World Bank, 2010; Fay, 2012). In order to avoid the threat posed by the accumulation of CO_2 emission and still ensure inclusive economic growth in different countries in the world, there is a need for a paradigm shift towards renewable source of generating energy.

It is estimated that about 1.1-1.6 billion people in low-income countries lack access to electricity and about 2.6-2.9 billion people adopt the traditional biomass as a source of heating for cooking and are thereby exposed to risks of lung diseases, burns and the possibility of even death (GTF, 2015; IEA, 2013). Africa is richly endowed with renewable energy resources which remain under-utilized because only about 7% of her enormous hydro potential excluding the small, mini and micro hydro opportunities are being harnessed. Kenya has only exploited about 60MW from the geothermal energy which stands at 9000MW (Karekezi et al., 2003).

The main source of electricity in Nigeria is the natural gas and hydro with ratio 70-30% respectively. These power sources are prone to sabotage and harsh weather conditions and there is an inadequate power supply due to low gas supply resulting from a lack of proper maintenance of the power plants, high costs and recurrent crises in the oil producing region of the country. Notwithstanding, the difficulties of meeting the nation's electricity needs, demand will continue to grow in response to the ever increasing population, urbanization, need for improved standard of living and achieving economic development (Sambo, 2008). In recent times, the rate at which fuel wood is being exploited is greater than its regeneration. However, if alternative sources or intervening measures are not implemented timely, fuel wood may no longer serve as a renewable energy resource in Nigeria (Akinbami, 2001). Nigeria has an average solar radiation level of about 5.5 Whm-2 days-1 and a prevailing efficiency of commercial-electric generators. Therefore, if solar collectors or modules are utilized in 1% of Nigeria's land area of 923,773 km^2, 1850GWh by 103GWh solar electricity will be generated per year, while this will give 100 times the grid electricity consumption level in Nigeria (Sambo, 2009).

With the present recession and economic downturn in Nigeria, the need to move away from the quantitative gross domestic product form of growth to a qualitative green growth path become imperative even in the face of serious environmental challenges like environmental degradation, oil spillage, bad weather, shortage of food, water and energy, carbon emission and health related issues which occurs as a result of over dependence on mono-natural resource product and its exploitation being witnessed across the resource base area of the Southern part of the country.

Nigeria quantitative economic progress has remained in daunting stage despite the endowed natural resources, leaving over 30% of its population in severe poverty and 62% below poverty line, having only 48% of its citizen access to electricity, 64% to water source and the resource areas (Niger-delta) with high benzo (a) pyrene concentration in the water, only 28% have access to improve sanitation, CO_2 emission of about 0.5 per capital metric tonnes 2012, unemployment moving from 6.6% in 2014 to 10.4% in 2015 and annual deforestation on the average of 3% yearly (World Bank, 2015). The nation is therefore still characterised by low investment, especially in the real sector, unemployment and poor finance of the health sector, test run economic policies, over dependence on foreign goods, high consumption and real purchasing power remains a critical issue in the mind of policy maker, in which the only solution remains transition from brown growth to green growth.

In the search for solution to most of the policy issues relating to economic growth, carbon emission, energy consumption and ensuring the sustenance of natural resources in different countries in the world. Several researches have been carried out in the energy literature, from various dimensions or point of view, but failed to look at the holistic view of environmental sustainability. Some studies examined the relationship or impact of gross domestic product (GDP) on energy consumption and carbon dioxide emissions (Diao et al., 2009; Zhang and Cheng, 2009; Menyah and Wolde-Rufael, 2010). The outcome of these studies proved ambiguous, with Diao et al. (2009) in their EKC model emphasised the complexity of the relationship between the economic growth and environmental quality, Menyah and Wolde-Rufael also discovering a bi-directional causality between electricity consumption and economic growth. Zhang and Cheng (2009) also found a long-run unidirectional Granger causality running from GDP to energy consumption, and a long-run unidirectional Granger causality running from energy.

From the foregoing, there is need to determine the long-lasting means of ensuring environmental sustainability in Nigeria from the holistic point of view. This aim can be achieved by investigating whether green growth can assist Nigeria in achieving sustainable environment, hence the research question of this study is: What are the impacts of the adoption of green growth towards achieving a sustainable environment in Nigeria? In a bid to providing answer to the research question, the study seek to examine the impact of greening the growth of the economy on the level of environmental degradation in the country.

The balance of this paper is organised as follows: Section 2 presents the related literature review of green growth and sustainable environment in Nigeria, Section 3 is the methodology and data analysis while the research findings is presented in Section 4, the conclusion and policy recommendations are presented in Section 5.

2. THEORETICAL LITERATURE REVIEW

Theoretically, the basis for green growth is rooted in correcting large scale market imperfection by maximising output through the increased combination of capital, labour, technology and human capital. The neo-classicalist believed that output growth is enhanced when factors of production are increased in size. Capital in its state depreciates over time but a huge investment in it can increase productivity through improved technology, clean environment, improved health services and education. An environment where the source of national income comes from, resources are found, waste are assimilated into, life is sustained with climatic regulation do act as a natural capital (Jacobs, 2012).

The main theory relating to this assertion was the simple Keynesian theory that in a slump, governments should maintain aggregate demand in the economy by adjusting lost private sector demand with public expenditure. This invariably will lead to multiplier effect which will increase income and employment growth. Such spending does not have to be on green growth technologies, but given the extent of the environmental opportunities available in going green, and the various benefits which include health and other green stimulus advantages. In a bid to fully key into green growth policies by the government, it will require replacing aging power stations or upgrading transmission lines with green technologies. However, the Keynesian stimulus would bring forward investment that would have been made in the future to the present, where it could both have a larger stimulatory effect and benefit from the cheaper labour, materials and financing costs available in a recession (Bowen et al., 2009). The need to ensure continuous use of natural and sustained environment calls for countries to consider the adoption of policies that can assist in maintaining natural reserves. The need to still maintain the natural resources of a country while trying to ensure development in the country resulted in the sustainable development theory.

The main concept of sustainable development lies in the integration of three pillars which are environmental, social and economic which encompasses all aspects of decision making (Dernbach, 2011). Kahn in 1995 adopts three pillars to describe sustainable development, which are: Economic, social and environmental sustainability. Economic Sustainability according to Kahn is viewed from the direction of growth, resource allocation and consumption. The economic sustainability aspect of the theory is with the assumption that natural resources are unlimited and a record of growth in the economy is expected to be extended to the poor people in the country. The social sustainability generally explains the idea of equity among the people, empowerment, participation, accessibility and institutional stability. Environmental sustainability looks at the ways through which resources will not be used up faster than they are being replenished, and the transition towards low carbon emission despite the increasing population (Kahn, 1995).

Imperfection in an economic sense occurs as a result of indifferent attitude or ignorance on the part of the economic actors in the production and consumption made in these environment that is characterised by soil erosion, land slide, depletion of aquatic habitat, deforestation, energy waste, pollution and general eco-system damage.

Green growth supporters are of the view that the current economic growth being witnessed in many nations are no longer sustainable because of the global recession, waste of resources, low budgetary component to environmental conservation, but spending a huge amount to curb various hazards that occur after exploration as a result of poor management of natural resources. The adoption and transition to green growth remains cardinal in the agenda of many nations, even though the move is characterised with mixed feelings like job losses, dwindling labour market and immobility of workers which might come as a result of tight environmental policies and regulations which may either cause the total closure or relocation of industries resulting into trade conflicts (Bowen, 2012).

The tenet of green growth is a way of advancing technologies and green industries through job creation, poverty reduction, increased social responsibility and improved environmental performance through access to clean water and energy. Morssy (2012) in a research carried out in Austria; believed that there should be a balance mechanism between the demand of consumers and the need to protect earthly resources through advance technology. He further saw green growth policy as an analytical and pure macroeconomic policy framework moving from archaic growth to a more sustainable new growth path while throwing a big weight behind innovation as a successful system framework for any country that desire green growth transition.

Besides the unpredictable climatic change which serve a s a major impediments to green growth, harnessing the link between environment and economy is another issue of discuss in which Kazzi (2014), in a research conducted in Arab nations revealed that integrating economy and environment remains the key to overall growth through job creation, social equity and sustained natural environmental endowment which is a benefit derived from green growth strategy in Arab nations.

Green growth determinants and its forecast is another major issue for discussion because of the fact that its policy is technological and innovation based which is not really captured in the existing quantitative approach to economic growth, but You and Huang (2014), investigates the determinant of green growth and its future sustenance using the OECD conceptual framework to measure the green growth rates for 30 provinces spanning between 1998 and 2011. The dynamic panel model at provincial level revealed that China has experienced green growth, but at a slower rate during the sampled period and therefore believed that financing innovation through government spending can stimulate more benefit of green growth. Also in line with this is the work of Smulders and Withagen (2012), who in an attempt to reveal lesson learnt from the green growth theory employed a dynamic general equilib1rium and Ramsey model to link the interaction between economic growth and environmental issues and he believed that green growth is the only substitution through the use of endogenous technical change and a clean back-up technology. By extension, Smulders et al. (2014), believed that balancing longer term investment in sustaining environment can be spread through income to reduce poverty and that the green growth is basically built on technical change of initial resource depletion.

Reduction in poverty, improved wellbeing, tackling resources scarcity and climate change as a path to inclusive growth in developing nations was the center point of Hynes and Wang (2012), who analysed the need, condition, and mechanism for green growth and the benefits that can be reaped in the policy. Kaggwa, 2013, wrote on South Africa green growth transition despite the mix challenges and opportunities, even in the face of the socio-economic problems affecting the nation, the policy maker still believed that maintain green industries is a panacea to reducing unemployment and high carbon emission.

Uwazie (2015) analysed the green growth and its implication on economic growth in Nigeria using a political economy approach to explain the core meaning of sustainable development in relation to environment, accessing selected few sectors to know if there exist economic benefit that could be witnessed than the present growth path if the transition takes place. The result revealed that a lot of benefit and opportunities are embedded if and only if Nigeria could integrate environmental policies with the present economic agenda.

There is limited literature pertaining to green growth in developing countries, this can be attributed to the absence of substantial formulation and implementation of policies on green growth strategies. Green growth strategies have been adopted in some countries like Brazil, Indonesia, China as the panacea towards addressing the issue of greenhouse emissions and other environmental threats posed as a result of the adoption of the non-renewable source of energy (Jupesta et al., 2011; Dudin et al., 2016; Akinyemi et al., 2017; Abdullah et al., 2017).

3. METHODOLOGY

The classical growth theory according to Solow in 1956 assumes that output (Y) is determined by the combination of technology (A), capital (K) and labour (L). The relationship can be stated as follows:

$$Y = f(A, K, L).$$

With $dY/dA>0$; $dY/dK>0$; and $dY/DL>0$

The equation above can be interpreted as output is determined by the interaction of the production function's physical capital, labour and the level of productivity, which is as a result of technological changes and the level of management or managerial strength. The output growth dY/dT is also explained by growth in K and L as factors of production and growth in productivity A. The growth in labour is determined by population growth, migration, improvement in health and education and the growth in k is determined by the level of investment (Fay, 2012; Hallegatte et al., 2012), in this approach, there is no room for the environment. The consideration of the environment as part of the determinant of the state of an economy or part of the production function was first put forward by Malthus in 1798. This was further emphasized in the literature regarding environmental economics in the early 1970s (Fay, 2012). Consequently, the environment becomes the "natural capital" in the production or growth function. The maximum possible production level with the assumption of maximum efficiency according to Fay (2012) is achieved by considering the available capital, labour can be written as:

$$Y = \psi f(A, K, L, E)$$

The idea of taking growth as the main driver for development has changed since the convention held in Rio in 1992 which endorsed the notion that for a country to assume an agreed level of sustainaiblity, development must be balanced across the three pillars of sustainable development according to Kahn (1995) which are social, economic and environment (Fay, 2012). This study is concerned with the environmental pillar of sustainable development as the thehoretical literature as shown that growth and population increase causes environmental degradation. This requires a cheap and sustainable means of ensuring environmental sustainability which is "green growth" as environmental degradation in its self is very costly. The study examines the impact of green growth on some environmental factors as stated below:

$$GRG_t = f(DEF_t, EDP_t, NRE_t + CO_{2t}) \quad (1)$$

GRGt is the green growth at time t, represented by alternative and nuclear energy (ANE), DEF_t is deforestation at time t, EDP_t is energy depletion at time t, NRE_t non renewable energy at time and CO_{2t} represents carbon dioxide emission. The new econometric model between green growth (GRG) and selected environmental variables can be stated as below:

$$GRG_t = \beta_1 + \beta_{DEF} DEF_t + \beta_{EDP} EDP_t + \beta_{NRE} NRE_t + \beta CO_2 CO_{2t} \quad (2)$$

The long-run relationship between green growth (GRG) and other variables was done using the autoregressive distributive lag (ARDL) bound testing approach.

$$GRG_t = \beta_1 + \beta_{DEF} DEF_t + \beta_{EDP} EDP_t + \beta_{NRE} NRE_t + \beta CO_2 CO_2 \quad (3)$$

This study sourced for data within the years 1980-2015 from the world bank data on economic indicators for each of the variables.

Gujarati (2013) states that the first empirical work with regards to time series is of the assumption that the underlying time series is stationary. Consequently, there was need to check if the time series data was non-stationary or posses a unit root. The study utilized the Augmented Dickey Fuller (ADF) test to ascertain the order of integration of the selected variables. Based on the result of this test which is consistent with the ARDL test and avoiding the unit root pre-testing. Ozturk and Acaravci (2010), state that the ARDL approach comes with the advantage of avoiding the I(0) and I(1) classification. Consequent upon the condition of the ARDL test met in the study, it adopts the ARDL bounds test. Chandran et al. (2010), is of the view that the ARDL bound testing techniques adopt an unrestricted error correction model (UECM) in first difference form to establish the long-run relationship between the estimated variables. This research will estimate the long-run relationship with the following UECM in consistence with (Khobai et al., 2017).

$$\Delta GRG_t = \beta_1 + \beta_T T + \beta_{DEF} DEF_{t-1} + \beta_{EDP} EDP_{t-1} + \beta_{NRE} NRE_{t-1} + \beta_{CO_2} CO_{2t-1} + \sum_{i=1}^{p} \beta_1 GRG_{t-i} + \sum_{j=1}^{p} \beta_J DEF_{t-j} \quad (4)$$

$$\Delta LnDEF_t = \beta_1 + \beta_T T + \beta_{GRG} GRG_{t-1} + \beta_{DEF} DEF_{t-1} + \beta_{EDP} EDP_{t-1} + \beta_{NRE} NRE_{2t-1} + \beta_{CO_2} CO_{2_{t-1}} \sum_{i=1}^{p} \beta_1 \Delta DEF_{t-i} + \sum_{j=0}^{p} \beta_j \Delta GRG_{t-j} + \sum_{k=0}^{p} \beta_k \Delta EDP_{t-k} + \sum_{l=0}^{p} \beta_l \Delta NRE_{t-l} + \sum_{m=0}^{p} \beta_m \Delta CO_{2_{t-m}} + \varepsilon_{2t} \quad (5)$$

$$\Delta EDP_t = \beta_1 + \beta_T T + \beta_{GRG} GRG_{t-1} + \beta_{DEF} DEF_{t-1} + \beta_{EDP} EDP_{t-1} + \beta_{NRE} NRE_{t-1} + \beta_{CO_2} CO_{2_{t-1}} \sum_{i=1}^{p} \beta_1 \Delta EDP_{t-i} + \sum_{j=0}^{p} \beta_j \Delta GRG_{t-j} + \sum_{k=0}^{p} \beta_k \Delta DEF_{t-k} + \sum_{l=0}^{p} \beta_l \Delta NRE_{t-l} + \sum_{m=0}^{p} \beta_m \Delta CO_{2_{t-m}} + \varepsilon_{3t} \quad (6)$$

$$\Delta NRE_t = \beta_1 + \beta_T T + \beta_{GRG} GRG_{t-1} + \beta_{DEF} DEF_{t-1} + \beta_{EDP} LnEDP_{t-1} + \beta_{NRE} NRE_{t-1} + \beta_{CO_2} CO_{2_{t-1}} \sum_{i=1}^{p} \beta_1 \Delta NRE_{t-i} + \sum_{j=0}^{p} \beta_j \Delta GRG_{t-j} + \sum_{k=0}^{p} \beta_k \Delta EDP_{t-k} + \sum_{l=0}^{p} \beta_l \Delta DEF_{t-l} + \sum_{m=0}^{p} \beta_m \Delta CO_{2_{t-m}} + \varepsilon_{4t} \quad (7)$$

$$\Delta CO_{2_{t-1}} = \beta_1 + \beta_T T + \beta_{GRG} GRG_{t-1} + \beta_{DEF} DEF_{t-1} + \beta_{EDP} EDP_{t-1} + \beta_{NRE} NRE_{t-1} + \beta_{CO_2} CO_{2_{t-1}} \sum_{i=1}^{p} \beta_1 \Delta CO_{2_{t-i}} + \sum_{j=0}^{p} \beta_j \Delta GRG_{t-j} + \sum_{k=0}^{p} \beta_k \Delta NRE_{k-i} + \sum_{l=0}^{p} \beta_l \Delta EDP_{t-m} + \sum_{m=0}^{p} \beta_m \Delta DEF_{t-m} + \varepsilon_{5t} \quad (8)$$

In the estimated variables above Δ stands for the first difference operation, the T connotes the time trend and $\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}, \varepsilon_{5t}$ are the residuals in the estimated equations. The GRG represents green growth, DEF is deforestation, NRE represents non-renewable energy, EDP is energy depletion while the CO_{2t} represents carbon dioxide emission. The β_{GRG}, β_{DEF}, β_{EDP}, β_{NRE}, β_{Co_2} represents the elasticities to be estimated in the models.

4. RESEARCH FINDINGS

The prevailing problem of spurious regression had necessitated the test for unit root of time series variables. The study adopted the ADF approach to identify the order of integration of the variables. The results are presented in Table 1.

From the result, it was observed that GRG, DEF, EDP and NRE are non-stationary in levels but they are all stationary after first differencing. While only CO_2 remains stationary at levels. Based on this ADF result, the condition for autoregressive distribution lag cointegration bound testing approach is met and we therefore discard the Johansen cointegration analysis. The ARDL bound testing result is presented in Table 2.

The ARDL result established an indirect short-run relationship between green growth and all the independent variables, which include carbon dioxide emission (CO_2), deforestation (DEF), non-renewable energy (NRE) and energy depletion (EDP); this implies that the following variables tend to decrease green growth

Table 1: Unit root test

Variable	At levels			1st difference			Level of integration
	ADF-test	1% CV	5% CV	ADF-test	1% CV	5% CV	
GRG	−9.06857	−3.6329	−2.9484	−7.4362	−3.63941	−2.95113	I(0)
CO_2	−5.84837	−3.6329	−2.9484	−7.07409	−3.65373	−2.95711	I(0)
DEF	−1.55149	−3.6329	−2.9484	−5.35942	−3.63941	−2.95113	I(1)
EDP	−0.56821	−3.64634	−2.95402	−6.79847	−3.64634	−2.95402	I(1)
NRE	−2.64715	−3.6329	−2.9484	−5.82008	−3.63941	−2.95113	I(1)

ADF: Augmented Dickey Fuller

Table 2: ARDL selected model: ARDL(3, 4, 3, 4, 3)

Dynamic regressors (4 lags, automatic): CO_2 DEF EDP NRE				
Variable	Coefficient	Standard error	t-statistic	P*
GRG(−1)	−0.821715	0.27724	−2.963912	0.0142
GRG(−2)	−0.789023	0.318445	−2.477736	0.0327
GRG(−3)	−0.560971	0.298058	−1.882089	0.0892
CO_2	−0.013963	0.011121	−1.255613	0.2378
CO_2(−1)	−0.003402	0.010708	−0.317717	0.7572
CO_2(−2)	−0.011978	0.009143	−1.309969	0.2195
CO_2(−3)	−0.028584	0.014133	−2.022479	0.0707
CO_2(−4)	0.008537	0.010457	0.816435	0.4333
DEF	−0.045593	0.374355	−0.12179	0.9055
DEF(−1)	0.551196	0.421051	1.309097	0.2198
DEF(−2)	−0.196078	0.516018	−0.379983	0.7119
DEF(−3)	0.407543	0.358423	1.137043	0.282
EDP	−0.018957	0.042025	−0.451084	0.6616
EDP(−1)	0.029562	0.043971	0.672313	0.5166
EDP(−2)	−0.064402	0.044099	−1.460403	0.1749
EDP(−3)	0.009986	0.059269	0.168481	0.8696
EDP(−4)	−0.071281	0.041478	−1.718502	0.1165
NRE	−0.032977	0.2511	−0.131332	0.8981
NRE(−1)	0.175862	0.260275	0.675679	0.5146
NRE(−2)	0.195646	0.192211	1.017874	0.3327
NRE(−3)	−0.457464	0.243851	−1.875995	0.0901
C	6.906211	5.140152	1.343581	0.2088
R^2	0.781937	Mean dependent variable		1.051469
Adjusted R^2	0.324006	SD dependent variable		0.800183
SE of regression	0.657901	Akaike info criterion		2.212326
Sum squared resid	4.328342	Schwarz criterion		3.220019
Log likelihood	−13.39721	Hannan-Quinn criterion		2.546348
F-statistic	1.707542	Durbin-Watson stat		2.0299
Prob(F-statistic)	0.019232			

*P-values and any subsequent tests do not account for model selection, ARDL: Autoregressive distributive lag

in the short run, and as each of this explanatory variable increases it brings about a decrease in the value of green growth. The R^2 which is the coefficient of determination and also measure of the goodness of fit records 0.78 This means 78% of the total variation in green growth (GRG) is been explained by other explanatory variables.

The bound test result for the existence of long run relationship among variables employed shows that F-statistic value is 5.119346 and the critical lower and upper bound test is presented in Table 3. As the value of F-statistic exceeds both the lower and upper bound at the 5% significant level, (i.e., 2.86 and 4.01), we can conclude that there is evidence of a long-run relationship between green growth and other explanatory variables employed. We can, therefore extract the long-run multiplier from the ARDL result. The long-run coefficient for the respective variables is presented in Table 4.

The co-integrating equation is thus presented below as:

$$GRG = 2.17744 - 0.015572CO_2^* + 0.226083DEF^* - 0.036287EDP^* - 0.037498NRE^*$$

The above equation confirms a negative long-run relationship between carbon dioxide emission (CO_2), energy depletion (EDP) and non-renewable energy, while a positive relationship is confirmed between green growth (GRG) and deforestation (DEF). This implies that carbon dioxide emission, energy depletion and non-renewable energy tend to decrease the level of green growth while deforestation tends to increase the level of green growth. When co-integration exists, there is need to analyse the short-run dynamics and coefficient of disequilibrium of the respective variables on green growth through the encompassing power of the error correction mechanism. The results of the error correction mechanism are presented in Table 5.

The result in Table 5 is the error correction mechanism. It is the dynamic adjustment to the disequilibrium in the short run. The coefficient of most importance is the ECM coefficient. From the result the ECM term is well defined, that is negative and

Table 3: ARDL bounds test

Test statistic	Value	K
F-statistic	5.119346	4
Critical value bounds		
Significance (%)	I0 bound	I1 bound
10	2.45	3.52
5	2.86	4.01
2.50	3.25	4.49
1	3.74	5.06

ARDL: Autoregressive distributive lag

Table 4: Long run coefficients

Variable	Coefficient	Standard error	t-statistic	P
CO_2	−0.015572	0.006982	−2.230316	0.0498
DEF	0.226083	0.078736	2.871414	0.0166
EDP	−0.036287	0.01692	−2.144666	0.0576
NRE	−0.037498	0.096905	−0.386955	0.7069
C	2.177441	1.750325	1.244021	0.2419

Table 5: Error correction results

Variable	Coefficient	Standard error	t-statistic	P
D(GRG(−1))	1.349995	0.546927	2.468327	0.0332
D(GRG(−2))	0.560971	0.298058	1.882089	0.0892
D(CO_2)	−0.013963	0.011121	−1.255613	0.2378
D(CO_2(−1))	0.011978	0.009143	1.309969	0.2195
D(CO_2(−2))	0.028584	0.014133	2.022479	0.0707
D(CO_2(−3))	−0.008537	0.010457	−0.816435	0.4333
D(DEF)	−0.045593	0.374355	−0.12179	0.9055
D(DEF(−1))	0.196078	0.516018	0.379983	0.7119
D(DEF(−2))	−0.407543	0.358423	−1.137043	0.282
D(EDP)	−0.018957	0.042025	−0.451084	0.6616
D(EDP(−1))	0.064402	0.044099	1.460403	0.1749
D(EDP(−2))	−0.009986	0.059269	−0.168481	0.8696
D(EDP(−3))	0.071281	0.041478	1.718502	0.1165
D(NRE)	−0.032977	0.2511	−0.131332	0.8981
D(NRE(−1))	−0.195646	0.192211	−1.017874	0.3327
D(NRE(−2))	0.457464	0.243851	1.875995	0.0901
CointEq(−1)	−3.17171	0.738987	−4.291971	0.0016

statistically insignificant at 5% level. The coefficient is −3.17 which indicates approximately −3.12% of the previous year's disequilibrium in gross domestic product. The negative value of the ECM coefficient (−3.12) confirms that there is disequilibrium in the short-run which the set of variables in the model are trying to correct in the long run as this also shows the speed at which the model converges to equilibrium. The magnitude of this coefficient implies that nearly −3.12% of any disequilibrium in GRG is corrected CO_2 and other independent macroeconomic variables within one period (1 year). The implication is that the present value of green growth will adjust to changes in CO_2, DEF, EDP and NRE.

6. CONCLUSION AND POLICY RECOMMENDATIONS

This paper was aimed at investigating the impact of green growth on environmental sustainability in Nigeria by adopting the ARDL bounds testing approach to examine the long-run relationship between green growth and the environmental variables which include carbon dioxide emission, deforestation, energy depletion and non-renewable energy. On the other hand, the study was also aimed at investigating the long-run equilibrium between these environmental factors and non-renewable energy sources.

The outcome of the ARDL bound testing reveals a negative short-run relationship between carbon dioxide emission, deforestation, energy depletion, non-renewable energy and green growth variable (ANE). The bound test also establishes the long run relationship in which all variables employed demonstrates an inverse relationship to green growth but only deforestation exhibits a direct link with green growth. This implies that increase investment in green growth technology will ultimately lead to decrease in carbon dioxide emission and energy depletion. Continuous energy depletion will cause prices to rise in the long-run leading to high level of poverty and sustenance will be very difficult as a result of over-dependence on this energy source in Nigeria. The increase in deforestation despite the increase in the level of green growth shows that the investment in green growth technology is not adequate to ensure a significant reduction in the the exploration of solid fuel as the source of energy especially in the rural areas and some parts of the urban area.

Green growth as an innovative strategy has emerged in recent times as the source of energy that can assist in reducing the increasing concerns from greenhouse emission, over reliance on the importation of fossil fuel, concern on subsidies on fossil fuel consumption in the country and reduce the risk from price fluctuations from oil importations. Hence, the government of Nigeria should fully be involved in the implementation of the green growth policy strategy by ensuring appropriate financing of the green growth projects, subsidizing the products for easy access to the people, simplification of licensing for easy investors entrance and implement methods of determining the level of adoption of the strategies in the country.

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