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CAUSAL DYNAMICS BETWEEN GREEN ENERGY, GOVERNANCE, FINANCIAL INCLUSION AND ECONOMIC GROWTH IN NIGERIA

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ABSTRACT

Purpose: This study investigates the causal dynamics between green energy, governance, financial inclusion and economic growth in Nigeria. In addition, the study examines the significance of green energy, governance and financial inclusion to economic growth in Nigeria.

Design/ Methodology/ Approach: Data sourced from the World Bank data base and the Central Bank of Nigeria Statistical Bulletin from 1996 to 2019 were used and real gross domestic product (RGDP) was regressed on co_2 emissions, greenhouse gas emissions, renewable energy consumptions, corruption control, political stability, number of commercial banks branches and commercial banks loans. The Generalised Method of Moments (GMM) and granger causality test were used for analyses.

Findings: Proxies of green energy are found to be not significant; co_2 gas emission, renewable energy consumption and green gas emissions have negative effects on real gross domestic product (RGDP). Governance indicators of corruption control has a negative and significant effect and political stability has a positive and a not significant on RGDP, lastly, the indicators of financial inclusion are not significant, commercial banks loan has a negative effect while number of commercial banks branches has a positive effect on RGDP. Real gross domestic product granger causes green gas emission, with other possible pairs, the test is not significant and no causal relationship exists. The causality test overwhelmingly supports the Neutrality hypotheses of no causal relationship between energy and growth.

Practical Implications

Majority of the indexes of green energy bears signs that support increase in output but are not significant, however, the absence of causal relationship between green energy with output is noticed. The reason for this result may be because efforts to deepen the use of renewable energy in Nigeria, by establishing sustainable investment in green energy, establishing enabling institutions and legal framework are still at the commencement stage. Political stability supports the fact that improvement in governance increases national output, but the reduction in output as corruption control increases presents a source of worry, this calls for the strengthening of corruption control institutions to ensure independence from political interference. Deepening financial inclusion increases output as indicated by number of banks branches but the negative effect of commercial banks loans on output may be because of the ever increasing interest rate on commercial loans in Nigeria.

Social Implications: A global shift from dirty energy to green energy has become imperative occasioned by the threat of climate change and increased energy usage, green energy is not only cheap it is also inexhaustible furthermore, an effective governance and adequate financial inclusion will facilitate this paradigm shift.

Originality and Value: This study contributed to knowledge by introducing financial inclusion and governance as additional independent variables in the model that investigated the effect of green energy on output, the Generalised Method of Moment (GMM) estimator which is most optimal method under the condition of heteroskedasticity was also deployed in the study.

Keywords: Green energy, governance, financial inclusion, GMM.

INTRODUCTION

The inevitability and drive for economic growth led to increased energy consumption in both developed and developing countries consequently the current energy issues center on depletion of the finite fossil fuel resources, climate change and global warming

(Apergis & Danuletiu, 2014) the increased CO_2 emissions due to use of fossil energy sources damages the protective layer of the atmosphere resulting into drought, flood, rising sea levels and reversing ocean currents (Alege et al., 2016). The Kyoto protocols identified seven gases which has to be reduced by 8% between 2008 and 2012 compared to 1990, these gases include; non fluorinated (carbon dioxide, CO_2, methane (CH_4) and nitrous oxide (N_20) and the fluorinated gases (hydroflouro carbons (HFCs), perflourocarbons (PFCs) Sulfur hexafluoride (SF_6) and nitrogen triflouride (NF_3)) furthermore the use of costly fossil energy sources led to increased cost of energy leading to economic problems and poverty aggravation (Terrapon-Pfaff et al., 2014). Renewable energy is infinite in supply and comparatively cheaper than energy from fossil sources (Vaona, 2016) the resultant savings from the increased use of renewable energy could be channeled towards improving citizens' welfare and the provision of facilities that are critical to economic growth. For instance, the Administration of Energy Information (AIE) from the United States of America and Outlook of International Energy (2016) opined that 48% increase in the utilization of global energy would be required by 2040, for sustainable economic growth therefore there must be a global shift away from consumption and dependence of fossil fuel to green energy.

Renewable energy or green energy is commonly understood to include energy generated from solar, geothermal, wind, tide and wave, waste and biomass (Apergis $ Danuletin, 2014). Chen et al. (2022) further noted that renewable energies are environmentally friendly and low carbon energy sources and include solar wind geothermal and hydroelectricity which do not produce green gases, Li et al. (2021) opined that renewable energies are those energy sources that can be replenished by nature over time, aside acting as a compliment to other energy sources, renewable energy do not pollute the environment thereby contributing to the sustainability of the biosphere, furthermore renewable energy is clean, safe and inexhaustible. The National Renewable Energy and Energy Efficiency Policy (2015) in Nigeria defines renewable energy as energy obtained from sources that does not deplete earth's resources including technologies that has minimal negative impact on the environment.

Governments all over the world have been paying attention to the issues surrounding energy and encouraging investment and use of renewable energy, this has resulted into improved market access of renewable energy sources at reduced cost (Abbasi et al., 2020) The International Energy Agency in 2009 was of the opinion that the current trends in energy supply are still economically, environmentally and socially not sustainable. The European Union (EU) also targets that 20% of its energy sources should be from renewable energy by 2020, the international energy statistics confirms that 19% of global energy needs is supplied from renewable energy sources and this is expected to increase to 50% by 2050 (Cheng et al., 2021; Li et al., 2021; Svenfelt et al., 2011). Efforts of the Nigerian government to promote a sustainable and pollution free environment is recently harmonized by the promulgation of the Nigerian Climate Change Act 2021 which sets a 2050 – 2070 net zero target. The act established the National Council on Climate Change that has the mandate to oversee, develop and improve Nigeria's climate change plans, the mobilization of resources and the administration of the newly established Climate change fund. The fund will cater for the finances of climate change actions which include the encouragement of the use of renewable energies. Main revenue into the fund is obtained from carbon taxes, emissions trading and fines paid by organisations that flouts their climate change mitigation obligations

Causal investigations in literature into the energy- growth relationship has established four possible relationships or hypotheses as noted by Payne (2010), they include, the growth, the conservation, the feedback and the neutrality hypotheses.

Where a unidirectional causal relationship flowing from energy consumption to output exists, it is known as the growth hypothesis, efforts to reduce energy consumption to achieve atmospheric conservation will negatively affect economic output, and conversely, the conservation hypothesis depicts a unidirectional causal relationship flowing from output to energy consumption and concludes that efforts to reduce pollution will not adversely affect output. The feedback hypothesis connotes situation of bidirectional causal relationship between energy consumption and output and lastly, the neutrality hypothesis is a situation of no causal relationship.

Apergis and Danuletin (2014) pointed to the omission of important variables that contribute to economic growth in their study, the variables include, non-renewable energy, foreign trade, foreign direct investment and financial development levels, this study includes financial inclusion variable to proxy financial development and address this gap. Apart from the traditional variables of capital and labour that determines output, effect of good governance, renewable energy consumption and financial inclusion on output are few in literature need to be further investigated using advanced econometric tools such as the Generalised Method of Moment, this study fills this gap by investigating the causal dynamics between green energy, governance, financial inclusion and economic growth in Nigeria using the Generalised Method of Moment method of estimating regression parameters. In addition, the study investigates the significance of green energy, governance and financial inclusion to economic growth in Nigeria. This section is followed by the literature review, the methodology, results and discussion of findings, implication of findings and recommendations in that order.

LITERATURE REVIEW

Theoretical Review

Theories linking variables to growth are replete in literature, however, this study reviews the Harrod-Domar, Solow model, Solow Swan model and the new endogeneous growth models in a bid to provide a logical sequence of theories linking output to energy consumption and financial inclusion.

Both Harrod and Domar in their models assert that growth of investment will lead to economic growth, the models identified two roles of investment; creation of income (demand effect) and increasing the capital stock (supply effect). For the economy to be at equilibrium or full employment therefore, output and income must increase at the rate the capital stock is increasing else it results into excess or idle capacity. The unrealistic assumption on which the model is constructed are its limitations, the assumptions of constant propensity to save, constant capital-output ratio, constant interest rate, no government interference and so on are impracticable in modern economy. The Solow model jettisons Harrod- Domar fixed proportion in production assumption and postulates a continuous production function which links output to the inputs of capital and labour which is substitutable, Solow asserts that with variable technical coefficient, capital-labour ratio will adjust over time in the direction of equilibrium where net investment (rate of increase of capital stock) equals capital, labour and savings.

The Solow -Swan model also draw from the traditional equation setting output as dependent on Capital (k), and labour. The objective is to maintain the capital- labour ratio for a growing population. The model asserts that the net change in capital per worker (k') over time is the excess of savings per worker (savings rate X output per worker) over the required investment to maintain capital per worker (population growth X output/worker + depreciation). The economy will be at equilibrium where k' equals zero, that is where savings per worker equals investment to maintain capital per

worker over time. Lastly the endogeneous growth theory emphasized that long run growth rate of an economy depends on endogeneous factors as against the exogeneous factors of the Solow-Swan growth theory which rules out government intervention. The endogeneous growth model emphasized technical progress resulting from rate of investment, size of capital and the labour stock, intuitively, technical progress can't be achieved without adequate injection of sustainable, cheap and affordable power supply, in addition, the critical financial intermediation function performed by financial institutions encourages savings, investment in technology and the growth of the capital stock.

Empirical Review

Reviewed literature based on foreign countries are either a panel study of groups of countries or based on a single country. The studies mainly investigated the effects of non renewable energy sources on economic growth with a common conclusion that renewable energy consumption accelerates economic growth and few examined the effect of economic activities and renewable energy consumption on environmental sustainability.

Lietao (2014) investigates the relationship between the dependent variable of economic growth and the independent variables of carbon dioxide emissions, renewable energy, energy consumption and globalization in the Portuguese economy between 1970 and 2010, the study used OLS, GMM, VEC and the Granger causality test. The OLS estimates revealed that all the independent variables have positive relationship with economic growth except energy consumption that had a negative sign, all the variables are significant between 1% and 5% levels. On the other hand, the GMM estimates revealed that only energy consumption and globalization are significant but have negative relationship with economic growth. The test of causality at 5% revealed that economic growth granger causes renewable energy and globalization, CO_2 emissions granger causes energy consumption, renewable energy and globalization, energy consumption granger causes renewable energy and globalization and lastly, renewable energy granger causes globalization. The study concludes that the use of renewable energy is necessary for sustainable economic growth. Abbasi et al. (2020) introduced effect of insecurity and explores the asymmetric relationship between renewable energy consumption, non renewable energy consumption and terrorism on the economic growth of Pakistan using the nonlinear autoregressive distributed lag modeling (NARDL), the study discovered that positive and negative changes in renewable energy and terrorism have significant effect on economic growth, in addition, there is a negative and significant relationship between non renewable energy source and economic growth. Again, Magazzino et al. (2021) tested the effect of global pandemic and examines the effect of renewable energy on economic growth in Brazil during the Covid-19 pandemic. The study used an Artificial Neutral Networks (ANNs) experiment in Machine Learning to achieve its objectives the study concludes that an increasing use of renewable energy triggers an acceleration of GDP.

Apergis and Danuletin (2014) focused on causal relationship; the study examines the dynamics between renewable energy and economic growth using a panel of 80 countries and the Canning Pedroni (2008) long- run causality test. To circumvent the problem of omitted variable bias, the effect of renewable energy was investigated within the framework of production model which include capital and labour , the study concludes that there is a bidirectional causal relationship between renewable energy consumption and economic growth in the total sample and across regions with a positive sign, the study further emphasize the importance of renewable energy to economic growth and recommends that policy makers must incentivize the

development and market accessibility of renewable energy products. Le et al. (2020) similarly conducted a panel data analyses on the effect of energy consumption on economic growth, the study used a global sample of 102 countries between 1996 and 2012 and examined separately the effects of renewable energy and non renewable energy. Economic growth was regressed on renewable energy, non-renewable energy, emissions , governance as well as the traditional production variables of capital and labour. The study discovered that the use of non-renewable energy raised the level of emissions in both developed and developing countries; however the use of renewable energy helped reduce emissions in developed countries but not in developing countries. Li et al. (2021) also conducted a regional panel data study and examine the effect of renewable energy sources of geothermal, hydro and wind on economic growth. Sample was drawn from SAARC countries from 1995 to 2018 using the Panel vector error correction model for analysis. All the renewable energy sources were found to have significant positive effect on economic growth with hydro sources having the greatest influence.

Furthermore, Fu et al. (2021) measures the contribution of renewable energy towards economic growth in Brazil, Russia, India, China and South Africa jointly known as the BRICS countries. For analyses, the study used Cross Dependency test, cross sectional augmented IPS (CIPS), dynamic ordinary least square (DOLS) and the fully modified ordinary least square (FMOLS). Additional objectives of the study are to examine the impact of renewable energy use on CO_2 emissions and to investigate the sensitivity of economic growth to CO_2 emissions in other to test the EKC theory. .The study confirms the existence of a bidirectional relationship between renewable energy usage and economic growth and a unidirectional causal relationship between renewable energy usage and CO_2 emissions which supports the conservation hypothesis. The study recommends that introduction of financial incentives to improve production and usage of renewable energy. Sahlian et al. (2021) similarly conducted a panel data analyses on EU countries, the study investigated if increase in the use of renewable energy can improve economic growth, the study regressed GDP/capita on the renewable energy measures of (GDP growth, total renewable energy consumption, production of biomass, hydro, geothermal, wind, and solar, renewable energy share, green house gas (GHG) Intensity of Energy and GHG Intensity to GDP) and the control variables (CO_2 gas emissions, GHG per capita, education expenditure and Human Development Index) using data from 2000 to 2019 sourced from Eurostat—European Commission and World Development Indicators (WDI) World Bank. The study used panel regression model with cross section fixed effect. The results indicates that economic growth is positively influenced by the production of renewable energy, the GHG per capita, and the GHG intensity per GDP.

Chen et al. (2022) explores the relationship between the various sources of renewable energy (hydro, wind, solar, geothermal and biomass) and economic growth allowing for the effects of the control variables of capital, government spending and trade openness. The study is based on selected Asian countries from 1992 to 2018 with data sourced from Energy Information Administration (EIA) and World Development Indicator (WDI) of the world bank, the study adopted the Cobb Douglas production model and regressed GDP per capita on hydropower, solar power, wind power, geo thermal power, biomass power and non renewable energy. Other independent variables include government spending, trade openness and capital formation. The study revealed ample evidence to back up the feedback assumption between renewable energy sources and economic growth and recommends that government should formulate and implement policies that will encourage use of renewable energy and reduce CO2 emissions.

He et al. (2022) investigated the dynamic relationship between the dependent variable of greenhouse gas emissions and the independent variables of renewable energy consumption, economic growth, oil rent and natural resources using China's economic data from 1971 to 2018. The study used the auto regressive distributed lag approach to estimate the relationships. The presence of a long run equilibrium relationship between the independent variable and greenhouse gas emissions was confirmed by the study in addition, renewable energy consumption and oil rent improves environmental sustainability while economic growth and natural resources hinders it.

Studies of the energy growth nexus in Nigeria follow the pattern of studies in foreign countries, studies either examine the effect of energy sources on economic growth (Maji, 2015; Olusanya, 2012) or the causal relationships among renewable energy sources and economic growth(Alege et al., 2020.) renewable energy sources being aggregated or disaggregated. A distinct and cheering effort to measure the effect of finance in the growth energy debate was however noticed in the work of Onabote et al. (2021) that introduced sources of financing renewable energy in their model.

Olusanya (2012) investigates the long run relationship between economic growth and energy consumption in Nigeria between 1985 and 2010 using the endogenous growth model, output was regressed on capital, labour and the energy sources of petroleum, electricity, coal and gas. The error correction model and cointegration tests were used as analysis tools. The study discovered that electricity and petroleum have positive effect on economic growth while coal and gas have negative effects; this suggests that generation of electricity from cheaper renewable sources will further reduce production costs and assuage the adverse effects of gas emission. Similarly, Maji (2015) examines the impact of clean energy on the economic growth of Nigeria, data covers from 1971 to 2011 and sourced from the World Bank development Indicators. Gross domestic product per capita was regressed on clean energy indicators of alternative and nuclear energy, combustible renewables and waste and electric power consumption. The Autoregressive distributed lag model was used for analyses, the result indicates a negative relationship between economic growth and alternative and nuclear, this may be as a result of the largely undeveloped clean energy potentials similarly, electric power consumption is inversely related to economic growth, this according to the study may be due to overinvestment in electricity and poor institutional framework of the electricity industry in Nigeria, however, combustible renewables and waste is positively related to economic growth The study recommends immediate investment to harness the clean energy potentials of the country for future. Population increase was adduced as a reason for increased energy demand this was empirically introduced by Riti and Shu (2016) who examines relationship between CO_2 emissions and economic growth, fossil fuel energy consumption, renewable energy consumption and population using Nigerian economic data from 1981 to 2013. For the analysis, the study adopts the autoregressive distributed lag (ARDL) bounds testing method of investigating co integration and the vector error correction model (VECM) granger causality test. The study affirms that, renewable energy has negative impact on environmental degradation while use of fossil fuel worsens it, however, the results of the examination of the growth impact on environmental degradation invalidates the environmental Kuznets curve (EKC) hypothesis for CO_2 emission in Nigeria. Nkoro et al. (2019) tests the short and long run effects of various sources of energy on economic growth in Nigeria between 1980 and 2016 using the modified Ordinary Least square, the study adopted the Cobb Douglas production framework in other to avoid the omitted variable bias and specifically modeled GDP as a function of total

consumption of renewable energy, CO_2 emissions, employment and gross fixed capital formation. The study discovers that while renewable energy affects economic goal in the long run, non renewable energy affects economic growth only in the short run the study advocates policies that could improve the supply and use of renewable energy and increase non renewable energy in the short run as an intervention measure.

Results of tests of causal relationships among energy sources and economic growth are mixed, among unidirectional, bidirectional and no causal relationships for instance, Alege et al. (2016) examines the direction of causal relationship among CO_2 gas emissions, energy consumption and economic growth in Nigeria between 1970 and 2013. The study's data were sourced from the World Development Indicators and the world governance indicators, the study modeled CO_2 emissions as dependent on GDP per capita, fossil fuel energy, Human capital, electric power consumption and institution (governance indicators) augmented Dickey fuller test, the vector error correction model and block Wald exogeniety granger causality test were used for analyses. The study's results indicates that GDP per capita have a negative relationship with CO_2 emissions, fossil fuel is positively related to CO_2 emissions and it is significant, electric power consumption is significant and negatively related to CO_2 emissions and the indicator of human capital is not having a significant effect on CO_2 emissions, these largely indicates that a shift away from the overreliance on fossil fuel as energy source to embrace consumption of cleaner renewable energy will improve environmental sustainability.

Imandojemu and Akinlosotu (2018) likewise examines the causal relationship between renewable energy consumption and economic growth in Nigeria between 1990 and 2017 using the Cobb Douglas production model, real GDP is set as a function of renewable energy consumption, labour force employed, gross fixed capital formation, CO_2 emissions per capita and official exchange, the study's data were obtained from the World Bank Development Indicator (WDI) and the US Energy Information Administration. The data were analyzed using the Ordinary Least Square, Augmented Dickey fuller test of unit root and the pairwise Granger Causality test. The study discovered that all the variables bear positive relationship with real GDP and renewable energy consumption, gross fixed capital formation and exchange rate are significant at 5%, however CO_2 emission is not significant, the study also established that at 5% level of significance, Real GDP granger causes renewable energy consumption and gross fixed capital formation, exchange rate granger causes Real GDP and CO_2 emissions and lastly CO_2 emissions granger causes renewable energy consumption, this results affirms the importance of renewable energy use for accelerated economic growth.

Azeakpono and Lloyd (2020), investigated the effect of renewable energy on economic growth and the causal relationship between the variables in Nigeria from 1990 to 2016, real GDP a proxy for economic growth was regressed on renewable energy consumption using correlation, cointegration tests, regression analysis and Granger causality tests. The study's results indicates that renewable energy consumption bears an inverse and not significant relationship with real GDP, this may be adduced to the largely undeveloped legal and institutional framework for investment and consumption of renewable energy sources in Nigeria, still, the study discover no causal relationship among the variables in the model.

Uzokwe and Onyije (2020) tested the relationship between renewable and nonrenewable energy consumption and economic growth in Nigeria using data from 1984 to 2015. The study used the Autoregessive Distributed Lag model (ARDL), the vector autoregressive (VAR) model and the Granger causality test for analyses. The study's findings confirm that there is no causal relationship among economic growth, renewable energy sources and the non-renewable energy sources, this supports the energy neutrality hypotheses. However, the positive signs of the coeficients of

renewable energy and non renewable energy both in the short run and long run indicates that the two energy sources stimulate economic growth in Nigeria. The study recommends that Nigeria should improve its energy supply mix and consumption.

Onabote et al. (2021) examines the long run relationship between economic growth, sustainable energy and financing options for sustainable energy in Nigeria from 1981 to 2014 using data obtained from the world bank development index (WDI) .and the study modeled GDP per capita as a function of renewable energy sources (i.e combustible renewables and waste, alternative and nuclear energy and hydroelectricity) and financing options (i.e net official development assistance received, net taxes on products and external debt). The unit root test, Johansson Cointegration test and the Granger causality tests were used for analyses. The test results indicate that GDP per capita granger causes alternative nuclear energy, hydroelectricity sources, net official development assistance received and external debt, in addition, net taxes on products granger causes GDP per capita. The result suggests that increase in economic output will necessarily elicits increased use of renewable energy sources financed by official development assistance received and external debt.

METHODOLOGY

Following the model used by Apergis and Danuletin (2014), that regressed real GDP on renewable energy, this study adapts the model and regressed real GDP on CO_2 gas emissions (CO_2), greenhouse gas emissions (GRGAS), renewable energy consumption (REN), corruption control (CCON), political stability (POLS), number of commercial banks branches (BBR) and commercial banks loans (COML). The model's equation is presented as

$$RGDP = \alpha_0 + \alpha_1 CO_2 + \alpha_2 GRGAS + \alpha_3 REN + \alpha_4 CCON + \alpha_5 POLS + \alpha_6 BBR + \alpha_7 COML + e \quad \ldots 1$$

For uniformity of scale the log (L) of some variables are used in the estimation thus

$$RGDP = \alpha_0 + \alpha_1 LCO_2 + \alpha_2 LGRGAS + \alpha_3 LREN + \alpha_4 CCON + \alpha_5 POLS + \alpha_6 LBBR + \alpha_7 LCOML + e. \quad \ldots\ldots\ldots 2$$

The study's data are sourced from the World Bank data base and the Central Bank of Nigeria Statistical Bulletin from 1996 to 2019 The Generalised Method of Moments (GMM) and granger causality test are used for analyses. The GMM is a method of regression analysis where assumptions about the moments of the variables are used to derive an objective function, in this method, sample moments are more than the number of model's parameters.

Given a sample moment condition of

$$\frac{1}{N}\sum_{i=1}^{N} y_i - u^{GMM} = 0 \quad \ldots\ldots\ldots 3$$

GMM is estimated by solving the sample moment condition

$$u^{GMM} = \frac{1}{N}\sum_{i=1}^{N} y_i \quad \ldots\ldots\ldots 4$$

The GMM estimator is most optimal method under the condition of heteroskedasticity that is for each exogeneous variable, the dispersion of the error term (u) is not constant.

Apraori expectation : CO_2, GRGAS <0 AND REN,CCON, POLS, BBR, COML>0. CO_2 gas emission and green house gas emission are expected to have negative relationship with real gross domestic product (output) while renewable energy consumption, corruption control, political stability, number of commercial bank branches and commercial banks loans are expected to have positive relationship with output.

RESULTS AND DISCUSSION OF FINDINGS

Unit Root Test
Table 1: Summary of unit root test result

VARIABLES	t statistics	Probabilities
D(RGDP,2)	-4.981	0.0042
D(LCO2)	-5.668	0.0008
D(LGRGAS)	-5.443	0.0012
D(LREN)	-3.720	0.0491
D(CCON)	-4.527	0.0084
D(POLS,2)	-6.781	0.0002
D(LBBR)	-3.889	0.0351
D(LCOML)	-4.519	0.0090

Source: Authors computation 2023.

The unit root tests were performed using the Augmented Dickey Fuller (ADF) test with the trend and intercept model. At 5% level of significance, table 1 indicates that all the variables are stationary at first difference, except, real gross domestic product and political stability that are stationary at second difference, to avoid spurious regression therefore; the variables enter the GMM regression at their stationary levels.

Correlation Coefficients

Table 2: Summary of Correlation Coefficients

	RGDP	LCO2	LGRGAS	LREN	CCON	POLS	LBBR	LCOML
RGDP	1.000000	-0.934203	0.754214	-0.665844	0.510048	-0.632478	0.936914	0.959181
LCO2	-0.934203	1.000000	-0.488151	0.423413	-0.635469	0.714191	-0.970920	-0.976047
LGRGAS	0.754214	-0.488151	1.000000	-0.835656	0.179001	-0.308068	0.556574	0.586454
LREN	-0.665844	0.423413	-0.835656	1.000000	0.135512	0.396636	-0.482444	-0.554853
CCON	0.510048	-0.635469	0.179001	0.135512	1.000000	-0.192476	0.602816	0.567719
POLS	-0.632478	0.714191	-0.308068	0.396636	-0.192476	1.000000	-0.729886	-0.751931
LBBR	0.936914	-0.970920	0.556574	-0.482444	0.602816	-0.729886	1.000000	0.962888
LCOML	0.959181	-0.976047	0.586454	-0.554853	0.567719	-0.751931	0.962888	1.000000

Source: Authors computation 2023.

Co_2 gas emission is negatively correlated with real gross domestic product which is in concord with *apraori* expectation, similarly renewable energy consumption and political stability are negatively correlated with real gross domestic product but contrary to *apraori* expectation, conversely green gas emission is positively correlated with real gross domestic product which is contrary to expectation, lastly, other variables are positively correlated with real gross domestic product which agree with *apraori* expectation.

Regression Result

Table 3: Regression results

Dependent Variable: D(RGDP,2)
Method: Generalized Method of Moments

Sample (adjusted): 1998 2019
Included observations: 22 after adjustments
Linear estimation with 1 weight update
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed bandwidth = 3.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: D(RGDP,2) D(LCO2) D(LGRGAS) D(LREN) D(CCON) D(POLS,2) D(LBBR) D(LCOML)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LCO_2)	-21.90409	53.72338	-0.407720	0.6892
D(LGRGAS)	-39.30203	69.38374	-0.566444	0.5795
D(LREN)	-158.9676	258.6452	-0.614616	0.5480
D(CCON)	-1.965848	0.854142	-2.301546	0.0361
D(POLS,2)	0.157954	0.263419	0.599630	0.5577
D(LBBR)	36.84924	28.65365	1.286023	0.2179
D(LCOML)	-0.546645	7.659049	-0.071372	0.9440

R-squared	0.321811	Mean dependent var	0.403468
Adjusted R-squared	0.050536	S.D. dependent var	13.46636
S.E. of regression	13.12168	Sum squared resid	2582.678
Durbin-Watson stat	2.206982	J-statistic	3.686507
Instrument rank	9	Prob(J-statistic)	0.158302

Authors Computation 2023

The regression result as contained in table 3 above indicates that the proxies for green energy presents similar effects. Reduction in CO_2 gas emission increases output which is in support of expectation and correlation, also, reduction in green gas emissions increase output, furthermore, increase in renewable energy consumption reduces output which is contrary to expectation. Considering the variables of governance, increase in corruption control reduces output and improvement in political stability advances output. Indices of financial inclusion presents mixed effects, as number of commercial banks branches increases, output also increases while increases in commercial banks loans reduces output. At 5% level of significance, only, corruption control has significant effect on real gross domestic product. Proxies of green energy and financial inclusion are not significant, this is similar to the results obtained by Maji (2015) and Azeakpono and Lloyd (2020).

Causal Relationship

Table 4: Pairwise Granger Causality Test

Sample: 1996 2019
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LCO2 does not Granger Cause RGDP	22	3.09550	0.0714
RGDP does not Granger Cause LCO2		0.22159	0.8035
LGRGAS does not Granger Cause RGDP	22	2.38079	0.1226
RGDP does not Granger Cause LGRGAS		4.60433	0.0252
LREN does not Granger Cause RGDP	22	1.24052	0.3141
RGDP does not Granger Cause LREN		1.33745	0.2888
LGRGAS does not Granger Cause LCO2	22	1.33345	0.2898
LCO2 does not Granger Cause LGRGAS		3.28336	0.0623
LREN does not Granger Cause LCO2	22	0.66631	0.5265
LCO2 does not Granger Cause LREN		0.83841	0.4495
LREN does not Granger Cause LGRGAS	22	0.74182	0.4910
LGRGAS does not Granger Cause LREN		0.28489	0.7556

Authors Computation 2023

Considering the Pairwise Granger Causality test result in table 4, at 5% level of significance, real gross domestic product granger causes green gas emission, with other possible pairs, the tests are not significant and no causal relationship exist. The causality test overwhelmingly supports the neutrality hypothesis of no causal relationship between energy and growth; this is similar to the result obtained by Uzokwe and Onyije (2020).

Implication of Findings

Majority of the indexes of green energy bears signs that support increase in output but not significant, however, the absence of causal relationship between green energy with output was noticed. The reason for this result may be because efforts to deepen the use of renewable energy in Nigeria, by establishing sustainable investment in green energy, establishing enabling institutions and legal framework are still at the commencement stage. Political stability supports the fact that improvement in governance increases national output, but the reduction in output as corruption control increases presents a source of worry, these calls for the strengthening of corruption control institutions to ensure independence from political interference. Deepening financial inclusion increases output as indicated by number of banks branches but the negative effect of commercial banks loans on output may be as a result of the ever increasing interest rate on commercial loans in Nigeria.

Recommendations

Renewable energy provides a cheap and non-exhaustible alternative and supplement to fossil energy, the Nigerian government at all tiers should invest in and encourage the use renewable energy, this may be done through a cautiously established rolling plan backed by an act of the legislature. Small business and households should be encouraged to wholly depend on self-financed renewable energy sources, the bank of industries and other development institutions in the country should make the use of self-financed renewable energy a condition to obtain advances by small and medium scale entrepreneurs from development banks, the energy saved will be available for the use of large industries for production which will result into improved economic growth. Fiscal incentives should be given to industries that could generate power for self-use and contribute to the national grid. Democratic and anti-corruption institutions in Nigeria should be strengthened by amending appropriate sections of acts establishing such institutions; this will deepen the current political stability witnessed in the country. The commercial banks and other financial institutions should be encouraged to establish rural branches and develop financial products that will meet the needs of rural dwellers and small scale entrepreneurs lastly, loans and advances should be provided to industries at single digit interest rate.

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