Innovations

Renewable Energy Policy and Economic Growth in Nigeria

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Abstract

The study used annual time series data covering the period of 1981 to 2021 from the World Development Indicators (2021) to examine the impact of renewable energy policy on economic growth in Nigeria. The variables used for the study are (GDPGR) as the dependent variable, while the independent variables are energy consumption, CO2 emission per capita, access to electricity (percentage of population), gross fixed capital formation, and labour force employed. The study used ARDL and granger causality estimation technique. The study found out that renewable energy consumption has a positive and significant impact on economic growth in Nigeria. The study also found a unidirectional causality running from energy consumption(ENCO) to gross domestic product(GDPGR). Based on the findings of the study, renewable energy consumption positively affects economic growth in Nigeria. These results therefore emphasize the potential significance of renewable energy policies in promoting sustainable economic growth in Nigeria.

Keywords: *Renewable Energy Policy, Economic Growth. Emission per capita*

Introduction

Energy consumption is one of the most important drivers of economic growth in any nation, and this energy is consumed predominantly in the form of fossil fuel consumption. However, it cannot be ignored that continuous consumption of fossil fuel energy over years has resulted in several ecological issues, majorly in the forms of rapid exhaustion of natural resource pool and increase in carbon emissions in the ambient atmosphere. Nations are gradually recognizing this intensifying environmental issue, and consequently, they have started developing clean technology solutions in pursuit of the gradual transformation from non-renewable energy sources to renewable energy sources. Under such circumstances, an increase in the share of renewable energy use in the total energy mix can be observed in recent years (Yang, 2016; Kung, 2017; Paramati, 2017; Zhang, 2017; Shahbaz, 2017; Sinha., 2017; Sinha and Shahbaz, 2018). From this discussion, it is assumed that the trilateral association between economic growth, energy consumption, and environmental degradation may appear to be significant from the perception of sustainable development, which is largely dependent on managing the energy challenges. From the perspective of emerging economies, this energy challenge can be observed in a dual form in these countries (Lin and Moubarak,2014; Shahbaz.2016). First, these nations are being faced with the problem of energy security and energy poverty. Second, these nations are in the transition phase to implement nationwide clean or low carbon energy systems, without compromising on economic growth.

Conceptual Review

The conceptual review of this paper was discussed under two major subheadings namely: renewable energy and economic growth.

Renewable Energy

Renewable energy can be broadly defined as any energy generated from natural processes including hydropower, geothermal, solar, tides, wind, biomass, and biofuels. Natural endowments are a rich source of adaptation, innovation and inspiration for numerous technologies and power generation. Renewable energy often displaces conventional fuels in four areas: electricity generation, hot water/space heating, transportation, and rural (off-grid) energy services (Renewable Energy Policy Network for the 21st Century, 2010). However, there are limitations that bedevil the use of renewable energy.

Economic Growth

Economic growth is the increase in the inflation-adjusted market value of the goods and services produced by an economy over time. It is conventional l y measured as the percent rate of increase in real gross domestic product (real GDP). Economic growth is an increase in the capacity of an economy to produce goods and services, compared from one period of time to another. It can be measured in nominal or real terms, the latter of which is adjusted for inflation. Traditionally, aggregate economic growth is measured in terms of gross national product (GNP) or gross domestic product (GDP). Economic growth is an important macro-economic objective because it enables increased living standards, improved tax revenues and helps to create new jobs.

Theoretical Review

Renewable energy policy and economic growth in Nigeria are interdependent concepts that have been the subject of extensive theoretical analysis. Scholars have explored the potential of renewable energy policy to support economic growth, reduce poverty, and promote environmental sustainability in Nigeria. A range of theoretical frameworks have been proposed to explain the relationships between renewable energy policy and economic growth in Nigeria. One of the most widely used frameworks is the Sustainable Development Goals (SDGs), which provide a comprehensive framework for promoting economic growth, social development, and environmental sustainability (United Nations, 2015). The SDGs highlight the importance of renewable energy in achieving sustainable development, and have been used as a basis for renewable energy policy development in Nigeria (Adebayo &Akeredolu, 2019). Another important framework is the political economy of renewable energy, which explores the relationship between political and economic factors in shaping renewable energy policy (Bolinger& Wiser, 2015). This framework highlights the role of political power and interests in shaping renewable energy policy, and the potential for policy to be influenced by vested interests.The literature has also emphasized the importance of innovation systems in supporting renewable energy development in Nigeria (Oyedepo &Adewumi, 2018). The innovation systems framework highlights the role of institutions, networks, and actors in supporting technological innovation and diffusion, and has been used to analyze renewable energy policy in Nigeria. Other theoretical frameworks include the resource curse hypothesis, which explores the potential for natural resource wealth to undermine economic development (Mbodja&Assoumou,

2018), and the energy poverty framework, which highlights the links between energy poverty and broader social and economic development goals (Adekoya et al., 2021).

Empirical Review

The empirical evidence on the relationship between renewable energy policy and economic growth in Nigeria continues to be mixed. While some studies find a positive relationship between renewable energy policy and economic growth, others report no significant relationship or negative impacts. For example, Adebayo and Akeredolu (2019) found a positive and significant impact of renewable energy consumption on economic growth in Nigeria. Similarly, Tiamiyu et al. (2021) reported a long-run causality running from renewable energy consumption to economic growth in Nigeria. In contrast, Oyedepo et al. (2021) found no significant relationship between renewable energy consumption and economic growth in Nigeria. For instance, Ogundele and Alege (2017) found that renewable energy consumption had a positive and significant impact on economic growth in Nigeria. Similarly, Olugbenga and Fasanya (2020) found a positive and significant relationship between renewable energy consumption and economic growth in the short and long run. In contrast, another study by Akinlo (2016) found a negative relationship between renewable energy consumption and economic growth in Nigeria. The mixed empirical results can be attributed to a variety of factors, including differences in data sources, sample size, econometric techniques, and the time period covered by the studies. Moreover, the effectiveness of renewable energy policies in Nigeria has been hampered by various challenges, including inadequate funding, weak institutional capacity, policy inconsistencies, and limited public awareness and participation.

Methodology and Discussion of Results

The study used annual time series data covering the period of 1981 to 2021 from the World Development Indicators (2021) to examine the impact of renewable energy policy on economic growth in Nigeria. This section also focuses on the results for this study which include graphs, descriptive statistics, stationarity test, the ARDL test and granger causality test.

Descriptive Statistics

Table 1: Descriptive Statistics

Descriptive	GDPGR	ENCO	CO2	ACCE	GFCF	LABF
Mean	4.320114	115.6978	33.32862	47.14553	2.188394	48746706
Median	4.430627	120.6098	33.04641	47.80501	2.613563	48230018
Maximum	15.32916	154.1723	39.06250	59.30000	40.38866	70620041
Minimum	-2.035119	74.14614	24.40333	27.30000	-23.74670	31936586
Std. Dev.	4.017196	27.34800	3.832178	7.837357	12.44626	11147705
Skewness	0.435426	-0.164357	-0.253980	-0.512168	0.313052	0.279833
Kurtosis	3.286568	1.457060	2.049267	2.499115	4.784686	2.076073
Jarque-Bera	1.120671	3.318290	1.549223	1.733533	4.769480	1.555822
Probability	0.571017	0.190302	0.460883	0.420308	0.092113	0.459365
Sum	138.2437	3702.330	1066.516	1508.657	70.02861	1.56E+09
Sum Sq. Dev.	500.2737	23185.31	455.2533	1904.149	4802.195	3.85E+15
Observations	32	32	32	32	32	32

Source: Author's Computation

The mean of GDP growth rate is 4.32%, with a standard deviation of 4.02%. The maximum and minimum values are 15.33% and -2.04%, respectively. The distribution of GDP growth rate appears to be slightly positively skewed (skewness=0.44) and moderately leptokurtic (kurtosis=3.29).

Energy consumption per capita has a mean value of 115.70, with a standard deviation of 27.35. The maximum and minimum values are 154.17 and 74.15, respectively. The distribution appears to be slightly negatively skewed (skewness=-0.16) and relatively mesokurtic (kurtosis=1.46).

The mean value of carbon dioxide emissions per capita is 33.33, with a standard deviation of 3.83. The maximum and minimum values are 39.06 and 24.40, respectively. The distribution appears to be slightly negatively skewed (skewness=-0.25) and moderately platykurtic (kurtosis=2.05).

Access to electricity (% of population) has a mean value of 47.15, with a standard deviation of 7.84. The maximum and minimum values are 59.30 and 27.30, respectively. The distribution appears to be moderately negatively skewed (skewness=-0.51) and moderately leptokurtic (kurtosis=2.50).

The mean value of gross fixed capital formation is 2.19, with a standard deviation of 12.45. The maximum and minimum values are 40.39 and -23.75, respectively. The distribution appears to be slightly positively skewed (skewness=0.31) and highly leptokurtic (kurtosis=4.78).

Finally, the labor force has a mean value of 48,746,706, with a standard deviation of 11,147,705. The maximum and minimum values are 70,620,041 and 31,936,586, respectively. The distribution appears to be slightly positively skewed (skewness=0.28) and moderately platykurtic (kurtosis=2.08).

The Jarque-Bera test is used to test whether the data is normally distributed. For each variable, the Jarque-Bera test statistic and the associated probability are provided. The results suggest that for all variables except GFCF, there is not enough evidence to reject the null hypothesis that the data is normally distributed at the 5% level of significance. The results for GFCF suggest that the data is not normally distributed at the 5% level of significance.

The graphical Trend

The graphical presentation of renewable energy variables such as energy consumption, CO2 emission per capita, and access to electricity against the dependent variable gross domestic product growth rate 1981 to 2021 is presented. This is to show the trend analysis of renewable energy policy on economic growth in Nigeria as presented in Figure 1, below. This means that an increase in energy consumption, CO2 emission per capita, and access to electricity, is likely to result in a positive economic growth in Nigeria.

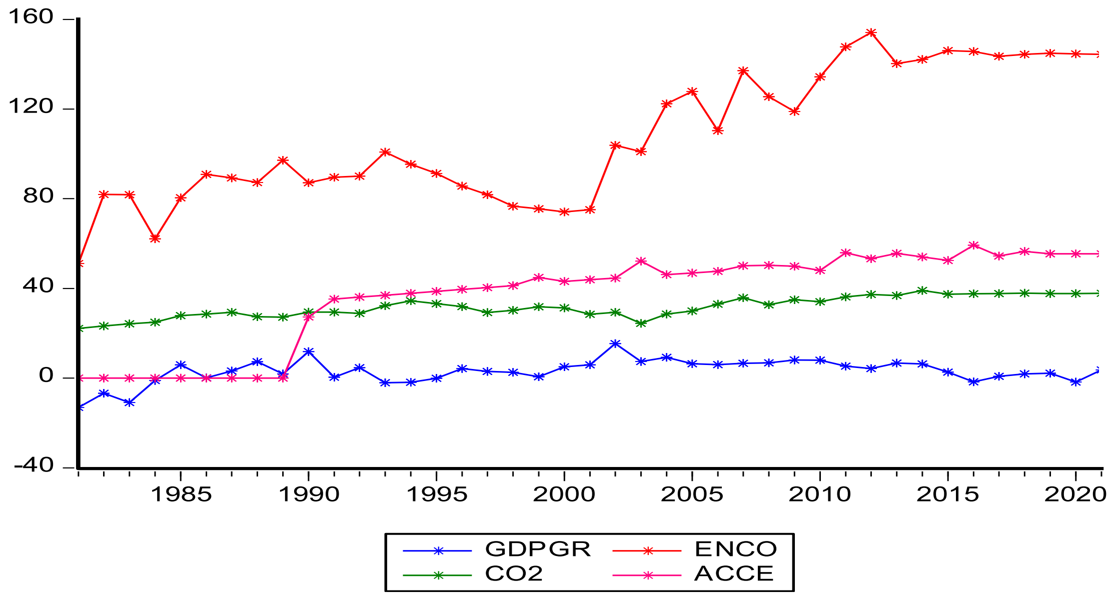

Figure 1: Renewable Energy Policy Trend

Unit Root Test

Table 2: Unit Root Test

Variables	*ADF*	*5%critical value (*)*	*Orderof integration*	*PP*	*5%critical value (*)*	*Order of integration*
GDPGR	-3.142158	-2.938987	I (0)	-4.273959	-2.936942	I (0)
ENCO	-8.343868	-2.938987	I (1)	-8.691326	-2.938987	I (1)
CO2	-7.262780	-2.938987	I (1)	-7.630125	-2.938987	I (1)
ACCE	-6.060415	-2.938987	I (1)	-6.059906	-2.938987	I (1)
GFCF	-5.175990	-2.938987	I (0)	-6.073492	-2.936942	I (0)
LABF	-2.979454	-2.963972	I (1)	-2.970855	-2.963972	I (1)

Source: Author's Computation

The table above provides the results of the Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test for the six variables .Based on the table we can see that GDPGR and GFCF are stationary at the 5% level since their ADF and PP test statistics are less than their corresponding critical values. ENCO, CO2, ACCE, and LABF have unit roots since their ADF and PP test statistics are greater than their corresponding critical values, and the PP test indicates they are integrated at order one. In summary, GDPGR and GFCF are stationary variables, while ENCO, CO2, ACCE, and LABF are non-stationary variables that require further differencing to become stationary. This, therefore determined the choice of autoregressive distributed lag (ARDL) test as analytical tool for this study.

Table 3: ARDL Test Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDPGR(-1)	0.246241	0.241567	1.019349	0.3232
GDPGR(-2)	0.414978	0.187985	2.207509	0.0422
ENCO	0.126652	0.070867	1.787178	0.0929
ENCO(-1)	0.292922	0.080985	-3.617001	0.0023
ENCO(-2)	0.129559	0.081627	1.587204	0.1320
CO2	-0.789790	0.427396	-1.847912	0.0832
CO2(-1)	0.495294	0.334903	1.478919	0.1586
ACCE	0.015482	0.243811	0.063500	0.9502
GFCF	0.055024	0.049436	1.113022	0.2821
GFCF(-1)	-0.108957	0.050559	-2.155064	0.0467
LABF	-3.55E-07	7.68E-07	-0.461666	0.6505
LABF(-1)	-1.06E-06	1.36E-06	-0.776620	0.4487
LABF(-2)	1.61E-06	8.82E-07	1.821367	0.0873
C	7.839822	9.390234	0.834891	0.4161
R-squared	0.766176	Mean dependent var		4.203614
Adjusted R-squared	0.576193	S.D. dependent var		3.844241
S.E. of regression	2.502618	Akaike info criterion		4.977277
Sum squared resid	100.2096	Schwarz criterion		5.631169
Log likelihood	-60.65915	Hannan-Quinn criter.		5.186462
F-statistic	4.032878	Durbin-Watson stat		1.674346
Prob(F-statistic)	0.004991			

Source: Author's Computation

The Autoregressive Distributed Lag (ARDL) Test

Based on the study objective, it is a superior model to others for capturing the short-run and long-run impact of independent variables. The table above shows the coefficients, standard errors, t-statistics, and probability values for the autoregressive distributed lag (ARDL) model. The coefficient for GDPGR(-1) is 0.246241, which indicates that a 1% increase in the lagged value of GDPGR will result in a 0.246241% increase in the current value of the dependent variable, holding all other variables constant.

The coefficient for GDPGR(-2) is 0.414978, indicating that a 1% increase in the value of GDPGR two periods ago will result in a 0.414978% increase in the current value of the dependent variable, holding all other variables constant. Similarly, the coefficients for the lagged values of ENCO and CO2 are positive, indicating that increases in these variables in the previous period or two periods ago are associated with increases in the current value of the dependent variable. The coefficient for ENCO(-1), however, is negative, indicating that an increase in ENCO in the previous period is associated with a decrease in the current value of the dependent variable. The coefficient for ACCE is positive but very small, indicating that ACCE has little effect on the dependent variable. The coefficient for GFCF(-1) is negative, indicating that an increase in GFCF in the previous period is associated with a decrease in the current value of the dependent variable.

The coefficients for the lagged values of LABF are very small and statistically insignificant, indicating that LABF has little effect on the dependent variable. Given some relevant statistical and econometric criteria of this model, for instance, the coefficient of multiple determination $R^2$is high, indicating that the explanatory power of the independent variables is more robust. In this regard, the coefficient of determination R^2 is 0.77 implying that approximately 77% of the variation in GDPGR is collectively explained by explanatory variables in the model. The F-Statistic reveals that the overall relationship in the model is significant, as is evident in the statistically significant value of the F-test statistic. The adjusted R-squared value of 0.576193 indicates that the independent variables in the model explain about 57.6% of the variation in the dependent variable. The F-statistic of 4.032878 has a probability value of 0.004991, which indicates that the model as a whole is statistically significant. However, in terms of the variable significance, GDPGR has no statistical significancein the first periodincluded in the model, but statistically significance in the second period. This suggests that the GDPGR model is an exogenous one.

Furthermore, ENCO was not statistically significance for the initial and second period, but was statistically significance at first period, and its coefficients indicate a positive relationship with economic growth. This, therefore, confirm to the study aprior expectation. This means that an increase in energy consumption will translate into economic growth in Nigeria. The result of this study therefore agree with empirical findings from previous studies of Ogundele and Alege (2017) on renewable energy consumption and economic growth in Nigeria who found that renewable energy consumption has a positive and significant impact on economic growth in Nigeria.

Also Olugbenga and Fasanya (2020) found a positive and significant relationship between renewable energy consumption and economic growth in the short and long run which conforms to the study aprior expectation as well. However, GFCF was statistically significance for the first period but indicate a negative relationship with economic growth. This result failed to confirm to the study aprior expectation. CO2, ACCE, and LABF were not statistically significance for all periods, but CO2 and ACCE have a positive relationship with economic growth which confirm to the study aprior expectation. LABF indicate a negative relationship with economic growth for the period under review and failed to confirm to the study aprior expectation.

Table 4: Granger Causality Test Result

Null Hypothesis	**Obs**	**F-Statistic**	**Prob**	**Decision**	**Type of Causality**
ENCO does not Granger Cause GDPGR	39	2.23181	0.1228	Accept H_0	Uni-directional causality
GDPGR does not Granger Cause ENCO		3.27823	0.0499	Reject H_0	Uni-directional causality
CO2 does not Granger Cause GDPGR	39	0.93543	0.4023	Accept H_0	No causality
GDPGR does not Granger Cause CO2		1.90661	0.1641	Accept H_0	No causality
ACCE does not Granger Cause GDPGR	39	1.08562	0.0491	Reject H_0	Bi-directionalcausality

GDPGR does not Granger Cause ACCE		1.63458	0.0100	Reject H_0	Bi-directionalcausality
GFCF does not Granger Cause GDPGR	39	2.22385	0.1237	Accept H_0	Uni-directional causality
GDPGR does not Granger Cause GFCF		7.03442	0.0028	Reject H_0	Uni-directional causality
LABF does not Granger Cause GDPGR	39	1.22327	0.3113	Accept H_0	No causality
GDPGR does not Granger Cause LABF		0.40917	0.6686	Accept H_0	No causality

Source: Authors' computation

Granger Causality Test

The table above shows the results of Granger causality tests conducted to determine whether there is a causal relationship between the variables.From the first panel, it is evident that there is a unidirectional causality running from energy consumption(ENCO) to gross domestic product(GDPGR) while the second panel, it is observed that there is no causal relationship between emission per capita(COE) and gross domestic product(GDPGR). However, access to electricity(ACCE) and gross domestic product(GDPGR) does indicate a bi-directional causality while gross fixed capital formation(GFCF) expresses a unidirectional causality with gross domestic product. However, there is no evidence of Granger causality between CO2 and GDPGR, or between LABF and GDPGR.product(GDPGR). Finally, labour force employed being the last panel indicated no causal relationship gross domestic product(GDPGR).

Findings

Based on these findings, it can be concluded that the lagged consumption of renewable energy positively affects economic growth in Nigeria. However, the immediate impact of renewable energy consumption and the relationship between CO2 emissions and economic growth require further examination. These results emphasize the potential significance of renewable energy policies in promoting sustainable economic growth in Nigeria.

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