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The Role of Renewable Energy Consumption on Economic Growth in Nigeria. A Nonlinear Autoregressive Distributive Lag Approach

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Abstract: *This study investigate the role of renewable energy consumption on economic growth in Nigeria using data from 1990-2017. The study adopted nonlinear autoregressive distributive lag model (NARDL) after accounting for nonlinearity and structural breaks in unit root and cointegration. The result reveal that renewable energy consumption has asymmetric effect on economic growth, a positive or negative change in renewable energy consumption has respective positive or negative changes on economic growth. To this end, it is imperative for Nigeria to explore its available renewable energy sources in order to achieve twin objectives of reducing carbon emissions and economic*

Keywords—Economic Growth, Nonlinear Autoregressive Distributive Lag Approach, Renewable energy Consumption

1. INTRODUCTION

The relationship between energy consumption and economic growth has been one of the most investigated yet controversial issues in the energy economics literature. The recent and alarming climate change and environmental degradation makes the transition to renewable energy necessary. Although Sub-Saharan Africa (SSA hereafter) countries have made almost no contributions to this unprecedented level of global emissions, the region is extremely vulnerable to climate change.[1]. Nigeria is among the vulnerable countries to climate change according to climate change vulnerability index.

Nigeria heavily rely on fossil fuel for economic activities, It is a well-known fact that the heavily usage of the non-renewable fossil fuels (e.g. coal, oil, natural gas) is the predominant contributors for these environmental hazards by releasing carbon dioxide (CO2), Beside the detrimental effects on the environment, fossil fuels face extinction [2]. The twin objective of maintaining economic growth level and low carbon emission has continued to be pressing issue to policy makers. Renewable energy is the only energy option that is sustainable, environmentally friendly, and the only viable energy option that could end global warming and climate changes[3].

Following the pioneering study of Kraft and Kraft (1978) the energy consumption and economic growth nexus has been studied extensively. The related literatures dwells mostly on linear relationship in energy-economics links and report a symmetry effect of energy consumption on economic growth, but in reality and theories the relationship can be asymmetry, as shown in Figure 1 and Figure 2 the trend in both renewable energy consumption and economic growth exhibit nonlinear trend, as such this study tend to fill this gap.

The rest of the study is categorized as literature review, methodology, empirical result and conclusion.

2. LITERATURE REVIEW

The literature is beset with studies on the relationship between energy consumption and economic growth. The recent research's is on the renewable energy, carbon emission and economics growth. Reference [4] examine the relationship between CO2 emissions, energy consumption, economic growth, and financial development in GCC countries, he results suggest long-run and causal relationships among carbon emissions, financial development, gross domestic product (GDP), and energy use in all GCC countries except United Arab Emirates (UAE), and he uses the linear ARDL approach. Similarly [5] re-investigate co-movement and the causal relationship between energy consumption and real GDP using panel unit root, heterogeneous panel cointegration and panel-based error correction models, The results support a positive long-run co-integrated relationship between real GDP and energy consumption and longrun unidirectional causality running from energy consumption.

References [6] uses time-varying Bayesian VAR model to investigate the dynamic relationships among CO2 emissions, renewable and non-renewable energy sources, and economic growth in India, the model observe impact transmission mechanisms among energy sources, CO2 emissions, and GDP.[7] examines the relationship between CO2 emissions, renewable energy consumption and economic growth in Tunisia via an Autoregressive Distributed Lag model; the results reveal longrun relationship, a bidirectional relationship between GDP and CO2 emissions, renewable energy consumption and GDP but no relationship between CO2 emissions and renewable energy consumption.

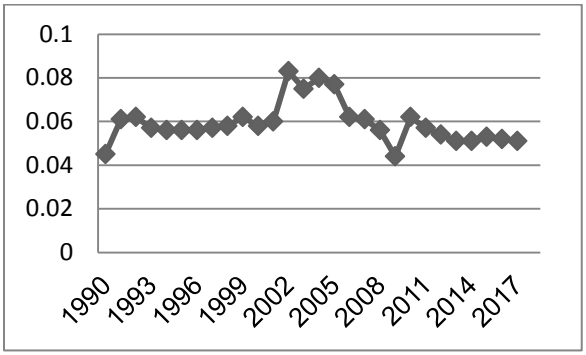

Figure 1: Renewable Energy Consumption Trend

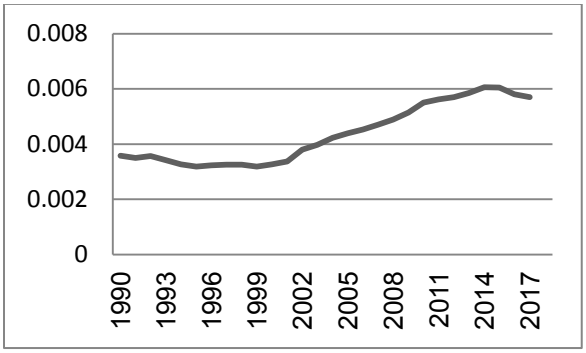

Figure 2 GDP Trend

Studies on renewable energy consumption-economics growth links in a nonlinear framework is scanty and requires utmost consideration, the relationship is assumed by many literatures to be symmetry, which is relatively biased considering the trend and the theoretical perspectives. This is the gap this research tends to fill.

3. METHODOLOGY

A new growth theory which incorporate the role of natural resources is written as in

$$Y = f(K,L,E) \quad \textbf{(1)}$$

Y=real GDP, K=capital stock, L=labour force

The Cobb Douglass form of the equation is written as:

$$y_t = AK^{\alpha t}L^{\beta t}E^{\theta t} \quad \textbf{(2)}$$

Where $\alpha+\beta+\theta=1$ refers to the coefficient elasticity of the variables. The linear form of the equation is

$$\ln y_t = a_0 + a_1\ln(e_t) + a_2\ln(k_t) + a_3\ln(l_t) + u_t \quad \textbf{(3)}$$

Where u_t is the residual term.

Nonlinear autoregressive distributive lag (NARDL) accounts for the possible influence of structural break in the consumption of renewable energy consumption on growth. It estimates the co-integrating relationship after determining the optimal lag order of the model while accommodating regressors that are stationary at either levels, I (0), or first difference, I (1)[8]

NARDL decomposed Renewable energy consumption into positive and negative partial sums for increase and decrease, therefore NARDL developed by shin et al (2014) which accommodates the potential longrun and shortrun asymmetry is specified as :

$$\Delta gdp_t = a_1 + \theta_1 gdp_{t-1} + \theta_2^{+} ec^{+}_{t-1} + \theta_3^{+} ec^{-}_{t} + \sum_{i=1}^{n}\rho_i \Delta gdp_{t-1} + \sum_{i=1}^{m}(\beta^{+}_{i}\Delta ec^{+}_{t-1} + \beta^{-}_{i}\Delta ec^{-}_{t-1}) + \pi_{1t} \quad \textbf{(4)}$$

Where θ^{+} and θ^{-} capture the short-run asymmetry, while β^{+} and β^{-} capture the long-run, with the subscript (+) and (-) referring to the positive and negative partial sum decomposition. Wald test can be performed on the null hypothesis of long-run symmetry.

The study used data from 1990 to 2017, the variables include gross domestic product at 2010 USD used as proxy for economic growth, renewable energy consumption, total labor force, gross fixed capital formation. The series were sourced from world development indicators.

4. RESULTS AND DISCUSSION

The summary statistic in Table 1 shows that the empirical distribution of the individual series is positively skewed (asymmetry) and is not normal. The skewness of a symmetric distribution such as the normal distribution is zero. Positive skewness (where the value is above zero) means that the distribution has a long right tail and is not normal.

Table 1 Summary Statistics

	GDP	ENERGY	CAPITAL	LABOR
Mean	625.764	0.059	4.15E+03	42294535
Median	548.25	0.057	3.27E+10	41307043
Maximum	1096.5	0.083	8.57E+10	59012447
Minimum	340.7	0.044	1.23E+10	29286947
Std. Dev.	280.681	0.009	2.23E+10	8902762
Skewness	0.506	1.043	0.312724	0.282779

Kurtosis	1.714	3.776	1.62103	1.927541
JB	3.124	5.776	2.674867	1.715026
Probability	0.21	0.056	0.262518	0.424216
Sum	17521.4	1.657	1.16E+12	1.18E+09

Source: author's compilation

Traditional unit root of ADF and PP were conducted to, also due to the possibility of asymmetry and structural change in renewable energy consumption series unit root test with structural break were conducted, this is presented in Table 2. None of the variable was found to be of second order, this warrant the ARDL.

Table 2: unit root test

Traditional Unit Root

variables	ADF		PP		decision
	t-statistics		t-statistics		
	Level	1st diff	Level	1st diff	
GDP	-2.101	-4.891	-2.15	-6.245	I(1)
Energy	-2.775	-6.462	-2.78	-6.536	I(1)
Capital	-1.99	-3.928	-2.17	-3.915	I(1)
Labour	-2.141	-2.141	-1.87	-11.971	I(1)

Unit Root with Breaks

variables	break date	t-statistics	break date	t-statistics	decision
		Level		1st diff	
GDP	2006	-2.6	2015	-4.843	I(1)
Energy	2001	-4.398	2006	-7.358	I(1)
Capital	2006	0.869	1999	-3.044	I(1)
Labour	2005	-1.204	2004	-8.899	I(1)

Source: author's compilation

Linear form of ARDL was conducted and the variables were found to be cointegrated in the longrun. The null hypothesis of no cointegration was rejected. The result was presented in Table 3, the residuals of the model were checked, the model was free from heteroskedasticity, serial correlation and the model was correctly specified. The establishment of longrun relationship in linear ARDL framework explains the need for nonlinear ARDL. This is because the traditional linear ARDL assumed the relationship to be symmetry, which may be biased. Table 4 present the nonlinear ARDL model for economic growth.

Table 3 Linear ARDL

Variables	coefficient	std. error	t-statistics	Prob.
Energy	3.468	4.684	0.74	0.469
Capital	0	0	3.165	0.005
Labor	0	0	2.787	0.012
C	4.601	0.307	14.991	0
BG	0.964	LM	0.955	
JB	0.534	Arch	0.479	
Ramsey	0.498			

Source: author's compilation.

The renewable energy consumption is decomposed into positive and negative to examine the longrun relationship with economic growth, the coefficient of the decomposed positive value of renewable energy (1.128) is positive, this explain a positive relationship between renewable energy consumption and economic in longrun, meaning a unit increase in renewable energy consumption is associated with a 1.128 increase in economic growth.

Similarly the negative energy consumption composition reveals a negative relationship, renewable energy consumption and economic growth has a negative relationship at longrun, a unit decrease in renewable energy consumption is associated with a -7.6% decrease in economic growth

The decomposed renewable energy consumption and its relationship with economic growth give a clear picture of the longrun relationship, and explain the asymmetry effect as the effect and the values of the coefficient are different when the renewable energy consumption is at the pace of increasing and or decreasing.

Table 4 Nonlinear ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Energy_pos	1.128	2.633	0.428	0.675
Energy_neg	-7.695	1.708	-4.504	0.001
Capital	0	0	3.269	0.006
Labor	0	0	3.636	0.003
C	4.998	0.12	41.723	0
LW			6.203	
SW			2.392	
Diagnostic Checks				
BG	0.912		LM	0.983
JB	1.881		Arch	0.818
Ramsey	0.855			

Source: author's compilation

The shortrun relationship is further examine using a Wald test, were the sum values of positive renewable energy consumption were compared with the sum of negative values. The t statistics value of 2.392 explains a positive relationship between renewable energy consumption and economic growth. The model is free from serial correlation, heteroskedesticity, and correctly specified.

5. CONCLUSION

This study measures the impact of renewable energy consumption on economic growth in Nigeria, using the data from 1980 to 2017. Nonlinear Autoregressive Distributive Lag (ARDL) model was used to estimates the cointegration and asymmetric effect of the energy consumption on economic growth.

The result of the estimates reveals that renewable energy consumption has asymmetric effect on economic growth in Nigeria, a positive or negative change in energy consumption has a respective positive or negative effect on economic growth. Based on the result the positive and negative effect of renewable energy consumption on economic growth is asymmetry both in the longrun and shortrun, unlike linear form of ARDL were symmetry longrun relationship between the variable was established. These relationships further reveal the importance of renewable form of energy for both economic growth and curbing environmental degradation.

To this end, it is imperative for Nigeria to further explore all its renewable energy source, the energy policies should be focus towards that, funding should be made available for improvement of renewable energy exploration, further and rigorous researches should be priorities for the development of energy sector, these will in turn improve the level economic growth and reduce carbon emissions.

REFERENCES

[1] M. Salahuddin, M. A. Habib, U. Al-Mulali, I. Ozturk, M. Marshall, and M. I. Ali, "Renewable energy and environmental quality: A second-generation panel evidence from the Sub Saharan Africa (SSA) countries," *Environ. Res.*, vol. 191, no. August, p. 110094, 2020, doi: 10.1016/j.envres.2020.110094.

[2] G. Vural, "Renewable and non-renewable energy-growth nexus: A panel data application for the selected Sub-Saharan African countries," *Resour. Policy*, vol. 65, no. November 2019, 2020, doi: 10.1016/j.resourpol.2019.101568.

[3] O. J. Akintande, O. E. Olubusoye, A. F. Adenikinju, and B. T. Olanrewaju, "Modeling the determinants of renewable energy consumption: Evidence from the five most populous nations in Africa," *Energy*, vol. 206, p. 117992, 2020, doi: 10.1016/j.energy.2020.117992.

[4] H. A. Bekhet, A. Matar, and T. Yasmin, "CO2 emissions, energy consumption, economic growth, and financial development in GCC countries: Dynamic simultaneous equation models," *Renew. Sustain. Energy Rev.*, vol. 70, no. 2017, pp. 117–132, 2017, doi: 10.1016/j.rser.2016.11.089.

[5] C. Lee and C. Chang, "Energy consumption and economic growth in Asian economies : A more comprehensive analysis using panel data," vol. 30, pp. 50–65, 2008, doi: 10.1016/j.reseneeco.2007.03.003.

[6] S. Hoon, F. Islam, and A. Kumar, "The dynamic relationships among CO 2 emissions , renewable and non-renewable energy sources , and economic growth in India : Evidence from time-varying Bayesian VAR model," *Struct. Chang. Econ. Dyn.*, vol. 50, pp. 90–101, 2019, doi: 10.1016/j.strueco.2019.05.006.

[7] A. Cherni and S. Essaber, "ScienceDirect An ARDL approach to the CO2 emissions , renewable energy and economic growth nexus : Tunisian evidence," *Int. J. Hydrogen Energy*, vol. 42, no. 48, pp. 29056–29066, 2017, doi: 10.1016/j.ijhydene.2017.08.072.

[8] O. Benjamin and A. Olusegun, "The role of non-renewable energy consumption in economic growth and carbon emission : Evidence from oil producing economies in Africa," *Energy Strateg. Rev.*, vol. 27, p. 100434, 2020, doi: 10.1016/j.esr.2019.100434.