Why Renewable Energy Use Is worth for East African Community (EAC) Countries' Economies

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Abstract: The positive impact of renewable energy use to spur the economic growth is being scrutinized to assess its economic impacts apart from its convenience to health conditions. This article investigates the direction of causation between renewable energy consumption and economic growth in 5 countries of East African Community (EAC) for the period of 1990Q1 to 2014Q4 due to the data availability. The analysis uses the panel ARDL approach and Pairwise Dumitrescu- Hurlin(2012) Panel Causality to study the interdependence between the use of renewable energy and economic growth in a bid to adequately inform related policies and initiatives in EAC. The findings strongly support the feedback hypothesis as well as the nexus between renewable energy use and economic growth in EAC for sampled period. Thus, policies that cheer joint projects to increase the renewable energy in the region, should be encouraged to harmlessly secure sustainable economic growth and environment protection as well as health.

1 INTRODUCTION

It is about three decades that the environment deterioration due greenhouse gas emissions from fossil fuels that leads even to the global warming and climate change issues became a substantial concern for international community, some countries 'leaders, different global institutions, researchers whose interests are in the line with environment protection and sustainable socio-economic development. The international community through Kyoto Protocol in 1997 advocated the use of renewable energy to mitigating the global warming and climate change mitigation and adaptation as well. Despite its slow implementation, this treaty marked an important global voice of environment protection and proposed to reduce the carbon dioxide emission with global warming mitigation through adopting the clean energy economy use where hydroelectric; wind and solar are the most sustainable clean energy recommended sources. It is important to study the causal relationship between renewable energy use and economic growth. The knowledge of interaction ways between the two variables supports the national and regional socio-economic development process as energy is recognized as the conditional factor to capital and labor in the production process(Stern and Cleveland 2004).

The renewable energy sector provides new investments opportunities worldwide. Individuals and institutions that make innovative renewable energy investment enjoy sustainable paybacks. The investment in renewable energy sector, makes affordable energy cost for investment in manufacturing and infrastructure projects. More renewable energy encourages investments that result into harmless economic growth. Thus, this hypothesized model can be more helpful in less developed economies where EAC member states are classified.

The core intention of this study is to determine the direction of causality between renewable energy consumption and economic growth for 5 East Africa Community (EAC) countries.

This paper is structured such that the section 2 deals with theoretical debate on the nexus between renewable energy use and economic growth, part 3 explains the methodology used, part4 presents and discusses findings while section5 is for conclusion and recommendations.

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2 THE THEORETICAL DEBATE ON NEXUS OF RENEWABLE ENERGY USE AND ECONOMIC GROWTH

A significant number of studies have propped up the renewable energy consumption and economic growth nexus based on four hypothesized energy consumption- growth models(Lee & Chang, 2007;Apergis & Payne, 2009, 2010; Ozturk, & Aslan, 2012; Nayan, & Abdullah, 2013): (i) growth hypothesis which states that energy consumption directly or indirectly causes economic growth; (ii) The conservation hypothesis is based on the evidences where economic growth induces energy consumption, (iii) the feedback hypothesis relies on the mutual interaction between energy and growth while (iv) the neutrality hypothesis means the nonexistence of energy-growth causation.

Using different techniques, studies at country and cross-country level in developed and less developed economies; findings have provided evidence that renewable energy consumption and economic growth have relationship. But the direction of causation continued to be contrasted from different contexts. At the cross section level in developed countries, Ozturk, & Aslan, (2012) studied the causal relationship between renewable energy consumption, non-renewable energy sources and economic growth for the G-7 using ARDL technique and causality test for the period of 1980–2009 and results evidenced that renewable and non-renewable energy consumption spur the production, Apergis & Payne, (2010) employed panel cointegration and error correction model for a panel of 20 OECD countries over the period 1985–2005, findings discovered a validation of feedback hypothesis in both short and long run between renewable energy consumption and economic growth; employing asymmetric causality test approach and autoregressive distributed lag (ARDL) techniques, Alper & Oguz, (2016) for the period of 1990–2009, investigated the renewable energy consumption and economic growth nexus for new EU members and results confirmed that renewable energy consumption is pro economic growth. For 80 mixed countries, Apergis & Dan, 2014), using Canning and Pedroni (2008) to test the long run causality for the sample period of 1990 - 2012 and findings supported the two ways relationship between renewable energy consumption and economic growth; (Cho & Kim, 2015) have done a comparative study of causal relationship between energy consumption and economic growth for 31 OECD countries developed countries and 49 non-OECD less developed countries for 1990–2010 under multivariate panel vector error correction technique and findings supported the conservative hypothesis in OECD countries and feedback hypothesis in non – OECD countries; (Al-Mulali.et al., 2013) investigated the renewable energy consumption-growth hypothesis for high income, upper middle income and lower middle income under fully modified OLS technique and findings testified that the feedback hypothesis is supported in 79% of total countries under the study, 2% with one way causality running from GDP to renewable energy use and 19% were found with neutrality hypothesis.

For less developed countries, (Hamit-haggar,2016) investigated clean energy consumption and economic growth for 11 sub-Saharan African countries for 1971–2007 with the use of bootstrap-corrected Granger causality test and results confirmed that clean energy consumption granger causes economic growth.

At the country revel also the renewable energy consumption and economic growth nexus got has been studied. For the German (Rafindadi & Ozturk, 2017) using combined cointegration test for the period of 1971Q1 to 2013QIV results validated that renewable energy consumption drives economic growth; for Turkey (Dogan, 2016) under the use of estimation techniques with structural break, renewable energy consumption was found insignificant while non-renewable energy consumption was found relevant to economic growth; in Lithuania (Bobinaite& Konstantinaviciute, 2011) studied the causal link between renewable energy and GDP for the time of 1990-2009 and have found one way causality running from renewable energy consumption granger to GDP.

This article seeks in the light of reviewed literature to scrutinize the route of Dumitrescu-Hurlin (2012) Panel Causality test between renewable energy use and economic growth in selected EAC countries.

3 DATA AND METHODOLOGY

3.1 Data

All used annual data that have been transformed into quarterly data arrayed from 1990Q1-2014Q4 for selected five East Africa Community (EAC) member countries (Burundi, Kenya, Rwanda, Tanzania and Uganda) were obtained from World Bank Development Indicators database 2019. This study considered this sample period because data for

renewable energy consumption were available till 2014.

3.2 Methodology

As the main purpose of this work is to investigate if there is cointegration and to determine the direction of causality between renewable energy consumption and economic growth in EAC. This study employs the Panel ARDL method to investigate the long run and short run dynamics between renewable energy consumption and economic growth as well as uses Dumitrescu-Hurlin (2012) Panel Causality test to assess the direction of causality among variables.

3.2.1 The Ardl Panel Method

The capability of panel Auto Regressive Distributed Lag (ARDL) test to test the existence of cointegration among variables for dynamic models has been recognized numerous researchers such as Simplice A.et al, 2015 and Offermanns, 2007 among others. The ARDL is advantageous in studies of dynamic models as it provides unbiased long run estimates. Following the Pesaran et al., (1999) tactic, the panel ARDL model with long run dynamics is structured as below.

$$\Delta LYi,t = \alpha i + \sum_{j=1}^{M-1} \beta ij \Delta LYi,t-j + \sum_{k=0}^{N-1} \Upsilon ik \Delta LEi,t-k + \sum_{p=0}^{Q-1} \Psi ip \Delta LIi,t-p + \gamma 1 LYi,t-1 + \phi 1 LEi,t-1 + \gamma 1 LIi,t-1 + \varepsilon 1i,t \quad (1)$$

Yi, t: Represents real gross domestic product in US dollars based on the 2000 constant price, for i that represents the cross-section dimension and at the time t. Ei, t: Stands for renewable energy consumption for individual i and at the period t. The E is the main independent variable in this work.

Ii, t: Is the gross fixed capital that represents the level of investments in US dollars, for individual country i and at the period t. It is considered as mediator factor between Y and E. Investing in renewable energy sector can make possible other investments that necessitate energy as input which late stimulate economic growth. To another hand investments in renewable energy due to the economic growth, the payback will come again through investments which need energy as a complement factor to capital and labour and later this will increase the economic growth. The Δ and L respectively represent first differentiator and the logarithmic expression, i: varies from 1to 5 stands for the cross countries under the study, t is the period of time, M, N, Q represent the lag order that must be identical for all countries under the study while εi, t, is the error term which must be normally distributed with mean zero constant covariance and variance.

The equation (1) included the short and long run equations. The part with first differentiator Δ stands for short run equation that includes lagged values of variables involved in this study and the remaining one in the right side represents the long run relationship between renewable energy use and economic growth.

$$\Delta LYi,t = \alpha 2i + \sum_{j=1}^{M} \beta 2ij \Delta LYi,t-j + \sum_{k=0}^{N} \Upsilon 2ik \Delta Lei,t-k + \sum_{p=0}^{Q} \Psi 2ip \Delta LIi,t-p + \varepsilon 2i,t \quad (2)$$

$$LYi,t = \alpha 3i + \gamma 2 LYi,t-1 + \phi 2 LEi,t-1 + \gamma 2 LIi,t-1 + \varepsilon 3i,t \quad (3)$$

3.2.2 The Pairwise Dumitrescu-Hurlin Panel Causality Test

Following the model of [20], the renewable energy consumption and economic growth panel granger causality for EAC 's countries represented by k(1 to 5) is specified as follow:

$$LYi,t = \alpha 4i + \sum_{k=1}^{k} \Omega 1ik LYi,t-k + \sum_{k=0}^{k} \gamma 1ik LEi,t-k + \sum_{k=0}^{k} \rho 1ik LIi,t-k + u1i,t \quad (4)$$

$$LEi,t = \alpha 5i + \sum_{k=1}^{k} \Omega 2ik LYi,t-k + \sum_{k=0}^{k} \gamma 2ik LEi,t-k + \sum_{k=0}^{k} \rho 2ik LIi,t-k + u2i,t \quad (5)$$

$$LIi,t = \alpha 5i + \sum_{k=1}^{k} \Omega 3ik LYi,t-k + \sum_{k=0}^{k} \gamma 3ik LEi,t-k + \sum_{k=0}^{k} \rho 3ik LIi,t-k + u3i,t \quad (6)$$

The dependent variable Yi, t-k, specifies the dynamic nature of real economic growth and explains the interdependence of economic growth. It means that the current economic growth requires the significance influence of previous growth as well as the significant influence of the previous values of renewable energy use and gross fixed capital formation. Thus, the existence of panel Granger causality between renewable energy and economic growth in EAC is proved by the validity as such as that:

$$\Omega i1 = \ldots = \Omega i3 \neq 0;\ \gamma i1 = \ldots\ldots = \gamma i3 \neq 0;\ \rho i1 = \ldots\ldots = \rho i3 \neq 0 \quad (7)$$

4 RESULTS AND DISCUSSION

This section presents and discusses results for panel unit root, panel, and individual country granger causality among variables.

4.1 Results of the Unit Root Test

The panel unit root tests to check whether data series is stationary on not is performed using the following tests: (Levin, Lin & Chu2002; Im, Pesaran & Shin, 2003; Dickey & Fuller, 1979; and Phillips & Perron, 1988) .The outcomes of panel unit root tests at first difference revealed that all variables are integrated of order I(1). The results prove that the null hypothesis of a panel unit root (non-stationarity) at the first difference of the series is rejected as per majority of unit root tests. The table 1below shows unit root test results.

***, ** and * are levels of statistical significance at 1%,5% and 10% respectively, ** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. The probability values for the tests are in parentheses.

4.2 The Panel ARD Results

Based on the results of specified panel ARDL model, estimates show that the renewable energy use is dynamically cointegrated with economic growth in selected EAC countries. As it is revealed by this investigation, if renewable energy use increases by 1% percent, the economic growth will increase by 0.99%. The adjustment coefficient sign also proves that the disequilibrium can be at quarterly adjusted on the rate of 7% to achieve the equilibrium. The summary of results for dynamic relationship is presented in table 2.

Table1: Panel unit root test results.

Variable	LLI	IPS	ADF	PP
LY	-0.153(0.44)	-4.81***	45.47***	69.12***
LE	-0.76 0(0.22)	-5.83***	56.50 ***	80.38***
LI	-0.290 (0.38)	-6.35***	62.14***	91.01***

Table 2: Panel ARDL results for long run and short run.

Long run relationship among variables: LYi, t=-0.4181+ 0.987LEi, t + 0.42 LIi,t				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEi, t	0.987154	0.139678	7.067337	0.0000
LIi,t	0.427631	0.038735	11.03979	0.0000
C	-0.418171	0.018260	-22.90113	0.0002
Short run relationship among variables				
CointEq(-1)	-0.070013	0.000617	-113.4361	0.0000
D (LEi, t)	0.309046	0.005349	57.77703	0.0000
D (LIi, t)	0.189139	0.000629	300.5361	0.0000

4.3 The Pairwise Dumitrescu- Hurlin Panel Causality Estimates

Employing granger causality based on the causality test proposed by Dumitrescu-Hurlin (2012) that even under the presence of cross-sectional dependence is believed to generate reliable results. The importance of checking the causation among multiple variables is intended to prove if previous values of K can be predictors of Y. In this case the null hypothesis is set as such K does not granger cause Y. The rejection of the null hypothesis due to the tiny probability values is the proof of the link between variables and it is said that variable K can granger cause variable Y.

The outcomes reported in the table 2, signify that there is a long rung and a bidirectional relationship between renewable energy consumption and economic growth in selected East African Countries (EAC). These findings are in the line with results of prior works such as the studies of (Nasreen & Anwar,

2014;Shakouri & Khoshnevis Yazdi, 2017). Findings supported that renewable energy use can cause international trade. This finding relates to one of Brini, Amara & Jemmali (2017). The highest level of significance of probability values validate the idea that the renewable energy use incites the economic growth in EA. The causation that runs from renewable energy use to investments and trade openness makes sense as the late two variables witnessed to be best predictors of economic growth. Furthermore, the two ways causality exists between investments and trade openness as it is presented in table3 below.

Table 3. Results of Dumitrescu- Hurlin panel causality tests.

Null hypothesis	No of lags/ AIC criteria	W stati	Z stat.	Prob.value
LE does not cause LY	3	**8.37**	**3.23**	**0.0013**
LY does not cause LE	3	**6.09**	**1.73**	**0.0844**
LI does not cause LY	3	8.052	2.67	0.0076
LY does not cause LI	3	10.41	4.08	0.00005
LI does not cause LE	3	6.33	1.65	0.0997
LE does not cause LI	3	9.96	3.81	0.0001

***, ** and * are levels of statistical significance at 1%,5% and 10% respectively. The probability values for the tests are in parentheses.

5 CONCLUSIONS

The contribution of renewable energy use to the economic growth cannot be neglected among the factors of pro economic growth in EAC. To find the dynamic nexus and the route of causation between main variables of the hypothesized study, the panel ARDL approach and Pairwise Dumitrescu- Hurlin Panel Causality techniques have been used. The fact of long run and two ways causal relationship between renewable energy and economic growth revealed that this study qualifies for feedback hypothesis. The results indicated that the renewable energy use is a best predictor of economic growth in all selected EAC countries and vice versa. The outcomes of this work advocate that using renewable energy is not useful for environmental purposes, but it at same time promotes the economic growth especially in developing countries such as EAC's countries that need to promote the manufacturing sector which necessitates a huge amount of energy for its operations. The EAC member states should take this opportunity of membership to bring big profitable renewable energy projects that can create a regional competitive advantage. Upcoming investigations with updated data sets for this critical research point are valuable as the renewable energy use produces more economic and environmental advantages that are harmless to the ecosystem.

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