International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2017, 7(2), 61-64.

Renewable Energy Consumption and Economic Growth: A Case Study for Developing Countries

Zahra Fotourehchi*

University of Mohaghegh Ardabili, Ardabil, Iran. *Email: z.faturechi@yahoo.com

ABSTRACT

In this paper, we analyze the long-run causality relationship between renewable/clean energy consumption and economic growth during the period 1990-2012 for 42 developing countries, under the Canning and Pedroni (2008) long-run causality test, which indicates that there is long-run positive causality running from renewable energy to real gross domestic product (GDP). This means that for developing countries where renewable energy consumption has a positive long-run causal effect on real GDP, renewable energy dependent conservation policies have prohibitive impact on economic growth. Moreover, government's\energy policies should encourage the development of clean energy sector instead of polluted energy sector for energy security and environmental challenges.

Keywords: Renewable Energy, Economic Growth, Developing Countries
JEL Classifications: O10, Q20

1. INTRODUCTION

Energy is key variable for growth and competitiveness. For producer energy is a key resource and a cost element. For consumer energy bills represents significant items in households budget and is particular challenge for low-income households. However, energy is depleting, any disruptions in non renewable energy supply, hitting non renewable-dependent activities and households, so leads to serious risks related to energy prices. Given the increasing demand and limited supply, it is inevitable that non renewable energy supply will be turned out. Moreover, non-renewable energy consumption has dependent-challenges such as environmental degradation, climate change and global warming that caused by rapidly increasing greenhouse gases emissions such as CO_2 and methane. The International Energy Agency (IEA, 2009) suggests that current trends in energy supply are still economically, environmentally and socially unsustainable. It is projected that the primary energy demand will increase by 1.5% per year between 2015 and 2030, with fossil fuels being a dominant energy source (Apergis and Danuletiu, 2014. p. 579). It is expected due to increasing energy demand, energy-related CO_2 emissions will more than double by 2050. Therefore, many countries are faced with energy security and environmental challenges, forced to look for energy alternative to fossil fuels. These challenges require to be appropriately managed by clean-renewable energy consumption. Renewable energy commonly is defined as energy generated from solar, wind, geothermal, tide, wood, waste and biomass. In contrast to conventional energy, renewable energy is safe, clean and inexhaustible. Consequently, many countries are making investment on renewable energy components in order to reduce their greenhouse gas emissions and increase the supply of secure energy. Therefore, it is growing around the world. In fact, rapidly increasing renewable energy demand (8% per year) in the world particularly in USA, Europe and China reflects environmental and awareness of public. During 2011 renewable energy sources supplied an estimated 16.7% of global final energy consumption, and global new investment in renewable energy increased by 17% due to cost reductions and technological innovations in renewable energy (REN, 21).

Although unsustainable economic growth is rapidly continuing in developing countries, these countries have potential for sustainable growth by substituting renewable energy consumption for non renewable energy. Because, in these countries renewable technology is suitable for local power generation in rural and remote areas, where the cost of provision and accessibility of non renewable energy are very high. Most developing countries have attempted to identify and implement programs and policies to improve the structure of renewable markets in rural and remote areas. Thus, rural-remote energy markets increase more and are more attractive to potential investors. IEA anticipates that annual investment in the rural energy sectors requires increasing more than 5-fold to achieve the wide use of new renewable energy by 2030 (Pao and Fu, 2013. p. 382). All these factors point to brighter future for renewable energy. This study aims to find whether growth benefits from substituting renewable energy for non renewable energy in developing countries, where there are no publication investigate the long-run casual relationship between renewable energy consumption and economic growth. The empirical findings are based on data selected for upper-lower middle income/developing countries over the period 1990-2012 under Canning and Pedroni (2008) long-run causality methodological approach. The remainder of the paper is organized as follows: Section 2 present a review of the existing literature. Methodology is described in Section 3 and followed by empirical results. Finally, conclusion and policy implication are provided in Section 4.

2. LITERATURE

In the literature, there are four hypotheses associated with causality direction between economic growth and renewable energy consumption:

1. Growth hypothesis that points out unidirectional/one-way causality from renewable energy consumption to economic growth. In this case, renewable energy dependent conservation policy may have prohibitive impact on economic growth.
2. Conservation hypothesis that is contrast to growth hypothesis. Based on this hypothesis there is unidirectional causality from economic growth to renewable energy consumption. Therefore, renewable energy-related conservation policy may have little or no effect on economic growth.
3. Feedback effect hypothesis that suggests bidirectional causality between renewable energy consumption and economic growth.
4. Neutrality hypothesis implies the absence of causality between renewable energy consumption and economic growth. Hence, implication of renewable energy conservation policy has an insignificant effect (Ozturk, 2010).

There are a lot of studies in the literature that have examined the causality relationship between renewable energy consumption and economic performance in confirming four above hypotheses. In terms of causality and in cross-countries and within country-specific contexts, several studies have found bidirectional causality between renewable energy consumption and economic growth, supporting the feedback hypothesis (Apergis and Payne, 2010; Fang, 2011; Rafindadi and Ozturk, 2017; Tugcu, 2013). While some studies have concluded unidirectional causality from renewable energy consumption to economic growth and confirmed the growth hypothesis (Bhattacharya et al., 2016; Esso, 2010; Fang, 2011; Leitão, 2014; Payne, 2010), some others have found unidirectional causality from economic growth to renewable energy consumption, supporting therefore the conservation hypothesis (Ocal and Aslan, 2013). Moreover, mixed results have been derived regarding the direction of causality between different proxy variables of renewable energy consumption and economic growth (Bowden and Payne, 2010; Jebli et al., 2016; Pao and Fu, 2013; Tugcu et al., 2012; Yildirim et al., 2012) and the absence of causality between renewable energy consumption and economic growth, supporting neutrality hypothesis (Menegaki, 2011; Payne, 2010). The results of the considered researches differ based on using different proxy variables for different types of renewable energy consumption. Therefore, the magnitude and the direction of causality between renewable energy consumption and economic growth are still unclear. Moreover, a general conclusion from studies reviewed in this section is that there is no consensus either on the existence or on the direction of causality between energy consumption and economic growth. This study aims to contribute to the literature by identifying the causality effect between two variables. Unlike previous works that have been examined this relationship in a specific country or whole world, in this paper is highlighted to developing countries, where renewable energy consumption is increasing, but no publication explore the causality relationship between energy consumption-economic growth.

3. EMPIRICAL ANALYSIS

3.1. Data and Model

During the period 1990-2012 data for 42 developing countries[1]' real gross domestic product (GDP) in billions of constant 2000 U.S dollars and renewable energy consumption (RE) that defined in the share of renewable energy in total final energy consumption were obtained from the World Development Indicator and Energy Information Administration.

The empirical model is used for examining long-run effect of renewable energy on economic growth written as (Apergis, 2014):

$$GDP_{it} = \beta_0 + \beta_1 RE_{it} + \varepsilon_{it} \quad (1)$$

Where, i = 1,...,N denotes each country and t = 1,...,T refers to the time period.

The parameter β_0 allows for the possibility of country specific fixed effects. The causality relationship between renewable energy consumption and economic growth is examined by the Canning and Pedroni (2008) methodological approach. This approach considers a dynamic error correction (EC) model but within a panel data framework. The EC model employed is:

$$\Delta GDP_{it} = \beta_{1i} + \sum_{j=1}^{k} \beta_{11ij}\, \Delta GDP_{i,t-j} + \sum_{j=1}^{k} \beta_{12\cdot ij}\, \Delta RE_{i,t-j} + \lambda_{1i} e_{it-j} + \varepsilon_{1it} \quad (2)$$

$$\Delta RE_{it} = \beta_{2i} + \sum_{j=1}^{k} \beta_{21ij}\, \Delta GDP_{i,t-j} + \sum_{j=1}^{k} \beta_{22\cdot ij}\, \Delta RE_{i,t-j} + \lambda_{2i} e_{it-j} + \varepsilon_{2it} \quad (3)$$

1 Algeria, Armenia, Bangladesh, Belarus, Bolivia, Botswana, Brazil, Bulgaria, Cameroon, China, Congo Republic, Costa Rica, Cuba, Ecuador, Egypt Arab Republic, El Salvador, Gabon, Guatemala, Honduras, India, Indonesia, Iran Islamic Republic, Jordan, Kazakhstan, Kenya, Kyrgyz Republic, Macedonia, FYR, Malaysia, Mexico, Morocco, Nigeria, Pakistan, Philippines, Romania, Senegal, South Africa, Sudan, Tajikistan, Thailand, Tunisia, Turkey, Ukraine.

Where, Δ is the first difference operator; β_{1i} and β_{2i} are the intercept terms; λ_{1i} and λ_{1i} are the speed of adjustment coefficients; e_{it-j} is the disequilibrium error, which is the residual from the cointegrating relationship; ε_{1it} and ε_{2it} are white noise error terms.

3.2. Empirical Findings

In the empirical analysis, before doing the panel cointegration tests, the degree of integration and stationary properties of the variables need to be examined. In the first step, different types of panel unit root tests are performed, including Breitung (2000) and Levin et al. (2002) (LLC), that the autoregressive coefficients are common across cross section and Fisher-type tests using augmented Dickey–Fuller and Phillips–Perron tests (Maddala and Wu, 1999 and Choi, 2001), and Im et al. (2003) (IPS) permit autoregressive coefficients to vary freely across cross-sections. The panel unit root tests, presented in Table 1, show except LLC test both variables are non-stationary. The panel unit root results recommend the potential presence of panel cointegration, which we conduct next.

In the next step, panel cointegration relationships between the variables are tested by two tests. The first is the Kao (1999) residual based test for panel Kao's test is essentially a panel version of the Engle and Granger (1987) test. The null hypothesis is that there is no cointegration. The second test is the Fisher (1932) test, proposed by Maddala and Wu (1999) to panel data models, where essentially the p-values from the univariate trace test and maximum eigenvalue test of Johansen (1988) are combined to test the null hypothesis of no cointegration and the null hypothesis of at most one cointegration, respectively. Table 2 presents the panel cointegration test statistics. Both the Kao residual test and the Fisher test statistics reject the null hypothesis of no cointegration. So we conclude that for developing countries real GDP and energy consumption are cointegrated.

If a set of variables are individually I(1) and a linear combination of them is I(0), then the variables can be represented by way of an EC model. In this section, we test the direction and sign of causality by employing a panel cointegration causality test (Canning and Pedroni, 2008). This test uses of the corresponding to panel cointegration EC model as it is presented from equations (2-3). The coefficients λ_1 and λ_2 show the speed of adjustment to equilibrium. The results of test is reported Table 3.

The parameter λ_1 indicates the presence or absence of long-run causality from renewable energy consumption to real GDP and λ_2 indicates the presence or absence of long-run causality from real GDP to renewable energy consumption. To test for the existence of long-run causal relationship between the variables, Canning and Pedroni (2008) construct two tests, viz., group mean based test and Lambda-Pearson test. The group mean based test averages the individual λ_{1i} and examines whether the long-run causal effect is zero on average for the panel. The group mean panel estimate for λ_{1i} is computed as given in equation (4).

$$\lambda_1 = \sum_{i=1}^{N} \lambda_{1i} / N \tag{4}$$

Table 1: Panel unit root test

Variables	ADF – Fisher	PP – Fisher	IPS	LLC	Breitung
GDP	115.90*	85.21*	0.17*	−9.85	8.98*
ΔGDP	177.32	315.53	−5.67	−6.13	−2.29
RE	104.27*	94.58*	−0.67*	−1.94	1.92*
ΔRE	236.25	759.51	−9.27	−7.22	−8.99

Panel unit root tests include intercept and trend. An *denotes the non-rejection of the null hypothesis on unit root at 5%. GDP: Gross domestic product, ADF: Augmented Dickey–Fuller

Table 2: Panel cointegration test

Kao (1999) test	Fisher (1932) test	
	From trace test	From maximum eigen value test
3.75	232.2*	217.4*

*,**,***denotes significance at the 1%, 5%, 10% level. * denotes significance at the 1% level.

Table 3: Long-run panel granger causality tests

Group mean/Lambda-Pearson	Estimate	Test	P value
Renewable energy→GDP			
Group mean	0.08	1.32	0.042
Lambda-Pearson		142.7	0.0034
GDP→Renewable energy			
Group mean	0.004	0.23	0.53
Lambda-Pearson		21.2	0.48

GDP: Gross domestic product

And the joint the panel test statistic (TT) which yields:

$$t_{\lambda 1} = \sum_{i=1}^{N} \Sigma t_{\lambda 1i} / N \tag{5}$$

with N being the number of countries in the panel, and $t_{\lambda 1}$ is the individual country test for the null hypothesis that renewable energy consumption does not Granger cause GDP, i.e. $\lambda_{1i} = 0$. The test statistic has a standard normal distribution. The second test they develop is the Lambda-Pearson (LP) panel test, which yields:

$$p\lambda_1 = -2\sum_{i=1}^{N} \ln p\lambda_{2i} \tag{6}$$

Where, $p\lambda_{1i}$ is the log of the p value associated with t-test of each individual cross section, for the null hypothesis that $\lambda_{1i} = 0$. Similarly, the Lambda-Pearson test is computed for λ_{2i}. The test statistics $p\lambda_1$ and $p\lambda_2$ follow χ^2 distribution with 2N degrees of freedom.

In Table 3, the parameter λ_1 indicates the long-run causal effect of renewable energy on real GDP, the results of group mean based test reject the null hypothesis that renewable energy has a zero average long-run effect on real GDP. Similarly, the lambda-Pearson test rejects the null hypothesis that the long-run effect of renewable energy on real GDP is pervasively zero. These results show that, renewable energy consumption has long-run causal effect on real GDP.

The parameter λ_2 indicates the long-run causal effect of real GDP on renewable energy consumption. The results of group mean based test fail to reject the null hypothesis that real GDP has a zero average long-run effect renewable energy consumption. However, the result of lambda-Pearson test does not reject the null that the long-run effect of real GDP on renewable energy consumption is pervasively zero.

Moreover, we found that in the long-run renewable energy consumption is positively Granger causes real GDP. This means that as renewable energy consumption increases, real GDP will increase.

4. CONCLUSION

In this paper, we attempt to find whether energy conversation policies are meaningful for developing countries by Canning and Pedroni panel causality test, a new panel Granger causality test that allows the determination not only of the presence of long-run causality, but also the sign on the direction of causation. The results show that at the 5% level renewable energy consumption Granger causes real GDP. In other words, growth benefits from substituting renewable energy for non renewable energy in developing countries. These results are consistent of those Esso (2010), and Fang (2011), Payne (2010). Moreover, the sign of the impact is positive.

The research findings support the growth hypothesis that points out unidirectional/one-way causality from renewable energy consumption to economic growth. In this case, renewable energy dependent conservation policies have prohibitive impact on economic growth. Therefore, to access the sustainable growth, policy makers must avoid renewable energy dependent conservation policies encourage the development of clean energy sector instead of polluted energy sector and introduce the appropriate incentive mechanisms for the development and market accessibility of renewable energy.

REFERENCES

Apergis, N., Danuletiu, D. (2014), Renewable energy and economic growth: Evidence from the sign of panel long-run causality. International Journal of Energy Economics and Policy, 4(4), 578-587.

Apergis, N., Payne, J.E. (2010), The renewable energy consumption-growth nexus in Central America. Applied Energy, 88, 343-347.

Bhattacharya, M., Paramati, S.R., Ozturk, I., Bhattacharya, S. (2016), The effect of renewable energy consumption on economic growth: Evidence from top 38 countries. Applied Energy, 162, 733-741.

Bowden, N., Payne, J.E. (2010), Sectorial analysis of the causal relationship between renewable and non-renewable energy consumption and real output in the U.S., Energy sources, Part B: Economics. Planning, and Policy, 5, 400-408.

Breitung, J. (2000), The local power of some unit root tests for panel data. In: Baltagi, B.H., editor. Nonstationary Panels, Panel Cointegration and Dynamic Panels. Amsterdam: Elsevier. p161-177.

Choi, I. (2001), Unit root tests for panel data. Journal of International Money and Finance, 20, 249-272.

Canning, D., Pedroni, P. (2008), Infrastructure, long-run economic growth and causality tests for cointegrated panels. The Manchester School, 76, 504-527.

Engle, R.F., Granger, C.W.J. (1987), Cointegration and error correction representation, estimation and testing. Econometrica, 55, 251-276.

Esso, J.L. (2010), The energy consumption-growth nexus on seven Sub-Sahara African countries. Economic Bulletin, 30, 1191-1209.

Economic welfare impacts from renewable energy consumption: The China experience. Renewable Sustainable Energy Review, 15, 5120-5128.

Fisher, R.A. (1932), Statistical Methods for Research Workers. 4th ed. Edinburgh: Oliver & Boyd.

IEA. (2009), World Energy Outlook. Paris, France: International Energy Agency.

Im, K.S., Pesaran, M.H., Shin, Y. (2003), Testing for unit roots in heterogeneous panels. Journal of Econometrics, 115, 53-74.

Jebli, M.B., Youssef, S.B., Ozturk, I. (2016), Testing environmental Kuznets curve hypothesis: The role of renewable and non-Renewable energy consumption and trade in OECD countries. Ecological Indicators, 60, 824-831.

Johansen, S. (1988), Statistical analysis of cointegrating vectors. Journal of Economic Dynamics and Control, 12, 231-254.

Kao, C. (1999), Spurious regression and residual-based tests for cointegration in panel data. Journal of Econometrics, 90, 1-44.

Leitão, N.C. (2014), Economic growth, carbon dioxide emissions, renewable energy and globalization. International Journal of Energy Economics and Policy, 4(3), 391-399.

Levin, A., Lin, C.F., Chu, C. (2002), Unit root tests in panel data: Asymptotic and finite-sample properties. Journal of Econometrics, 108, 1-24.

Maddala, G.S., Wu, S.A. (1999), Comparative study of unit root tests with panel data and a new simple test. Oxford Bulletin of Economics and Statistics, 108, 1-24.

Menegaki, A.N. (2011), Growth and renewable energy in Europe: A random effect model with evidence for neutrality hypothesis. Energy Economics, 33, 257-263.

Ocal, O., Aslan, A. (2013), Renewable energy consumption-economic growth nexus in Turkey. Renewable and Sustainable Energy Reviews, 28, 494-499.

Ozturk, I. (2010), A literature survey on energy-growth nexus. Energy Policy, 38(1), 340-349.

Pao, H.T., Fu, H.C. (2013), The causal relationship between energy resources and economic growth in Brazil. Energy Policy, 61, 793-801.

Payne, J.E. (2010), Survey of the international evidence on the causal relationship between energy consumption and growth. Journal of Economic Studies, 37, 53-95.

Rafindadi, A.A., Ozturk, I. (2017), Impacts of renewable energy consumption on the German economic growth: Evidence from combined cointegration test. Renewable and Sustainable Energy Reviews. Elsevier: In Press.

RN21. Renewables 2012 Global Status Report. Available from: http://www.ren21.net.

Tugcu, C.C., Ozturk, I., Aslan, A. (2012), Renewable and non-renewable energy consumption and economic growth relationship revisited: Evidence from G7 countries. Energy Economics, 34(6), 1942-1950.

Tugcu, T. (2013), Disaggregate energy consumption and total factor productivity: A cointegration and causality analysis for the Turkish economy. International Journal of Energy Economics and Policy, 3, 307-314.

Yildirim, E., Sarac, S., Aslan, A. (2012), Energy consumption and economic growth in the USA: Evidence from renewable energy. Renewable and Sustainable Energy Review, 16, 6770-6774.