Renewable and Sustainable Energy Reviews 52 (2015) 534–546

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

The relationship between economic growth and electricity consumption from renewable and non-renewable sources: A study of Turkey

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ARTICLE INFO

Article history:
Received 4 January 2015
Received in revised form
1 July 2015
Accepted 28 July 2015
Available online 25 August 2015

Keywords:
Economic growth
Renewable and non-renewable electricity consumption
Energy consumption
ARDL approach
Granger causality

ABSTRACT

The main objective of this study is to analyze the short and long run estimates as well as the causality relationships between economic growth (GR), electricity consumption from renewable sources (RELC) and electricity consumption from non-renewable sources (NRELC) for Turkey in a multivariate model wherein capital (*K*) and labor (*L*) are included as additional variables. Using the autoregressive distributed lag (ARDL) approach to cointegration, the Johansen cointegration test and the Gregory–Hansen cointegration test with structural break, we show that GR, RELC, NRELC, *K* and *L* are cointegrated. Although NRELC has a long run positive effect on GR, the long run estimate of RELC is negative but insignificant at 5% level of significance. The Granger causality test based on the vector error correction model reveals the evidence of neutrality hypothesis between RELC and GR, and between NRELC and GR in Turkey in the short run. In addition, the Granger causality runs from RELC, NRELC, *K* and *L* to GR as well as from GR, RELC, *K* and *L* to NRELC in the long run, which supports the existence of growth hypothesis between RELC and GR, and feedback hypothesis between NRELC and GR in the long run. It is advised that policy makers in the Turkish government should continue to reduce the share of electricity consumption from renewable sources and encourage the usage of electricity from non-renewable sources to have sustainable long run growth rates. It is also essential to promote the investment projects to increase the efficiency of electricity generation from non-renewable sources.

Contents

1. Introduction

Energy has served as an important source of economy for many decades. For instance, a variety of energy (i.e., natural gas, diesel, coal and electricity) is consumed to running vehicles, machines and devices, to producing goods, to fertilizing and irrigating lands, and harvesting crops, and to lighting up and heating apartments, buildings and factories. Since the use of energy is involved in each step of the process, producers' productivity and people's welfare within countries are likely to go down in the lack of energy. Thus, a large number of research studies have analyzed the relationship

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http://dx.doi.org/10.1016/j.rser.2015.07.130

between energy consumption (EC) and economic growth (GR) for a variety of countries and regions to show whether or not EC has statistically significant impact on GR, vice versa, by constructing several different econometric models (Ozturk [1], Smyth and Narayan [2], Dogan [3]).

Recently, studies in the energy-growth literature focus on the omitted-variable bias problem which arises when one or more relevant explanatory variables are ignored in the estimated model makes the estimation results biased and inconsistent (Wooldridge [4]). The recent studies, by including several relevant additional variables (i.e., capital and labor) into a multivariate model in order to eliminate the potential omitted-variable bias problem, usually found different cause-effect (causality) relationship between EC and GR than those used the simple bivariate model (Dogan [5]). In detail, the simple bivariate model refers to a model at which economic growth is regressed solely on energy consumption, and a multivariate model refers to a model at which economic growth is regressed on energy consumption in addition to one or more relevant variables such as capital, labor, trade and energy prices. A brief comparison between the findings of studies used the bivariate and multivariate models are provided to understand the concept clearly. Soytas and Sari [6] found the evidence of no cause-effect relationship (no causality) between EC and GR for the USA and the UK using the bivariate model, whereas Soytas and Sari [7] supported that the changes in EC and GR simultaneously impacted each other (bidirectional causality) for the same countries in a multivariate analysis wherein capital and labor were included as additional variables. In addition, Ozturk and Acaravci [8] revealed that the changes in economic growth affected energy consumption, not vice versa, (unidirectional causality ran from economic growth to energy consumption) for Oman using GR and electricity consumption (ELC) in the bivariate model; however, Al-Mulali and Ozturk [9] supported that the changes in energy consumption impacted economic growth, not vice versa, (unidirectional causality ran from energy consumption to economic growth) for the same country employing GR, ELC, capital, labor, export and import in a multivariate framework. Furthermore, Wolde-Rufael [10] reported different causality directions for thirteen of seventeen countries in the multivariate model by accounting for capital and labor in addition to economic growth and energy consumption as opposed to Wolde-Rufael [11] that analyzed the linkage between EC and GR for the same 17 countries in the bivariate model. Moreover, Lutkepohl [12] noted that no-causality between the variables could be found in the bivariate framework owing to the relevant omitted variables. Lean and Smyth [13] argued that EC was not the only element impacting economic growth.

In addition to those dealing with the omitted-variable bias problem, a number of studies disaggregated energy into types (i.e., nuclear energy, natural gas, coal and electricity) and sources (i.e., renewable and non-renewable). The purpose behind the disaggregation is to find out whether the short and long run coefficient estimates, and the direction of causality for the listed energy types and sources differ from each other. This kind of diversity among research studies in the energy-growth literature makes sense as it brings out interesting outcomes for the policy makers and governments which should formulate different strategies and policies for each of energy types and sources in order to reach sustainable growth rates. For the sake of empirical clarification, let us consider the case of France. Lee [14] found one-way (unidirectional) causality running from GR to EC at the aggregate level; Lee and Chiu [15] exposed no causality between economic growth and nuclear energy consumption; Bildirici et al. [16] indicated that causality ran from economic growth to electricity consumption; Shahbaz et al. [17] revealed two-way (bidirectional) causal relationship between GR and natural gas consumption. As is clear from the mentioned-articles, policy makers in France are advised to encourage natural gas consumption for the sake of GR; however, they would presumably regulate an inconsistent energy policy if they were to rely on the results based on the aggregate data.

The descriptions of hypothesis commonly used in the energy-growth literature are given in Table 1 in advance to elaborating the findings of existing studies. As seen in Table 2, a lot of studies have investigated the relationship between economic growth and a type of disaggregated energy consumption; namely, electricity consumption, for various countries, regions and economic groups by using either the bivariate or multivariate framework. As Smyth and Narayan [2] claim that there is a trade-off between the usage of bivariate and multivariate models such that the bivariate model is likely to suffer from omitted-variable bias problem while a multivariate model can suffer from over-parameterization problem. Researchers are left to take their decision on which model they are willing to use constrained by the possible aforementioned concerns. Starting with the bivariate model in which economic growth is the response variable and aggregate electricity consumption is the predictor variable, Altinay and Karagol [18] supported the evidence of growth hypothesis in Turkey by employing the Dolado–Lutkepohl test and the Granger causality tests from 1950–2000. Aslan [19] showed the presence of neutrality hypothesis and feedback hypothesis in Turkey in the short run and long run, respectively, by applying the autoregressive distributed lag approach (ARDL) and the Granger causality tests to an annual data 1968–2008. Shiu and Lam [20] found the existence of growth hypothesis both in the short run and long run in China from 1971–2000 by employing the Granger causality tests. Ozturk and Acaravci [21] did not find a long run relation between economic growth and aggregate electricity consumption in a panel study of 15 transition economies by applying the Pedroni panel cointegration test to an annual data from 1990–2006. Yoo [22] revealed the existence of feedback hypothesis for Malaysia and Singapore, and conservation hypothesis for Indonesia and Thailand by using the Engle-Granger cointegration and the Granger causality tests for the years of 1971–2002. Squalli[23] focused on OPEC members and supported the evidence of growth hypothesis for Indonesia, Nigeria, United Arab Emirates and Venezuela, conservation hypothesis for Algeria, Iraq, Kuwait and Libya, and feedback hypothesis for Iran, Qatar and Saudi Arabia by applying the ARDL and the Granger causality tests to an annual from 1980–2003. Wolde-Rufael [24] analyzed 17 African countries by using the ARDL and the Granger causality tests for 1971–2001 period, and found the presence of conservation hypothesis for Cameroon, Ghana, Nigeria, Senegal, Zambia and Zimbabwe, growth hypothesis for Benin, Congo and Tunisia, and feedback hypothesis for Egypt, Gabon and Morocco.

Most studies have recently used a multivariate model at which economic growth is regressed on aggregate electricity

Table 1
Some useful definitions.

Neutrality hypothesis implies that there is no causal-effect relationship (no causality) between economic growth and energy consumption.
Growth hypothesis implies that unidirectional causality only runs from energy consumption to economic growth.
Conservation hypothesis implies that unidirectional causality only runs from economic growth to energy consumption.
Feedback hypothesis implies that bidirectional causality exists between energy consumption and economic growth.