Energy Economics 38 (2013) 24–31

Contents lists available at SciVerse ScienceDirect

Energy Economics

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

Is the energy-led growth hypothesis valid? New evidence from a sample of 85 countries

Nicholas Apergis [a,*], Chor Foon Tang [b]

[a] Department of Banking and Financial Management, University of Piraeus, Greece
[b] Department of Economics, Faculty of Economics and Administration, University of Malaya, Malaysia

ARTICLE INFO

Article history:
Received 9 July 2012
Received in revised form 11 February 2013
Accepted 15 February 2013
Available online 27 February 2013

JEL classification:
Q43
C33

Keywords:
Energy-led growth
TYDL causality
Logit model
85 countries

ABSTRACT

The energy-growth literature contains a large number of discussions on the causal relationship between energy consumption and economic growth. The central debate focuses on whether energy consumption contributes or not to economic growth since it has direct implications for the formulation of strategic policies. Nevertheless, current studies cannot provide a conclusive suggestion due to mixed causality results. This inconclusive evidence is potentially attributed to model specifications and the stage of economic development of the countries under investigation. Hence, this study attempts to empirically re-investigate the validity of the energy-led growth hypothesis using a different model specification and different stages of economic development for 85 selected countries around the globe. Overall, although the causality results are mixed among countries, we do find a systematic pattern. In particular, Granger causality models with three and four variables are more likely to support the hypothesis compared to their counterparts that contain only two variables. In addition, both developed and developing countries are more likely to support the energy-led growth hypothesis compared to the less developed or low income countries. Therefore, causality results are very sensitive to the choice of the model specification along with the stages of economic development. Finally, energy conservation policies should only focus on low income countries as these policies may not retard the process of economic growth.

1. Introduction

To achieve high and sustainable economic growth is a major concern for practically every policymaker around the world. Over the past decades, energy has been one of the fastest growing factors of production used, particularly, in the developing countries. Hence, the causal relationship between energy consumption and economic growth has been a relevant topic in a growing body of the empirical research in many countries. Jumbe (2004) and Squalli (2007) narrate that comprehending the actual direction of causality between energy consumption and economic growth has substantial implications for policymakers as well as for the natural environments.

In terms of the causality methodology, there are two main hypotheses under investigation: the energy-led growth hypothesis and the growth-led energy hypothesis. Within this framework, Granger-causality gives rise to four alternative cases. In particular, causality may result in: i) unidirectional causality from energy consumption to economic growth (the growth hypothesis), ii) unidirectional causality from economic growth to energy consumption (the conservation hypothesis), iii) bi-directional causality from energy consumption to economic growth (the feedback hypothesis), and iv) no causality between energy consumption and economic growth (the neutrality hypothesis). However, according to Bartleet and Gounder (2010), it is more important to investigate the validity of the growth hypothesis because it is getting more difficult for policymakers to implement energy conservation policies, especially for energy dependent countries, and, thus, efforts to reduce energy consumption are potentially harmful for economic growth.

If energy consumption Granger-causes economic growth, then energy conservation policies aiming at protecting the environment are expecting to deteriorate the current stage of economic growth. In addition, if economic growth Granger-causes energy consumption, energy conservation policies can be implemented to reduce carbon dioxide (CO2) emissions and global warming without deleterious effects on the process of economic growth. Apparently, comprehending the direction of causality between energy consumption and economic growth is not only important for policymakers to enhance economic growth, but it is also important for them to converse energy consumption to reduce both CO2 emissions and global warming. Given the policy relevance of testing Granger causality between energy consumption and economic growth, a vast number of empirical works has been conducted on the issue. Nonetheless, it is hard to convince that findings of earlier studies have reached a consensus (Ozturk, 2010; Payne, 2010). To this reason, earlier studies cannot provide accurate recommendations to policymakers to design effective policies in order to stimulate economic growth and/or to safeguard the environment.

* Corresponding author at: Department of Banking & Financial Management, University of Piraeus, 80 Karaoli & Dimitriou, 18534 Piraeus, Greece.
E-mail address: napergis@unipi.gr (N. Apergis).

0140-9883/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.eneco.2013.02.007

The primary goal of this paper is to revisit the validity of energy-led growth hypothesis for 85 countries using the Toda–Yamamoto–Dolado–Lütkepohl (TYDL) causality test (Dolado and Lütkepohl, 1996; Toda and Yamamoto, 1995). The novelties of this study are threefold. First, this is the most encompassing study on the causal relationship between energy consumption and economic growth, covering 85 countries at different stages of economic development, i.e. 34 high-income, 18 upper middle-income, 24 lower-middle income and 9 low-income. Second, to check the robustness of causality results, we reinvestigate the validity of energy-led growth hypothesis using bivariate, trivariate and multivariate models. This is the first time where a study on energy-led growth hypothesis considers a large group of countries with different model specifications. To strengthen our results, we also adopt a rigorous statistical approach — a logistic regression method to analyze the effects of model specification and the stages of economic development on the likelihood whether the energy-led growth hypothesis is valid. Karanfil (2009) and Ozturk (2010) highlight that studies that merely change the data span without innovating on the model specification have no significant contribution to the energy-growth literature. Moreover, they also document that these studies only increase the number of conflicting causality results and make the policymaking more uncertain. By applying the logistic regression method, we can measure the possibility of conflicted causality results attributed to model specifications and the stages of economic development.[1] Our results are expected to be of very high importance in terms of the effective design and implementation of energy and environmental policies, especially when certain countries included in our sample do not pay any serious attention on environmental issues.

The structure of the remaining paper is organized as follows. The insights from the previous empirical literature are presented in Section 2. Section 3 provides some discussion on the data, the empirical model and methodological issues used in this study. Next, the empirical results are reported in Section 4. Finally, Section 5 presents the concluding remarks along with certain policy implications.

2. Literature review

Studies on the causal relationship between energy consumption and economic growth have received widespread attention in the energy economics as well as the environmental literature, following the seminal work of Kraft and Kraft (1978) in the United States. However, the causal relationships between energy consumption and economic growth remain yet an unsolved conundrum. Ozturk (2010) and Payne (2010) provide comprehensive surveys for the energy-growth nexus. A perusal of energy-growth literature reveal that a strand of the literature support the view that energy consumption Granger-causes economic growth (Ang, 2007; Apergis and Payne, 2009, 2010a, 2010b, 2010c; Mishra et al., 2009; Stern, 1993), while another strand argues that economic growth does not result from energy consumption (Cheng and Lai, 1997; Karanfil, 2009; Payne, 2009; Yu and Jin, 1992). If the former case applies, then economic growth is dependent on energy consumption; thus, any decreases in energy consumption are expected to restrain economic growth (Yuan et al., 2010; Zhang and Cheng, 2009). By contrast, the literature has provided evidence that under certain conditions, any increases in energy consumption have negative effects on economic growth; this fact is attributed to the pattern of economic growth that requires decreasing amounts of energy, as production shifts toward sectors that require less energy (i.e. services) or to the provision of energy to sectors that suffer from capacity constraints and less efficiencies (Pradhan, 2012). On the other hand, the presence of bi-directional causality indicates that the two variables are interrelated and satisfy a complementarily association, implying that higher energy consumption levels do not generate any harmful effects on economic growth (Hatemi-J and Irandoust, 2005). Finally, in terms of the absence of any causality between them, the findings provide support for the neutrality hypothesis, implying that energy conservation policies have no adverse impact on economic growth (Paul and Bhattacharya, 2004). Belloumi (2009) also asserts that the neutrality hypothesis implies that the cost of energy is negligible and it does not affect the economic growth process.

Evidently, it is hard to convince that the Granger causality findings of previous empirical studies have reached a general consensus. These uncertain causality results are rationalized by the heterogeneity in data spans, causality techniques, model specifications, lag order choices, and country's characteristics, such as the stages of economic development (Lütkepohl, 1982; Masih and Masih, 1997, 1998; Ozturk, 2010; Payne, 2010).

With reference to a country's characteristics, the majority of the studies focus on developed and industrialized countries due to the availability and reliability of data (Payne, 2010). In this respect, the empirical literature for the less developed countries is inadequate, even though the use of energy mushroomed over the near past. Narayan and Prasad (2008) identify that energy consumption and economic growth are not related in 22 out of 30 selected OECD countries. By contrast, in the remaining 8 OECD countries the evidence reveals that Granger causality runs from energy consumption to economic growth. Chontanawat et al. (2008) re-investigate the causal relationship between energy consumption and economic growth for 30 OECD countries and 78 non-OECD countries. In contrast to the Narayan and Prasad (2008) study, they find that 70% of the selected OECD countries display that energy consumption Granger-causes economic growth, while only 46% of the selected non-OECD countries support this evidence. Astonishingly, the study finds that the energy-led growth hypothesis is valid in 69% of the high-development countries, 42% of the middle-development countries and 35% of the low-income countries. Huang et al. (2008) find that energy consumption and economic growth are neutrally caused in the low-income countries, while uni-directional causality runs from economic growth to energy consumption in the middle- and high-income countries.

With respect to the model specification, we identify that the previous studies use bivariate, trivariate and multivariate models to test the causality between energy consumption and economic growth. However, studies with bivariate models (Chontanawat et al., 2008; Hwang and Gum, 1991; Masih and Masih, 1996; Murry and Nan, 1994; Narayan and Prasad, 2008; Tang, 2008) are equally compared to the studies with trivariate and multivariate models (Chandran et al., 2010; Chang et al., 2001; Mishra et al., 2009; Shahbaz et al., 2011; Tang, 2009; Tang and Tan, 2012). The main motivation of these studies to use trivariate or multivariate models is to avoid potentials problems caused by the omitted variable bias in a bivariate model specification (Lütkepohl, 1982). In this respect, Karanfil (2009) states that Granger causality testing in a bivariate model is problematic and he recommends the inclusion of new variables into the model to increase reliability. An astonishing finding that emerges at this stage of literature survey is that the causality results are inconsistent across model specifications, particularly, in bivariate and multivariate models.

Another strand of the literature employs panel data to provide further evidence on the investigated relationship. In particular, Lee (2005) makes use of a multivariate model and through panel cointegration and causality tests shows both in the short- and in the long-run causality runs from energy consumption to GDP. Menegaki (2011) also makes use of a multivariate panel framework and a random effect model to examine the impact of renewable

[1] One may argue that causality results are sensitive to the choice of data span and causality tests (Chowdhury, 1987). However, this is beyond the scope of this study. To control the effects of data span and causality tests on the likelihood of the validity of the energy-led growth hypothesis, this study makes use of only one causality test, while it maintains the sample period from 1975 to 2007 for all countries within the sample.