Renewable and non-renewable energy consumption and economic growth relationship revisited: Evidence from G7 countries

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ABSTRACT

The aim of this study is to investigate the long-run and causal relationships between renewable and non-renewable energy consumption and economic growth by using classical and augmented production functions, and making a comparison between renewable and non-renewable energy sources in order to determine which type of energy consumption is more important for economic growth in G7 countries for 1980–2009 period. Autoregressive Distributed Lag approach to cointegration was employed for this purpose. Also, causality among energy consumption and economic growth was investigated by employing a recently developed causality test by Hatemi-J (2012). The long-run estimates showed that either renewable or non-renewable energy consumption matters for economic growth and augmented production function is more effective on explaining the considered relationship. On the other hand, although bidirectional causality is found for all countries in case of classical production function, mixed results are found for each country when the production function is augmented.

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1. Introduction

Energy consumption and economic growth nexus is one of the most popular topics in the literature of energy economics (Ozturk, 2010; Payne, 2010). One of the reasons behind focusing on this topic is that energy consumption shows considerable promise understanding the role of energy consumption in economic growth. At the first glance, the link between energy consumption and economic growth is clear. However, the empirical outcomes of the studies which investigate the relationship between these variables are sometimes inconsistent with each other. According to Ozturk (2010), using different data sets, alternative econometric methodologies and different countries' characteristics are the main reasons of this conflicting result.

If one looks at the studies, it is seen that the relationship between energy consumption and economic growth is set around four different hypotheses (Apergis and Payne, 2009a, 2011b; Bowden and Payne, 2010; Ewing et al., 2007; Lee, 2006; Ozturk, 2010; Payne, 2010; Soytas and Sari, 2003):

i) *The growth hypothesis* refers to a situation in which energy consumption plays a vital role in the economic growth process directly and/or as a complement to capital and labor. *The growth hypothesis* is supported, if uni-directional causality is found from energy consumption to economic growth. In this case, energy conservation policies aimed at reducing energy consumption will have negative impacts on economic growth.

ii) *The conservation hypothesis* means that economic growth is the dynamic which causes the consumption of energy sources. The validity of *the conservation hypothesis* is proved if there is uni-directional causality from economic growth to energy consumption. In this situation, energy conservation policies which may prevent energy consumption will not have negative impact on economic growth.

iii) *The feedback hypothesis* states a mutual relationship among energy consumption and economic growth. *The feedback hypothesis* is supported if there exists bi-directional causality between energy consumption and economic growth. In case of the validity of this hypothesis, energy conservation policies designed to reduce energy consumption may decrease

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economic growth performance, and likewise, changes in economic growth are reflected back to energy consumption.

iv) *The neutrality hypothesis* indicates that energy consumption does not affect economic growth. The absence of causality between energy consumption and economic growth provides evidence for the presence of *the neutrality hypothesis.* In this case, energy conservation policies devoted to reducing energy consumption will not have any impact on economic growth.

Another reason, which conducts researchers to focus on the link between energy consumption and economic growth, is the vision of sustainable development. The fact that many countries agreed on conserving energy and reducing CO_2 emissions has increased the attractiveness of energy consumption related studies. However, the key dynamic in those studies is the consumption of renewable energy sources. With the growing importance of sustainable development, researchers have interested more in the effects of renewable energy consumption on economic growth and renewable energy sources have begun to be seen as one of the most important components in the total energy consumption of the World.

In this regard, this study aims at investigating the long-run and causal relationships between renewable and non-renewable energy consumption and economic growth, and making a comparison between renewable and non-renewable energy sources in order to determine which type of energy consumption is more important for economic growth in G7 countries for 1980–2009 periods. The reason for choosing G7 countries as sample is that, G7 economies are the one who consumes 36.6% of World's total energy production, and causes 33.7% of World's total CO_2 emissions, in average terms, over the period 2000–2008 (WDI, World Development Indicators 2012).

The paper is organized as follows: Next section is devoted to the literature and novelty. Section 3 presents the data, methodology and results. Finally, Section 4 concludes.

2. Literature review

The idea that energy consumption is one of the basic indicators of economic development (Halicioglu, 2009) has attracted economists to deal with the studies which try to explain the interrelations between energy consumption and economic growth. Thus, energy consumption and growth nexus has a growing literature since the seminal study of Kraft and Kraft (1978).

It is possible to classify the considered literature under three strands. The first strand includes studies which investigate the relationship between (dis)aggregate energy consumption and economic growth without making any qualitative discrimination (see in Table 1). In this context Chontanawat et al. (2008), Narayan and Smyth (2008), Apergis and Payne (2009a), Bowden and Payne (2009), and Apergis and Payne (2010b) proved the validity of *the growth hypothesis*; Apergis and Payne (2010a), Belke et al. (2011), Eggoh et al. (2011), Fuinhas and Marques (2011), and Kaplan et al. (2011) proved the validity of *the feedback hypothesis*; Lise and Montfort (2007) and Huang et al. (2008) proved the validity of *the conservation hypothesis*, and Soytas et al. (2007) proved the validity of *the neutrality hypothesis.* On the other hand, Apergis and Payne

Table 1
Summary of recent literature review for energy consumption and economic growth.

Study	Methodology	Period	Country	Confirmed hypothesis
Lise and Montfort (2007)	Vector error correction model	1970–2003	Turkey	Conservation
Soytas et al. (2007)	Toda–Yamamoto procedure	1960–2004	US	Neutrality
Huang et al. (2008)	Generalized Method of Moment System	1972–2002	82 countries	Conservation
Chontanawat et al. (2008)	Granger causality	1971–2000	30 OECD and 78 non-OECD countries	Growth
Narayan and Smyth (2008)	Panel Cointegration and Granger causality	1972–2002	G7	Growth
Apergis and Payne (2009a)	Panel Cointegration and Granger causality	1980–2004	Six Central American countries	Growth
Bowden and Payne (2009)	Toda–Yamamoto procedure	1949–2006	US	Growth
Apergis and Payne (2010b)	Panel Cointegration and Granger causality	1980–2005	Nine South American countries	Growth
Apergis and Payne (2010a)	Panel cointegration and fully modified OLS	1992–2004	11 Common wealth of independent states	Feedback
Belke et al. (2011)	Panel cointegration Vector error-correction model Granger causality	1981–2007	25 OECD countries	Feedback
Eggoh et al. (2011)	Panel cointegration and Panel Causality Tests	1970–2006	21 African countries	Feedback
Fuinhas and Marques (2011)	Autoregressive distributed lag (ARDL)	1965–2009	Portugal, Italy, Greece, Spain and Turkey	Feedback
Kaplan et al. (2011)	Johansen and Juselius cointegration, Granger causality	1971–2006	Turkey	Feedback
Soytas and Sari (2003)	Cointegration and vector error correction techniques	1950–1992	Top 10 emerging markets and the G-7 countries	Growth, the feedback and the conservation
Soytas and Sari (2006)	Johansen and Juselius cointegration and causality tests	1960–2004	G-7 countries	Growth, the feedback and the conservation
Lee (2006)	Toda–Yamamoto procedure	1947–1974	11 major industrialized countries	Feedback, the conservation and the neutrality
Akinlo (2008)	Autoregressive distributed lag (ARDL)	1980–2003	11 Sub-Sahara African countries	Feedback, the conservation and the neutrality
Apergis and Payne (2009b)	Panel Cointegration and Granger causality	1991–2005	11 Common wealth of Independent States	Growth and the feedback
Belloumi (2009)	Granger causality test	1971–2004	Tunisia	Growth and the feedback
Ozturk et al. (2010)	Panel cointegration and Panel Causality Tests	1971–2005	51 countries	Feedback and the conversation