



Energy consumption and economic growth: A causality analysis for Greece

Stela Z. Tsani*

The University of Reading, Department of Economics, Henley Business School, PO Box 218, Reading, RG6 6AA, UK

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ABSTRACT

This paper investigates the causal relationship between aggregated and disaggregated levels of energy consumption and economic growth for Greece for the period 1960–2006 through the application of a later development in the methodology of time series proposed by Toda and Yamamoto (1995). At aggregated levels of energy consumption empirical findings suggest the presence of a uni-directional causal relationship running from total energy consumption to real GDP. At disaggregated levels empirical evidence suggests that there is a bi-directional causal relationship between industrial and residential energy consumption to real GDP but this is not the case for the transport energy consumption with causal relationship being identified in neither direction. The importance of these findings lies on their policy implications and their adoption on structural policies affecting energy consumption in Greece suggesting that in order to address energy import dependence and environmental concerns without hindering economic growth emphasis should be put on the demand side and energy efficiency improvements.

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1. Introduction

Recent experiences with unprecedented high levels of energy prices, especially of oil prices and the commitment to international initiatives on reduction of greenhouse gas emissions such as the Kyoto protocol have revitalized the debate on the implementation of energy conservation policies. In this context, policies aiming at the gradual curtailing of energy needs have to consider the potential causal linkages between economic growth and energy consumption. Into this direction empirical research dating back to the 1970s and the first energy crisis offers an extensive and significant volume of investigation. The empirical focus has concentrated on whether economic growth boosts energy consumption or whether energy consumption takes precedence over economic growth. The investigation and the understanding of the direction of the causality between energy consumption and economic growth are of great value due to their policy implications. The existence of any causal relationships running from energy consumption to economic growth would indicate the dependence of the economy on energy with the latter being a stimulus to economic growth. In the presence of such causal relationships any structural policies aiming at the reduction of energy consumption like the policies following the Kyoto protocol or the recent surge in the fuel prices might possibly slow economic growth.

This paper takes a fresh look at the causal relationship between energy consumption and economic growth for Greece for the period

1960–2006. The empirical investigation is conducted with the employment of a later development in the methodology of time series proposed by Toda and Yamamoto (1995). The aim is to identify the causal linkages between energy consumption and economic growth and to further assess the degree of energy consumption dependence for Greece overcoming limitations possibly present in earlier assessments. In addition to this we chose Greece, a medium sized economy, as an example to our empirical investigation with the aim to draw conclusions that could be further useful for the analysis of other small and medium sized economies like Portugal, Ireland, Spain, Malta, Luxemburg, Belgium and Cyprus all of the latter being countries faced with similar energy conservation policies deriving from commitments to international initiatives such as the Kyoto protocol and high levels of dependence on energy imports. Aiming at a rich insight on the causal relationships between energy consumption and economic growth, consumption patterns are assessed at aggregated as well as at disaggregated levels accounting for the energy consumption of the industrial, transport and residential sectors.

At aggregated levels the findings remain important as heavy dependence of the country on energy consumption would render it weak to adverse effects on economic growth that environmental policies and energy conservation initiatives could cause. At disaggregated levels the findings help us understand better the relative importance that each sector bears as a causal factor of economic growth providing us at the same time with a clearer picture of the developments on energy consumption patterns across time and sectors and of their subsequent interactions with economic growth. The assessment of the relationship between energy consumption and economic growth in the case of a medium size country like Greece

* Tel.: +44 118 378 6637; fax: +44 118 378 6274.
E-mail address: s.cani@reading.ac.uk.

remains interesting in the context of serving as a representative empirical investigation case where practical conclusions could serve as the basis for further comparative analysis. In addition the employment of a later methodology in time series analysis could complement previous studies looking on the causal relationships between energy consumption and economic growth for Greece overcoming their methodological limitations.

The theoretical approaches to date regarding the relationship between energy consumption and economic growth offer different models. In the traditional neo-classical growth model energy is introduced as an intermediate input next to the basic factors of land, labor and capital contributing to economic growth both directly and/or indirectly (Akarka and Long, 1979; Stern, 1993; Stern, 2000; Payne, 2008; Yuan et al., 2008). On the biophysical approach energy becomes an important determinant of income with economies depending significantly on energy being affected heavily by changes in energy consumption (Cleveland et al., 1984). Following different theoretical approaches empirical investigations in the literature to date on the nature and the direction of the causal relationships between energy consumption and economic growth yield various and often contradictory results. The plethora of the latter appears to be the outcome of a diverse set of samples studied with different characteristics in each case, a variety of variables included, as well as of the implementation of different econometric approaches developed.

The pioneer work of Kraft and Kraft (1978) with the application of a standard Granger (1969) test finds a uni-directional long-run relationship running from GDP to energy consumption in the USA for the period 1947–1974. Yu and Hwang (1984) employing the same methodology find no causality in the case of the USA for the period 1947–1979. Ever since, empirical investigations extended to developed and developing countries yielding mixed and often contradictory results. Yu and Choi (1985) employ the standard Granger (1969) test for the period 1954–1976 for a set of countries finding that causality runs from GDP to energy consumption for Korea, causality runs in the opposite direction for the Philippines while no causality is identified in the case of the USA, Poland and UK. Erol and Yu (1987) find the uni-directional relationship running from energy consumption to growth for Japan for the period 1950–1982.

Employing the same test for Taiwan, Hwang and Gum (1992) for the period 1955–1993 and Yang (2000) for the period 1954–1997 find a bi-directional causal relationship between energy consumption and economic growth. Similarly Cheng (1997) and Wolde-Rufael (2004) find long-run causal relationship running from energy consumption to GDP in the case of Brazil for the period 1963–1993 and the case of Shanghai for the period 1952–1999 accordingly. Lee (2006) investigates the existence of causal relationships between energy consumption and economic growth for 11 developed countries for the period 1960–2001 deriving mixed results on the nature and the direction of causality. Cheng and Lai (1997) employ Hsiao's (1981) Granger causality test for Taiwan for the period 1995–1993. Their results in contrast to the work of Hwang and Gum (1992) and Yang (2000) suggest the causal relationship being uni-directional running from GDP to energy consumption. Chiou-Wei et al. (2008) apply both linear and nonlinear Granger causality tests to examine the causal relationship between energy consumption and economic growth for a sample of Asian newly industrialized countries as well as the USA for the period 1954–2006. Their study finds evidence supporting a neutrality hypothesis for the USA, Thailand, and South Korea. Moreover they find the existence of a uni-directional causality running from economic growth to energy consumption for Philippines and Singapore while energy consumption may have affected economic growth for Taiwan, Hong Kong, Malaysia and Indonesia. Chontanawat et al. (2008) test for causality between energy and GDP using a consistent data set and Granger test methodology for 30 OECD countries and 78 non-OECD countries. They find that causality from energy to GDP is found to be more prevalent in the developed OECD countries compared to the developing non-OECD

countries. In the light of these findings the existing literature fails to come to a consensus on the nature of causal relationships between energy consumption and economic growth. The conflicting and inconsistent results may be attributed to different frameworks of institutions, structures and policies adopted by the countries as well as to the different methodological applications employed.¹

The empirical investigation to date of the relationship between energy consumption and economic growth in the case of Greece offers a range of techniques employed looking mainly on energy demand associated to output and prices. Mitropoulos et al. (1982) employing Kalman filter techniques suggest that price elasticities behave as a cluster against energy demand. Samouilidis and Mitropoulos (1984) assess the interdependence of economic growth and energy consumption over the 1960s and the 1970s suggesting decreasing income and price elasticity of energy demand. Donatos and Mergos (1989) conclude that energy demand remains rather inelastic with respect to prices when looking at the developments over the period 1963–1984. In a more recent time framework Zonzilos and Losos (1996) and Christodoulakis and Kalyvitis (1998) yield similar results on energy demand being rather inelastic with respect to prices. Hondroyiannis et al. (2002) re-examine the relationship between energy consumption, output and prices for the period 1960–1996 looking at their interdependency through the employment of vector error-correlation model estimation. Their findings suggest the existence of a long-run relationship between energy consumption, output and prices.

The present attempt aims to complement the empirical investigations of the causal relationship between energy consumption and economic growth for Greece assessing recent developments of the latter and to overcome limitations present in the previous empirical approaches through the employment of a later technique proposed by Toda and Yamamoto (1995). Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996) develop an alternative procedure for testing the Granger causality in possibly integrated and cointegrated systems of any integration order through the employment of an augmented level Vector autoregression (VAR) model. In this way Granger causality tests can be performed allowing for the long-run information often ignored in systems that require first differencing and pre-whitening (Masih and Masih, 1999; Awokuse and Yang, 2003). Moreover the methodology may be preferred as it bypasses the need of unit root and cointegration pre-tests, tests that are often implemented in models like the vector error correlation model therefore overcoming the problems of biased pre-tests.

The rest of the paper is organized as follows. Section 2 reviews the developments of energy consumption and economic growth in Greece. Section 3 presents the data and the econometric specification employed. Section 4 summarizes the empirical investigation and the estimation results at both aggregated and disaggregated levels of energy consumption. The last section summarizes the conclusions of the analysis and discusses the policy implications.

¹ A significant amount of empirical work on the relationship between energy consumption and economic growth employ alternatives to the Granger test approaches but similarly results do not come to a general agreement. Employing error correlation models Yu and Jin (1992) investigate the case of USA for the period 1974–1990, finding no cointegration between energy consumption and economic growth. Masih and Masih (1996) and Masih and Masih (1997) find a bi-directional long-run relationship between energy consumption and economic growth in most of the countries examined while Soytas and Sari (2003) and Oh and Lee (2004) when employ the same model for a set of countries yield mixed results. In a panel vector error correlation model for 18 developing countries for the period 1975–2001 Lee (2005) identifies the causal relationship running from energy consumption to GDP. Apergis and Payne (2009) examine the relationship between energy consumption and economic growth for six Central American countries over the period 1980–2004 within a multivariate error correlation framework identifying the presence of both short-run and long-run causality from energy consumption to economic growth. Recent approaches of Zamani (2007), Lise and Van Montfort (2007), Mehrrara (2007) and Zachariadis (2007) employ bi-variate models but their findings still do not come to a general agreement on the nature of the relationship between energy consumption and economic growth.

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