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Energy consumption and economic growth nexus in Portugal, Italy, Greece, Spain and Turkey: An ARDL bounds test approach (1965–2009) ☆

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ABSTRACT

The paper examines the nexus between primary energy consumption and growth in Portugal, Italy, Greece, Spain and Turkey (PIGST), with annual time series data, from 1965 to 2009. PIGST are southern European economies which have experienced several episodes that make them of particular interest to the study of periods of economic expansion and stagnation. An ARDL bounds test approach is a suitable technique to examine energy-growth nexus, within the context of countries with both sporadic shocks (outliers) and permanent shocks (structural breaks). Empirical results suggest bidirectional causality between energy and growth in both the long-run and short-run, supporting the *feedback hypothesis*. The results reveal themselves to be robust to panel framework. An energy conservation policy will reduce GDP growth, while a saving phenomenon is observed, since one additional unit of product requires less than one unit of energy.

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1. Introduction

Working with lengthy time series has the advantage of enabling us to identify the nature of the relationships over time, especially if we are in the presence of long-term phenomena. Although energy-growth nexus has been the object of numerous empirical papers, the literature has not taken advantage of series beginning in the mid-1960s. For most countries, working on long time spans is advised to deal with shocks and economic regime shifts, such as political instability and international commitments. Indeed, if we do not take into account these outliers and structural breaks, then cointegration relations in energy-growth nexus could be masked. This is the reason why the models should to incorporate both impulse and shift dummies.

In general, the literature does not take into account that economic regime shifts, such as the membership of economic blocks or monetary union, could permanently change the nature of the energy–growth relationship (cointegration in the presence of a structural break), but not destabilize it (lack of cointegration). Indeed, the absence of these dummies could lead to the misinterpretation of causality, elasticities and cointegration between variables and, ultimately, lead to wrong policy measures.

We use the autoregressive distributed lag (ARDL) bounds test approach. This well tested econometric approach: (i) guarantees robust results; (ii) allows handling of a diverse number of optimal lags for different variables; and (iii) is not affected by the inclusion of “one-zero” dummy variables.

Portugal, Italy, Greece, Spain and Turkey (PIGST) are countries of southern Europe that have experienced periods of turbulence. This turbulence results from a mix of political and economic facts. Indeed, these countries had suffered coups, such as “The Carnation Revolution” (1974) in Portugal, “The Regime of the Colonels” (1974) in Greece, “Coup by Memorandum” (1971) and “The 12 September 1980 Turkish coup d'état” in Turkey; or attempted coups, such as Italy's “The Golpe Borghese” (1970), Spain's “Operación Galaxia” (1978), “23-F” (1981), and “The October 27, 1982 coup d'état attempt”. Most of them have undergone regime shifts from an authoritarian dictatorship to a democracy (Portugal, Greece, Spain and Turkey). Greece (1981), and Portugal and Spain (1986) become members of the European Economic Community and are, together with Italy, founding members of the Economic and Monetary Union (1999). These economies have experienced periods of strong growth and lengthy stagnation. Moreover, they also share strong energy dependency, which exposed them to the oil shocks of 1973 and 1979. It is highly probable that these former occurrences are being manifested in the forms of either shocks or structural breaks. For PIGST, the relationship between primary energy

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consumption (hereafter energy) and economic growth (hereafter growth) has been poorly studied. Their characteristics make it interesting to focus our analysis on these countries.

We innovate by exploring the potential of dummies to control for outliers and structural breaks through the use of ARDL bounds test. With impulse dummies and shift dummies, we show how it is possible and desirable to work upon distinctive characteristics of data. We assess the direction of causality, calculate the magnitude of short and long-run elasticities, and compute the cointegration equations between variables. Moreover, we add empirical evidence for a new set of countries.

As a whole, results suggest that growth is highly driven by energy in PIGST, since growth appears to be elastic in both the short and long term. The variables are cointegrated. Empirical support was found for the *feedback hypothesis*, since we obtained two cointegrating vectors: (i) one running from primary energy consumption to growth; and (ii) the other running from growth to primary energy consumption.

The remainder of the paper is organized as follows: Section 2 provides a brief review of energy-growth nexus; Section 3 describes the data, sets out the method and exposes the models; Section 4 analyzes the empirical results; Section 5 debates the robustness of the results; and Section 6 concludes.

2. Energy-growth nexus

There is a large body of literature focusing on the nexus between energy consumption and growth. The recent papers of Odhiambo (2010), Ozturk (2010), and Payne (2010) summarize that literature. Some of those studies focus on the analysis of a particular country (e.g. Lee and Chang, 2007; Wolde-Rufael, 2009), while others analyze groups of countries (e.g. Akinlo, 2008; Chiou-Wei et al., 2008). Nevertheless, as pointed out by Ozturk (2010), empirical outcomes on the direction of causality, and short and long-run impacts, seem to depend on data, countries' characteristics, and econometric methodologies.

The causal relationship between energy and growth has strong implications from the theoretical, practical and policy points of view. From an empirical standpoint, there are four possible hypotheses (Ozturk, 2010): (i) *growth hypothesis*, states a unidirectional causality running from energy to growth, implying that growth requires energy, and a drop off in energy will possibly restrain growth; (ii) *conservation hypothesis*, specifies a unidirectional causality running from growth to energy, denoting that a country is not fully dependent on energy for growth, and that energy conservation policies can be put into practice with few or no adverse effects on growth; (iii) *feedback hypothesis*, assumes bidirectional causality between energy and growth, since when the economy grows, energy demand increases, and the reverse is also true; and (iv) *neutrality hypothesis*, asserts that energy and growth are neutral with respect to each other, and implies that energy conservation policies have no effect on growth.

In the literature on energy-growth nexus, the option for either bivariate or multivariate model (e.g. Lean and Smyth, 2010; Wolde-Rufael, 2010) is usual. Empirical literature that considers long periods is scarce, which is possibly a consequence of a poor understanding of the countries' political and economic past. Their history could reveal shocks and economic regime shifts, i.e., the data could include outliers and structural breaks that must be corrected. The literature analyzing the energy-growth nexus, controlling for particular sporadic and permanent shocks by country (e.g. Zachariadis, 2007), is still scarce.

When structural breaks are found, it means that the coefficients of variables have changed and this occurrence cannot be overcome by the inclusion of more variables. In line with recent literature (e.g. Odhiambo, 2009; Ozturk et al., 2010; Paul and Uddin, 2010; Tsani, 2010), we use a bivariate model. In principle, multivariate models are only applied when it is not possible to detect causal relationships in bivariate models. A bivariate model may not detect the causality, but if it is detected, then there is no reason to incorporate more variables when the aim is to assess causality. Moreover, the bivariate models have the advantage of allowing straight interpretation of relationships between variables and dummies.

The ARDL bounds test approach, introduced by Pesaran and Shin (1999) and later extended by Pesaran et al. (2001), is extensively used in the literature of energy-growth (e.g. Odhiambo, 2009; Wolde-Rufael, 2010). This technique allows data to be handled in a flexible way, enabling it to overcome most of the shortcomings of alternative methodologies. The ARDL bounds test is robust for finite samples, even in the presence of phenomena of shocks and regime shifts. In practice, these phenomena could be modeled by using "one-zero" dummy variables. Furthermore, the technique allows conclusions to be drawn about cointegration among variables even with these dummies.

In the energy-growth nexus the presence of complex dynamic effects was expected. The interaction among the variables can be different in time, and may be delayed to a lesser or greater extent. In other words, the time responsiveness of variables may be different, which implies that the optimal lags for different variables could be dissimilar. The ARDL bounds test also allows a diverse number of optimal lags to be handled. Moreover, it does not impose a restrictive assumption that all variables should have the same integration order, which is very useful when the integration of variables is borderline I(0)/I(1).

3. Data, methodology and models

The study uses annual data for Gross Domestic Product (GDP) and primary energy consumption, for the time span 1965 to 2009. The sources of data are:—European Commission—Economic and Financial Affairs—Indicators—AMECO database, for GDP, at 2000 market prices; and—BP Statistical Review of World Energy (June 2010), for the primary energy consumption, in million tons oil equivalent. The data series for PIGST economies has 45 years of observations (a moderate number), revealing idiosyncratic outliers and structural breaks. As pointed out above, an adequate technique to handle these handicaps is the ARDL bounds test approach.

Let Y denote GDP, E denote primary energy consumption, L denote the natural logarithm, and D denote the first difference operator. Eqs. (1) and (2) are general equations in relating LE and LY, once stationarity or cointegration are verified:

$$LY_t = \theta_0 + \theta_1 t + \theta_2 LE_t + \mu_{1t}, \tag{1}$$

$$LE_t = \varphi_0 + \varphi_1 t + \varphi_2 LY_t + \mu_{2t}, \tag{2}$$

where θ_0 and φ_0 means the intercepts, t the trends, and μ_{1t} and μ_{2t} are the disturbance terms assuming white noise and normal distribution. If these relationships prove to be cointegrated, this assures the presence of causality and its direction. Furthermore, they provide information about long-run elasticities. Eqs. (1) and (2) could be converted into their equivalent autoregressive distributed lag and, if variables are cointegrated, into an unrestricted error-correction model (UECM). The general UECM could be specified in its equivalent ARDL bounds test Eqs. (3) and (4), as follows:

$$DLY_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{m} \alpha_{2i} DLY_{t-i} + \sum_{i=0}^{n} \alpha_{3i} DLE_{t-i} + \alpha_4 LY_{t-1} + \alpha_5 LE_{t-1} \mu_{3t}, \tag{3}$$

where the expected signs of the parameters are: $\alpha_0 \neq 0$; $\alpha_1 \neq 0$; $\alpha_{2i} \neq 0$; $\alpha_{3i} \neq 0$; $\alpha_4 < 0$; and $\alpha_5 \neq 0$. The parameters α_{2i} and α_{3i} explain the short-run dynamic coefficients, while α_4 and α_5 explain the long-run multipliers of the equation.

$$DLE_t = \beta_0 + \beta_1 t + \sum_{i=1}^{m} \beta_{2i} DLE_{t-i} + \sum_{i=0}^{n} \beta_{3i} DLY_{t-i} + \beta_4 LE_{t-1} + \beta_5 LY_{t-1} + \mu_{4t}, \tag{4}$$

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