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Re-investigating the electricity consumption and economic growth nexus in Portugal



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HIGHLIGHTS

- Electricity consumption and economic growth series in Portugal are cointegrated.
- There is evidence of feedback effects between the two variables.
- Energy is an important source of economic growth in Portugal.

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ABSTRACT

In the previous decades, a number of studies have been conducted to analyse the causal relationship between electricity consumption and economic growth in the Portuguese economy. However, the evidence remains controversial because the previous studies do not provide clear causality evidence. This might be attributed to the omitted variables bias because most previous studies only focus on the relationship between electricity consumption and economic growth in a bi-variate model. This paper attempts to re-investigate the relationship between electricity consumption and economic growth in Portugal using a multivariate model. Based on the bounds testing approach to cointegration and the Granger causality test within the vector error-correction model (VECM), our empirical results confirm the presence of cointegration among the variables. Moreover, there is evidence of bi-directional causality between electricity consumption and economic growth in the short- and long-run. This suggests that energy is an important source of economic growth in Portugal. Therefore, energy conservation policies should not be implemented because it would deteriorate the process of economic growth and development of the Portuguese economy.

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1. Background

Retrospectively, Kraft and Kraft (1978) was the first empirical work dealing with the causal relationship between energy consumption and economic growth. Their findings suggested strong uni-directional causality running from economic growth to energy consumption in the United States. These interesting findings motivated many researchers to replicate the causal relationship between energy consumption and economic growth at different countries and/or regions (Abosedra et al., 2009; Apergis and Payne, 2010; Li et al., 2008; Shahbaz and Lean, 2012b). The energy-growth nexus is of great interest because it has significant policy implications. For example, if the causality finding

supports the *growth hypothesis* that is uni-directional causality running from energy consumption to economic growth, then energy conservation policies may retard the process of economic growth. On the other hand, if the causality finding supports the *conservation hypothesis* that is uni-directional causality running from economic growth to energy consumption, then energy conservation policies may have less or no impact on economic growth. Hence, it is utmost important to verify the actual direction of causal relationship between the variables.

Although there are many studies have been conducted in this area, empirical analysis for Portugal is relatively scarce. As far as we know, only Murry and Nan (1994), Narayan and Prasad (2008), Chontanawat et al. (2008), Ciarreta et al. (2009) and Shahbaz et al. (2011) have investigated the energy-growth nexus in Portugal. Unfortunately, most of these studies examined the energy-growth nexus in a bi-variate framework. Consequently, those studies in bi-variate setting cannot find cointegration and long-run causality. Furthermore, the direction of causality between energy consumption and economic growth

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remains controversial. For example, Murry and Nan (1994) supported the *neutrality hypothesis* where energy consumption and economic growth does not Granger cause each other, but Narayan and Prasad (2008) and Chontanawat et al. (2008) exhibited that energy consumption Granger causes economic growth in Portugal. On the contrary, Ciarreta et al. (2009) found that economic growth Granger causes electricity consumption in Portugal instead of the other way around. Recently, Shahbaz et al. (2011) found bi-directional causality between electricity consumption and economic growth in Portugal. According to Lütkepohl (1982), Granger causality test with a bi-variate model tend to produce bias result due to omitted variable(s). Previous empirical studies reviewed by Ozturk (2010) and Payne (2010) also found that omitted variable(s) bias is the key factor explaining the ambiguous causality evidences among the energy-growth studies. Karanfil (2009) and Bartleet and Rukmani (2010) suggested to accommodate other important variables to analyse the energy-growth nexus.

Strictly speaking, relative price, foreign direct investment (FDI), trade openness and financial development are the potential variables affecting energy (or electricity) consumption and its relationship with economic growth. The theory of consumer behaviour emphasised that price is the key factor in demand function. Dunkerley (1982) and Hoa (1993) added that price of energy must not be ignored because it is very important in affecting income and the demand for energy. In opened economy, capitals and goods are highly mobilised due to the presence of FDI, foreign trade and the well functioning financial system. The inflows of FDI can affect energy consumption and economic growth via the expansion of industrialisation, transportation and manufacturing sectors (Tang, 2009). However, FDI is the main channel for technology transfer that may also help to use energy more efficiently. Next, both exports and imports activities (i.e. trade openness) can also influence the demand for energy and economic growth. For example, export expansion will increase the demand for energy use to operate the machines and equipments in production and transportation of export products. Likewise, the export expansion will also increase a country's economic output via specialisation in production of exports which can lead to higher degree of competition, economies of scale and technology transfer. With regard to imports, if more energy-intensive products like television, computer, automobile, air-conditioner and washing machine are imported, the demand for energy will also increase. However, the endogenous growth theory stipulated that imports can be a potential channel to promote economic growth by transferring technology and factors of production into the domestic economy. Finally, financial development is another important variable for energy consumption and economic growth. Sadorsky (2010, 2011) stressed that financial development is required to operate the equity market, allow easy access to financial capital for investment across countries, facilitate inflows of FDI and lower the financial risk and borrowing costs between lenders and borrowers. Financial development directly affects the energy consumption by improving the easy access of consumers and producers to financial resources offered by the banks at low interest rates to purchase the durable items like televisions, computers, refrigerators, washing machines, mobiles and air conditioners (Sadorsky, 2011; Shahbaz and Lean, 2012a). Hence, financial development will enhance economic efficiency and growth, which in turn affects the demand for energy. Nevertheless, financial development can also improve energy efficiency by lending money to support the development of energy savings industries and infrastructures.

In light of these compelling arguments, the purpose of this study is to fill the lacuna by re-assessing the nexus between electricity consumption and economic growth in Portugal using a multivariate model. This study contributes to the existing

energy-growth literature in several contexts. First, unlike the earlier studies in Portugal, we take into account other control variables such as relative price, FDI, trade openness and financial development to avoid the omitted variables bias. At best, these control variables have not been considered by the previous studies in Portugal. Therefore, this is the first study investigating the link between electricity consumption, economic growth, relative price, FDI, trade openness and financial development in Portugal. Second, the theoretical framework of this study is constructed based upon the theory of consumer behaviour rather than an ad hoc specification. By doing so, we have effectively married four catalysts of growth in a system—energy-led growth, trade-led growth, FDI-led growth and finance-led growth. Therefore, the results of this study are more robust, reliable and policy-orientated. Third, the existing studies (e.g. Chandran et al., 2010; Masih and Masih, 1997) used the price of energy, while this study uses the relative price of energy to non-energy goods as a control variable. Following the theory of consumer behaviour and Nordhaus (1979), consumer's decision-making does not only based upon the price of energy, but they will also consider the price of non-energy goods. Therefore, relative price of energy to non-energy goods is more comprehensive compared with the price of energy. Besides empirical modeling, another contribution of this study is to address the small sample property ($T=36$) by following Ozturk's (2010) recommendation to employ the bounds testing approach to cointegration advocated by Pesaran et al. (2001) to examine the presence of a long-run equilibrium relationship between electricity consumption, economic growth, relative price, trade openness, FDI and financial development in Portugal. The bounds testing approach cointegration is superior to other cointegration tests when the order of integration of the explanatory variables are either $I(0)$ or $I(1)$. Finally, the multivariate Granger causality test within the vector error-correction model (VECM) will be employed to verify the direction of Granger causality between the variables of interest. By doing so, we can obtain the dynamic relationship between the variables of interest and better policy recommendations pertaining to the Portuguese economy can be derived from the findings of this study.

The remainder of this study is structured as follows. Section 2 will review the electricity consumption and economic growth in Portugal. Section 3 presents the literature review. Section 4 sets out the theoretical framework, estimation procedures and data used in this study. Section 5 discusses the empirical findings and Section 6 will reports the conclusion and policy implications of this study.

2. The Portuguese economy

Among the European Union (EU) members, Portugal is one of the steadily growing European nations after joined the EU in 1986 and the European Monetary Union (EMU) in 1999. Over the past two decades, the Portuguese governments have privatised many state-controlled agencies and the economic structure has been diversified to services-based economy such as energy, transportation, finance and telecommunication sectors (Shahbaz et al., 2011). In order to facilitate the services-based economy, the transportation network and infrastructure must be modernised and improved (Brown, 2002). Such economic transformation has put enormous pressure on electricity consumption in Portugal. It is therefore, the demand for electricity in Portugal has grown substantially from 1875.5 million kilowatt hour (kW h) per capita in 1985 to approximately 4800 million kW h per capita in 2006. Apart from economic transformation, the significance increase of electricity consumption is also attributed to residential electricity consumption (IEA, 2004). With respect to this outperform

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