Energy Policy 110 (2017) 588–599

Contents lists available at ScienceDirect

Energy Policy

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

Production function with electricity consumption and policy implications in Portugal

Muhammad Shahbaz[a], Ramzi Benkraiem[b], Anthony Miloudi[c], Amine Lahiani[a,d,*]

[a] Montpellier Business School, France
[b] Institute of Finance, Audencia Business School, Nantes, France
[c] La Rochelle Business School & CRIEF University of Poitiers, France
[d] LEO, University of Orleans, France

ARTICLE INFO

JEL classification:
D24
B23

Keywords:
Production function
Asymmetries
Portugal

ABSTRACT

Using a sample of quarterly data, we investigate the effect of electricity consumption, capital formation and financial development on economic growth in Portugal. A positive (negative) shock of electricity consumption is estimated to have increased (decreased) economic growth. Economic growth is positively affected by positive shock stems in capital. A positive (negative) shock in financial development declines (increases) economic growth. These findings reveal that (a) Portugal is still an energy-dependent economy; (b) energy is one of the major inputs for economic growth and development; (c) a conservation energy policy should not be implemented because energy is an important driver of growth; (d) economic growth enhances capital formation and not the opposite. Hence, it appears more relevant to boost economic growth before enhancing capital formation; (e) financial development does not appear to be an important catalyst for economic growth. Findings also highlight (f) the relevance of the recent energy policy implemented in Portugal and (g) the need to limit energy imports by means of producing electricity through renewable energy to reduce the external debt level in Portugal, especially after the 2008 crisis.

1. Introduction

Energy plays a fundamental role in sustainable economic development for both developing and developed countries. It is a key input in most of the production processes. In particular, due to its importance for the economy, numerous researchers have focused on examining the relationship between electricity consumption and economic growth (e.g., Squalli, 2007, Apergis and Payne, 2011, Shahbaz et al., 2013, Wolde-Rufael, 2014, Rafindadi and Ozturk, 2016, Sarwar et al., 2017). Manufacturing industries rely heavily on the production of electricity. Indeed, electricity shortages may cause serious distortions to the gross domestic product (GDP) and subsequently destabilize a country's economy (Shahbaz and Ali, 2016). As a result, electricity consumption can be viewed as a relevant factor of domestic production and, hence, economic growth. Costantini and Martini (2010), among others, argue that electricity consumption should be a component of the production function in the same way as capital and labor. Therefore, policy makers have habitually been highly concerned by the causal links between electricity consumption and economic growth. These links have significant energy policy implications for the government in different ways. An important way concerns electricity conservation policies. These policies should be developed to avoid the wastage of electricity and reduce electricity consumption whenever possible (Shahbaz and Ali, 2016).

Portugal produced 5.6 million tonnes of oil-equivalent (Mtoe) energy in 2014. Energy is essentially provided by renewables, including biofuels and waste, because Portugal has limited access to fossil fuel production. The final demand represents approximately 16 Mtoe in 2013. Fossil fuels account for 74.3% (including oil, 45.1%; natural gas, 16.4%; and coal, 12.7%) and renewables account for 25.4%. In view of the large gap between supply and demand for energy, Portugal is an energy-dependent country. Nevertheless, since the implementation of new environmental energy policies proposed by the National Energy Efficiency Action Plan (NEEAP),[1] Portugal has embarked on a series of

* Corresponding author at: LEO, University of Orleans, France.
E-mail addresses: shahbazmohd@live.com (M. Shahbaz), rbenkraiem@audencia.com (R. Benkraiem), miloudia@esc-larochelle.fr (A. Miloudi), amine.lahiani@univ-orleans.fr (A. Lahiani).

[1] Since 2008, the European Union has made a set of recommendations that aim at promoting renewable energy deployment and supporting economic and environmental sustainability. The NEEAP has proposed several other energy policy actions that concern market liberalization in the electricity and natural gas sectors. The new NEEAP, established in 2013, has defined targets for reducing energy consumption and developing renewable energy production. These targets are to be achieved by 2020.

http://dx.doi.org/10.1016/j.enpol.2017.08.056
Received 11 May 2017; Received in revised form 27 August 2017; Accepted 31 August 2017

reforms to produce more renewable energy. The results are not long in coming: in 2014, renewables accounted for 25.4% of Portugal's total primary energy supply and 61.3% of electricity generation. Portugal has become one of the leaders in the European Union in terms of renewable energy sources. This specific energy strategy makes it possible to reduce both natural gas and crude oil imports and enhances domestic economic output. Indeed, Portugal has imported 2.8 Mt of oil products in 2014, which represents a decrease of approximately 40% compared to 2004 (International Energy Agency, 2016). Bhattacharya et al. (2016) have found that renewable energy consumption positively affects economic growth in the long term for the Portuguese economy. Economic growth also relies on other important inputs such as financial development and gross fixed capital formation. Financial development can play a role in sustaining energy efficient technology (e.g., Shahbaz et al., 2011, Tang et al., 2013) to enhance domestic production and provide public and private investments to reduce greenhouse gases emissions. Capital formation is another notable driver of domestic economic growth. In a recent empirical investigation, Best (2017) finds that capital (especially private credit from banks) facilitates the transition from fossil fuels to alternative renewable energy sources.

Electricity policy depends on the existence and direction of the causality links between electricity consumption and economic growth. It is possible to consider and discuss at least four hypotheses regarding these causality links. First, the growth hypothesis suggests a unidirectional causality relationship from electricity consumption to economic growth (e.g., Ouedraogo, 2013, Shahbaz et al., 2013, Iyke, 2015, Acaravci et al., 2015, Tang et al., 2016). In this context, the reduction of electricity consumption negatively affects economic growth. As a result, electricity conservation policies should be counterproductive for the economy because a decrease in electricity consumption can induce a decrease in economic growth. Second, the conservation hypothesis puts forward the existence of an opposing unidirectional causality relationship from economic growth to electricity consumption (e.g., Cheng and Lai, 1997, Narayan et al., 2010, Kasnan and Dunan, 2015, Arora and Shi, 2016). In other words, an increase in economic growth creates an increase in electricity consumption. In this situation, electricity conservation policies may be implemented without affecting economic growth. Third, the feedback hypothesis evokes a bidirectional causality relationship between economic growth and electricity consumption (e.g., Constantini and Martini, 2010, Shahbaz and Lean, 2012, Polemis and Dagoumas, 2013, Mutascu, 2016, Sarwar et al., 2017). This feedback effect can serve to implement both energy conservation and efficiency policies without negatively affecting economic growth. Additionally, this reduction of energy use could be more appropriate if policy makers promote a shift from less efficient energy consuming sectors to more efficient counterparts. Fourth, the neutrality hypothesis does not consider any causal relationship between electricity consumption and economic growth. Hence, the neutrality hypothesis suggests that electricity consumption plays a limited role in the economic growth of a given country (e.g., Wolde-Rufael, 2009, Smiech and Papiez, 2014). In this case, any increase or decrease in electricity consumption has no effect on the economic output. At the energy policy level, this neutrality effect means that an increase or decrease in energy consumption would not have any effect on the national income.

Currently, examination of the causal links between electricity consumption and economic growth is an ongoing concern and is more important than ever. Indeed, around the world, economists and governmental authorities place a large amount of importance on reducing greenhouse gas emissions. This objective constitutes the priority of contemporary energy policies. However, the implementation of such energy policies obviously depends on the impact of electricity consumption on economic growth. Various non-stationary econometric methodologies have been deployed in numerous empirical studies to determine long-term and short-term links between electricity consumption and economic growth (Chen et al., 2007; Narayan and Prasad, 2008; Iyke, 2015; Mutascu, 2016; Streimikiene and Kasperowicz, 2016; Tang et al., 2016, Shabhaz et al., 2016 to name a few). In a recent survey, Omri (2014) investigates different empirical study results of the casual links between electricity consumption and economic growth. The author notes the mixed conclusions: 29% of previous empirical studies corroborate the growth hypothesis; 27% support the feedback hypothesis; 23% confirm the conservation hypothesis; and 21% validate the neutrality hypothesis.

Some recent empirical studies on the energy-growth nexus have extended the production function or Solow's growth model by incorporating some additional variables of interest. Narayan and Smyth (2009) study the relationship between energy consumption and exports. They confirm that the causality direction may be different if economists incorporate another relevant factor in the production function. Similarly, Sadorsky (2011a) reveals a positive causality running from export to energy consumption and a feedback effect between import and energy consumption. Shabhaz et al. (2013) argue that the exclusion of some relevant variables in the empirical model clearly causes two main drawbacks. First, the econometric specification may induce inconsistent and biased estimates. Second, the potential omitted variables in the econometric modeling may lead to confirming the only neutral hypothesis. Consequently, the authors add a set of macroeconomic variables to the model, such as financial development, trade openness (imports, exports), international trade and capital.[2] Their results show that these variables have a positive impact on economic growth in China over the period of 1971–2011. In the short run, their findings corroborate the growth hypothesis, meaning that China is an energy-dependent country. Tang et al. (2016) investigate this relationship for Vietnam by using an extended neoclassical Solow growth model for the period from 1971 to 2011. The particularity of this study is the use of foreign direct investment (FDI) associated with capital stock in the production function. The main reason for this choice is that capital stock and FDI are two important variables affecting economic growth, especially for developing countries.[3]

Economists and policy makers are aware that the use of electricity consumption may be a powerful economic tool to sustain economic growth. However, they face conflicting results from an academic standpoint. The ambiguity in the empirical results may be due to the ignorance of asymmetry or non-linearity arising in time series due to structural reforms; regimes shifts; financial, economic and energy reforms; and regional and global imbalances. This presence of asymmetry in time series may change the impact of electricity consumption on economic growth and the direction of causality between both variables (Shahbaz et al., 2017). Few studies in the existing energy economic literature employed the production function in the case of Portugal (Tang et al., 2013, Tang and Tan, 2014 and, Marques and Fuinhas, 2015). These studies provide conflicting empirical results. The main reason for the conflicting empirical results may be the presence of asymmetries in times series. The presence of asymmetry in time series leads us to examine how positive (negative) fluctuations in electricity consumption impact economic growth. This paper aims at narrowing the gap between the literature and practice by reconsidering the relationship between electricity consumption and economic growth in the particularly interesting case of Portugal. Portugal is an interesting case study for many reasons. First, Portugal has established a clear strategic energy plan for the coming years. Indeed, the council of ministers of Portugal has recently formulated an ambitious national energy strategy

[2] Cole (2006) investigates the link between trade liberalization and energy consumption for 32 developed and developing countries. The study findings suggest a positive relationship between trade liberalization, energy consumption and economic growth, meaning that trade liberalization is likely to increase energy consumption. Lean and Smyth (2010) investigate the energy-growth nexus by incorporating international trade for Malaysia during the period from 1971 to 2006. Their empirical results are in line with those of Sadorski (2011a).

[3] Rafindadi and Ozturk (2016) examine the growth-electricity nexus for the Japanese economy by incorporating the financial development, capital and trade openness variables in an extended Cobb-Douglas production function.