Economic Modelling 54 (2016) 515–521

Contents lists available at ScienceDirect

Economic Modelling

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

Predictability within the energy consumption–economic growth nexus: Some evidence from income and regional groups

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ARTICLE INFO

Article history:
Accepted 31 December 2015
Available online xxxx

Keywords:
Predictability
Panel data
Economic growth
Energy consumption

ABSTRACT

In re-examining the nexus between energy consumption and economic growth through the predictability framework, we adopt a panel data predictive regression model to examine the possibility of growth, conservative, feedback, or neutrality hypotheses for 135 countries. A predictive regression model is fitted to panels of countries on the basis of location and level of economic development. Findings suggest strong support for the neutrality hypothesis. A developing economy panel (90 countries) favours the conservative hypothesis, although a panel of 32 lower middle-income countries suggests that energy consumption per capita predicts real GDP per capita. These forecasts could provide future policy directions.

1. Introduction

This study re-examines the traditional energy economics nexus between energy consumption and economic growth. Four hypotheses are important here. First is the growth hypothesis, which argues that energy consumption leads economic growth. The second, referred to as the conservation hypothesis, perceives economic growth as leading energy consumption. The third hypothesis treats both energy consumption and economic growth as leading each other; this relationship has been termed the feedback hypothesis. The final hypothesis, described as the neutrality hypothesis, relates to a case where neither economic consumption nor economic growth leads to one another. These hypotheses have important implications for energy conservation policies and have received attention for a particular income or regional group or for individual countries (for a survey on these studies, see Ozturk, 2010, and Payne, 2010).[1] In particular, failure to reject hypothesis 1 or 3 suggests a unidirectional flow from energy consumption to economic growth or a bidirectional link between energy consumption and economic growth. These hypotheses discourage restrictive energy policies but call for policies that promote energy efficiency. In the meantime, the prevalence of hypothesis 2 or 4 emphasises a disconnection between energy policies and economic growth and gives a green light to energy conservation policies.

This paper examines the four hypotheses within the forecasting framework for various income and regional groups generated from a sample of 135 countries. Previous studies on the topic have covered either cointegration and Granger causality type tests which are known to depict weak links between economic growth and energy consumption; or time series or panel regression analyses, which focus on identifying strong links. In doing so, these studies clarify causal effects, which is an important first step in establishing support, or not, for past policies and informing future policy directions. However, forecasting provides the best tools for establishing any statistical confidence in potential economic policy.

This study applies a recent panel data predictive regression model proposed by Westerlund And Narayan (fortcoming). There are several favourable features of this test which motivate its application to testing the four hypotheses outlined above. First, the Westerlund and Narayan predictability test addresses the issue of endogeneity, which, as suggested by the feedback hypothesis, is a feature of the energy consumption and economic growth nexus.

Second, in systems (of energy and real GDP variables) where there is no evidence for a cointegrating relationship, the VAR model ends up losing information content in the variables as it is based on the first difference variable. with the Westerlund and Narayan test, one does not need to first difference the predictor variable. in other words, the predictor variable is allowed to be persistent, which means it always contains all the information it has, and therefore a researcher always ends up using the predictor variable in its 'original' form. this is important because diluting the variable through first differencing may be costly if it provides deceptive evidence on whether or not it can predict energy consumption growth or economic growth.

Third, with any panel data regression model, cross-sectional dependence is an important statistical issue that needs to be addressed in order to obviate bias inference on the validity or otherwise of a particular hypothesis. The Westerlund and Narayan predictive regression model controls for cross-sectional dependence.

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[1] See Section 2 that examines the four hypotheses in terms of evidence from panel based studies.

http://dx.doi.org/10.1016/j.econmod.2015.12.037
0264-9993/

Further, high income nations (mostly in Europe and Oceania) have greater access to energy (on a per capita basis) than less fortunate nations in Africa, Latin America and Asia (see Table 2). In this paper, when examining the four hypotheses, we pay attention to this disparity in energy consumption by income and geography. We examine a sample of 135 countries divided into panels by income, region, developing and developed. We also create a global panel of all 135 countries.

Panel-based studies that have examined the causal links between energy consumption and economic growth have mainly focused on countries belonging to one particular income or regional group (see, for example, Al-Iriani, 2006; Wolde-Rufael, 2009; Lee and Chang, 2007; Akinlo, 2008; Kahsai et al., 2012; Kasman and Duman, 2015; Esseghir and Khouni, 2014; Apergis and Payne, 2009a). In these studies, differences in results are usually suggested to be a by-product of the use a variety of econometric techniques and samples. This study holds sample size and estimation technique constant such that differences in results can be traced to differences in countries' economic and geographic characteristics.[2]

Some previous studies, which do focus on more than one income or regional group, report sensitivity of the causal results to income or regional differences (Huang et al., 2008; Ozturk, et al., 2010; Kahsai et al., 2012). Huang et al. (2008) examined income groups created from 73 nations and found support for the neutrality hypothesis in the low-income panel and for the conservative hypothesis in the upper and lower middle-income groups. The authors also found that economic growth reduced energy consumption in the high-income panel. Ozturk et al. (2010) examined three income groups (low income, middle income, and upper middle income) from 51 countries and found evidence in favour of the conservative hypothesis for low-income countries and long-run support for the feedback hypothesis for the middle-income countries. Kahsai et al. (2012) focused on 40 Sub-Saharan African nations to examine low- and middle-income countries. The Kahsai et al. study finds evidence of bidirectional causation in the long run for both panels and middle-income countries in the short run but short-term neutrality for low-income countries. Lee and Chang (2007) examined 22 developed and 18 developing countries using panel VARs and GMM and finds evidence of the feedback hypothesis for developed countries and the conservative hypothesis for developing countries.

While these studies focus on causal links, this current study conducts a forecasting exercise. Similar to these studies, our study allows comparison within the income and regional groups, something that is sparsely understood. This exercise will help gauge the standing of an income or regional group on issues relating to energy conservation capabilities. Large-scale studies such as ours can inform decisions on a global scale, such as those relating to global energy conservation and environmental protection agreements and arrangements.

At a more technical level, the organisation of panels by region and income should also serve as a robust test for clarifying whether the results are sensitive to the nations included in each panel.

Foreshadowing our key findings about the energy consumption/economic growth predictability, most country panels (developed; high-income OECD and non-OECD; high middle income; low income; and regional) suggest strong support for the neutrality hypothesis. Some causal studies, including Huang et al. (2008), Wolde-Rufael (2009), Akinlo (2008), Chiou-Wei et al. (2008), Kahsai et al. (2012), and Karanfil and Li (2015) show support for this hypothesis for similar income panels. However, our findings establish that there is a high chance that observed levels of energy consumption do not predict future levels of economic growth and that observed levels of economic growth are not predictors of future levels of energy consumption. An explanation of the forecasted disconnects between GDP and energy consumption for most groups of countries is provided later.

Our second finding is that the developing country panel (comprising 90 countries) favours economic growth as a predictor of energy consumption, although a separate income panel, of 32 lower middle-income countries, gives the opposite result, i.e. that energy consumption predicts economic growth.

The remainder of the paper is organised as follows. The next section explains the four hypotheses and provides a brief review of panel-based studies over the last decade. The predictive regression model is explained in Section 3. Data are explained in Section 4. Section 5 undertakes some preliminary analysis of the data while the penultimate section discusses the results. The final section concludes the paper.

2. The four hypotheses, their economic significance, and current evidence from panel-based studies: A brief review of the last 10 years (2005–2014)

2.1. The growth hypothesis

The hypothesis that energy consumption leads to economic growth suggests that energy consumption entails economic growth and, therefore, inadequate provision of energy limits economic growth. This unidirectional argument relies on the fact that energy is not only an input for the production of goods and services but energy also complements labour and capital inputs.

Recent panel evidence in favour of the growth hypothesis is limited. Interestingly, in reviewing the literature, we encountered some evidence in support of this hypothesis for high-income groups but some for upper and lower middle in the short-term and low-income countries for the long-run.

Apergis and Payne (2009b) apply panel cointegration and ECM model for the 12 countries that constitute their commonwealth of independent states (upper middle-income countries) in the short-run to find evidence in favour of the hypothesis. Ouedraogo (2013) found support for the growth hypothesis for the upper and lower middle-income countries panel of West African states using panel-based cointegration and Granger causality tests. Applying similar estimation techniques on seven Central American countries classified as lower middle-income countries, Apergis and Payne (2009a) find evidence of unidirectional causation flowing from energy consumption to GDP. Ozturk et al. (2010), on the other hand, use panel causality testing to find evidence of a long-run Granger causality running from GDP to energy consumption for low-income countries.

Relying on Pedroni's cointegration test and causality relations between GDP and energy consumption for 18 developing countries for the period 1975–2001, Lee (2005) finds evidence of long- and short-run unidirectional causality flowing from energy consumption to GDP.

Narayan and Popp (2012) examined 93 countries by regional, G6, and global panels. The authors find that while energy consumption panel Granger caused real GDP for Western Europe, Asia, Latin America, Africa, G6, and the globe, the long-run point effects, although positive, were either zero or close to zero.

2.2. The conservation hypothesis

The argument that economic growth influences energy consumption suggests the economy is less energy dependent and has the

[2] Several country-specific studies on the subject also show results which are sensitive to econometric techniques and the country data applied (see Ajmi et al., 2013; Yang and Yongliang, 2014; Hamdi et al., 2014). Ajmi et al. (2013), for instance, using nonlinear causality tests shows that Hiemstra–Jones test indicates unidirectional causality running from energy consumption to GDP for the United Kingdom, while a bidirectional causality between energy consumption and GDP is found for Canada, France, Japan, and United States. On the other hand, in the same study, Kyrtsou–Labys test shows that a unidirectional causality runs from energy consumption to GDP for France and the United States and from GDP to energy consumption for Germany. Applying out-of-sample Granger causality tests and directed acyclic graphs for the Indian economy, Yang and Yongliang (2014) show contemporaneous causality running from economic growth to energy consumption. Hamdi et al. (2014) find that for Bahrain, VECM Granger causality analysis suggests the feedback effect between electricity consumption and economic growth.