Energy Economics 44 (2014) 325–330

Contents lists available at ScienceDirect

Energy Economics

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

Electricity consumption and economic growth in transition countries: A revisit using bootstrap panel Granger causality analysis

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ARTICLE INFO

Article history:
Received 30 October 2013
Received in revised form 24 April 2014
Accepted 26 April 2014
Available online 9 May 2014

JEL classification:
C23
Q43

Keywords:
Electricity consumption
Economic growth
Panel bootstrap causality
Cross-sectional dependency
Slope heterogeneity

ABSTRACT

The purpose of this paper is to revisit the Granger causal relationship between electricity consumption and economic growth for 15 transition economies for the period 1975–2010 using a bootstrap panel causality approach that allows for both cross-sectional dependency and for heterogeneity across countries. Applying this approach, we found a unidirectional causality running from electricity consumption to economic growth only in Belarus and Bulgaria; from economic growth to electricity consumption in the Czech Republic, Latvia, Lithuania and the Russian Federation; bidirectional causality only in Ukraine while no Granger causality in any direction in Albania, Macedonia, Moldova, Poland, Romania, Serbia, Slovak Republic and Slovenia. These results show that there is a limited support for the electricity-led growth hypothesis. Nevertheless these different findings provide important implications for energy strategies and policies for transition countries.

1. Introduction

The purpose of this paper is to revisit the Granger causal relationship between electricity consumption and economic growth for 15 transition countries using a panel causality approach developed by Kónya (2006) which allows for both cross-sectional dependency and for heterogeneity across countries. Like many countries, as these countries continue to develop and grow rapidly, they face a common challenge: securing a sustainable supply of energy and ensuring that it is used efficiently, while limiting carbon emissions and protecting the environment [European Bank for Reconstruction and Development (EBRD, 2010)]. Demand for energy in transition economies, mainly electricity has been rising strongly for several years. However, research that looks into the causal relationship between electricity consumption and economic growth in transition countries is sparse. The purpose of this paper is to fill this gap. The paper differs from previous studies on transition countries in four important ways. First to the best of our knowledge, this is the first study that uses a bootstrap panel Granger causality test to investigate the causal relationship between electricity consumption and economic growth in transition countries. Second, we take into consideration cross-sectional dependence and country-specific heterogeneity across the 15 transition countries. Third, we apply a country-specific bootstrap panel causality approach developed by Kónya (2006) with country specific bootstrap critical values. This allows testing for Granger causality on each individual panel members separately by taking into account the possible contemporaneous correlation across countries (Chang et al., 2013; Kónya, 2006). By generating country specific bootstrap critical values there is no need for pretesting for unit roots and cointegration (Chang et al., 2013; Kónya, 2006). Unlike Ozturk and Acaravci (2011) who did not carry out panel causality analysis for 15 transition economies because their series were not panel cointegrated, we carry out panel causality analysis irrespective of the time series properties of the data we used for the 15 transition countries. Fourth, by applying the bootstrapping technique we can minimize the distortions caused by small samples as conventional time series analysis not only fails to consider information across countries but also have lower power tests (see Chu and Chang, 2012; Kar et al., 2011).

We believe that the diversity of the empirical findings (see Payne, 2010) together with the important role the electricity sector can play in economic development not only necessitates further research but also use of new alternative methodologies for testing the causal relationship between electricity consumption and economic growth. For devising appropriate electricity consumption strategies and policies in these countries knowledge of the causal relationship between electricity consumption and economic growth is of crucial importance.

The rest of the paper is structured as follows. In Section 2 we present a brief account of the empirical literature followed by the methodology

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http://dx.doi.org/10.1016/j.eneco.2014.04.019
0140-9883/

used in Section 3. The empirical evidence is presented in Section 4, while concluding remarks are presented in Section 5.

2. Literature review

The role of electricity consumption in economic growth has been extensively studied but the evidence so far is contradictory and inconclusive (see inter alia, Acaravci and Ozturk, 2010; Bildirici et al., 2012; Chen et al., 2007; Lee and Lee, 2010; Ozturk and Acaravci, 2011; Payne, 2010; Shahbaz and Feridun, 2012; Wolde-Rufael, 2006). Central to the debate is whether electricity consumption promotes, retards or is neutral to economic growth. The literature has identified four possible hypotheses on the possible existence and nature of the causal relationship between electricity consumption and economic growth (Apergis and Payne, 2011; Behmiri and Manso, 2013). First the *growth hypothesis* postulates that there is a one-way Granger causality running from electricity consumption to economic growth. In this case, if increases in electricity consumption lead to increases in economic growth, then policies that decrease electricity consumption could lead to a fall in economic growth. Empirical evidence in support of this hypothesis, for instance, comes from Apergis and Payne (2011), Jamil and Ahmad (2011), Kouakou (2011), Narayan and Singh (2007), Ozturk and Acaravci (2011), Sari and Soytas (2004), Shiu and Lam (2004), Wolde-Rufael (2006) and Yoo and Kwak, 2011). The second hypothesis is the *conservation hypothesis* which implies one-way causality running from economic growth to electricity consumption where economic growth induces higher electricity consumption. According to this hypothesis, conservation policies are possible because a strategy that reduces electricity consumption may not have a negative impact on economic growth as it may be possible to reduce electricity consumption without harming economic growth. This hypothesis is supported, among others, by the findings of Ciarreta and Zarraga (2010); Jamil and Ahmed (2011); Jumbe (2004); Lee and Lee (2010); Shahbaz et al. (2011); Shahbaz and Feridun (2012) and Wolde-Rufael (2006). The third hypothesis is the *feedback hypothesis*, where a two-way causality that runs between electricity consumption and economic growth is postulated as implying that electricity consumption and economic growth are mutually determined. This interdependence may imply that policies that limit the growth of electricity consumption may have a negative impact on economic growth. Conversely, any potential impact on economic growth can be negatively transmitted back to electricity consumption (Apergis and Payne, 2011). Empirical evidence in support of this hypothesis, for instance, comes from Cheng-Lang et al. (2010), Mahadevan and Asafu-Adjaye (2007), Ouédraogo (2010), Ozturk and Acaravci (2011), Polemis and Dagoumas (2013), Squalli (2007), Tang (2008), Wolde-Rufael (2006), Yoo and Kwak (2010) and Zachariadis and Pashourtidou (2007). The fourth view is the *neutrality hypothesis* of no causality in any direction implying that reducing electricity consumption may not affect economic growth and economic growth does not affect electricity consumption. Ozturk and Acaravci (2011), Wolde-Rufael (2006) and Yoo and Kwak (2010) among others present evidence in support of this neutrality hypothesis.

3. Methodology

3.1. Cross-section dependence tests

The empirical analysis in this paper is carried out in two steps. First, as a prerequisite to our Granger causality tests, we carry out tests for cross-section dependence and slope homogeneity. In the second step, based on the results from preliminary analysis, we apply a panel causality test that takes into consideration the issues of cross-section dependence and slope homogeneity (Kónya, 2006). A brief account of the econometric models used is presented below.

Recent advances in panel causality analysis have brought to the fore two basic econometric issues that cannot be ignored in undertaking panel Granger causality tests. The first concerns the issue of cross-dependence and the second concerns the issue of heterogeneity across countries. The recent world economic situation has shown that turbulence in a country can easily be transmitted to other countries through international trade and economic and financial integration (see Nazlioglu et al., 2011; Pan et al., in press). As pointed out by Pesaran (2006) ignoring cross-section dependency leads to substantial bias and size distortions implying that testing for the cross-section dependence is a crucial step in a panel data analysis (see Boubtane et al., 2013; Chang et al., 2013; Chu and Chang, 2012; Nazlioglu et al., 2011).

Following Boubtane et al. (2013), Chang et al. (2013) and Kar et al. (2011) to test for cross-sectional dependency, we use three tests. The first is the Lagrange Multiplier (LM) test developed by Breusch and Pagan (1980) which requires the estimation of the following panel data model:

$$\ln y_{it} = \alpha_i + \beta_i \ln e_{it} + \varepsilon_{it} \quad \text{for } i = 1, 2, \ldots, N; t = 1, 2, \ldots T \tag{1}$$

where *lny* (*lne*) represents real GDP per capita (electricity consumption per capita), *i* is the cross-section dimension, *t* is the time dimension and α_i and β_i are, respectively, the individual intercepts and slope coefficients that are allowed to vary across countries. The Lagrange multiplier test statistic for cross-sectional dependence of Breusch and Pagan (1980) is given by:

$$CD_{BP} = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widetilde{\rho}^{2}_{ij} \tag{2}$$

where $\widetilde{\rho}_{ij}$ is the estimated correlation coefficient among the residuals obtained from individual OLS estimations. Under the null hypothesis of no cross-sectional dependence with a fixed *N* and large *T*, CD_{BP} asymptotically follows a chi-squared distribution with $N(N-1)/2$ degrees of freedom (see Boubtane et al., 2013; Chang et al., 2013; Pan et al., in press).

As pointed out by Pesaran (2004) the CD_{BP} test has a drawback when *N* is large, consequently Pesaran (2004) proposes another Lagrange multiplier (CD_{LM}) statistic for cross-sectional dependence that does not suffer from this problem (see Boubtane et al., 2013; Chang et al., 2013). The CD_{LM} statistic is given as follows:

$$CD_{LM} = \sqrt{\frac{1}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left(T\widetilde{\rho}^{2}_{ij-1}\right) \tag{3}$$

Under the null hypothesis of no cross-sectional dependence with $T \to \infty$ and then $N \to \infty$, CD_{LM} asymptotically follows a normal distribution. However, this test is likely to exhibit substantial size distortions when *N* is large relative to *T* and due to this problem, Pesaran (2004) proposes a new test for cross-sectional dependence (*CD*) that can be used where *N* is large and *T* is small (see Chang et al., 2013; Pan et al., in press). This test is given by:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\widetilde{\rho}_{ij} \tag{4}$$

According to Pesaran (2004) under the null hypothesis of no cross-sectional dependence with $T \to \infty$ and then $N \to \infty$ in any order, *CD* asymptotically follows a normal distribution and is likely to have good small sample properties for both *N* and *T* small (Chang et al., 2013).

3.2. Slope homogeneity test

Even though there may be a strong dependence across countries, it is also possible that each country maintains its own dynamics in the development process implying that it is important to consider controlling