

Communication

Electricity consumption–real GDP causality nexus: Evidence from a bootstrapped causality test for 30 OECD countries

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Abstract

The goal of this paper is to examine any causal effects between electricity consumption and real GDP for 30 OECD countries. We use a bootstrapped causality testing approach and unravel evidence in favour of electricity consumption causing real GDP in Australia, Iceland, Italy, the Slovak Republic, the Czech Republic, Korea, Portugal, and the UK. The implication is that electricity conservation policies will negatively impact real GDP in these countries. However, for the rest of the 22 countries our findings suggest that electricity conservation policies will not affect real GDP.

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1. Introduction

From a policy viewpoint, the direction of causality between electricity consumption and real GDP has important implications (Narayan and Smyth, 2005a). If uni-directional Granger causality runs from income to electricity consumption or if there is no causality in either direction this implies that electricity conservation policies would not affect economic growth. However, if uni-directional causality runs from electricity consumption to income then reducing electricity consumption could lead to a fall in income. Thus, the motivation for examining the direction of causation between electricity consumption and GDP has roots in energy conservation policies.

Given the environmental implications of electricity usage and the ensuing need for conservation policies, a large literature has evolved. There are studies for Australia (see, Narayan and Smyth, 2005a, b), for OPEC countries

(Squalli, 2007), for the G7 countries (Narayan et al., 2007), for Asian countries, including China and India (Yuan et al., 2007; Shiu and Lam, 2004; Chen et al., 2007; Yoo, 2005, 2006), for a group of 17 African countries (Wolde-Rufael, 2006), for Malawi (Jumbe, 2004), for Turkey (Altinay and Karagol, 2005; Halicioglu, 2007), Fiji (Narayan and Singh, 2007), Cyprus (Zachariadis and Pashouortidou, 2007), and Bangladesh (Mozumder and Marathe, 2007). The results are at best mixed. We undertake a more detailed review of the literature in Section 2.

The goal of this paper is to add to this group of studies by considering the electricity consumption–real GDP causality nexus for 30 OECD countries. The novelty of our work is twofold. First, this is the first study that considers a large group of industrialised countries for a test of the causal relationship between electricity consumption and real GDP. Second, our modelling approach is novel in this literature on energy policy and energy economics, for we use the bootstrap approach to testing for causality. It is now widely known that the bootstrap approach to causality produces robust critical values (see, *inter alia*, Horowitz, 1994; Mantalos and Shukur, 1998; Mantalos, 2000).

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The bootstrap approach has not been previously used in this energy literature. Granger's (1969) test for causality, which has been widely used in this literature, was based on asymptotic distribution theory. However, the work of Granger and Newbold (1974) suggested that causality tests based on two non-stationary ($I(1)$) variables were likely to be spurious. One solution was to convert the $I(1)$ variable into $I(0)$ (stationary) form either through first differencing or simply taking the growth rate form of the $I(1)$ variable. However, in taking this approach, the practitioner loses long-run information, and thus can only estimate short-run causation. Hacker and Hatemi (2003) show, using Monte Carlo simulations that bootstrap distribution reduces size distortions compared with an asymptotic distribution. Thus, the bootstrap approach used in this paper is likely to produce more efficient results compared with other tests for causality.

Foreshadowing the main results, we find evidence in favour of electricity consumption causing real GDP in the long run in Australia, Iceland, Italy, the Slovak Republic, the Czech Republic, Korea, Portugal, and the UK; electricity consumption Granger causes real GDP. The implication is that electricity conservation policies will negatively impact real GDP in these countries. However, for the rest of the countries (approximately 73 per cent of the OECD countries) our findings suggest that electricity conservation policies will not affect real GDP.

We organise the rest of the paper as follows. In Section 2, we review previous studies on the causal relationship between electricity consumption and real GDP. In Section 3, we discuss the bootstrap approach to causality testing. In Section 4, we present and discuss the results. In Section 5, we provide some concluding remarks.

2. Literature review

Electricity consumption and economic growth nexus has emerged to be a topic of immense interest recently. The growing interest in the area has largely been triggered by the growing demand for energy across the world fuelled mainly by increasing economic activities across economies. The aim of this section is to review selected studies, which examine the casual relationship between electricity consumption and economic growth.

Shiu and Lam (2004) study the above relationship for the Chinese economy using data for the 1971–2000 period. By employing the Granger causality test, they find a short-run uni-directional casualty running from electricity consumption to real economic growth. This implies that an increase in electricity consumption raised economic growth in China during the review period. According to the authors, around 70–80 per cent of electricity during the 1971–2001 period was consumed by China's industrial sector. Moreover, industrial production was one of the significant drivers of China's economic growth. Therefore, increases in industrial sector demand for electricity consequently

increased electrical energy consumption, which in turn raised economic growth. The authors recommend that China needs to enhance its electricity generation capacity and shield the sector from any adverse supply shocks, which has the potential to impair China's economic performance.

Yuan et al. (2007) support the Shiu and Lam's (2004) findings for China. Their study reveals that for the sample period 1978–2004, there is a uni-directional relationship running from electricity consumption to GDP.

Jumbe (2004) also applies the Granger causality test on Malawian time series data over the period 1970–1999. He finds, based on the Granger causality test, that there exists a bi-directional causality between GDP and electricity consumption. The error correction model, however, portrays a uni-directional relationship running from GDP to electricity consumption.

Yoo (2005) conducts a similar analysis for Korea and uses the Granger causality test to identify causality between electrical energy consumption and economic growth over the period 1970–2002. Yoo (2005) finds a short-run uni-directional causal relationship running from electricity consumption to real GDP.

In a more extensive study, Narayan and Smyth (2005a) find that real income Granger causes electricity consumption in Australia. Their sample period is 1966–1999.

For Turkey, an emerging economy, Altinay and Karagol (2005) find causality running from electricity consumption to income over the period 1950–2000. They employ the Granger non-causality tests: the Dolado and Lutkepohl (1996) and the standard Granger causality tests. Altinay and Karagol (2005) establish that electricity generation is crucial for the well-being of the Turkish economy. They find electricity consumption to be a leading indicator of economic performance in Turkey. Halicioğlu (2007) also assesses the Turkish economy in a similar context over the 1968–2005 period and finds long-run causality running from income to electricity consumption. The short-run causality test, nonetheless, renders inconclusive results.

Yoo (2006) conducts the Granger causality test among real GDP and electricity consumption for four ASEAN member countries, namely, Indonesia, Malaysia, Singapore, and Thailand, over 1971–2002. His results reveal a strong bi-directional relationship between electricity consumption and economic growth for Malaysia and Singapore. This suggests that electricity consumption and real GDP are interdependent. Evidence of uni-directional causality running from economic growth to electricity consumption is found for Indonesia and Thailand, implying that energy conservation policies would not dampen economic performance of these two countries. Generally, in all the four countries economic growth is found to stimulate electricity consumption.

In a recent study, Wolde-Rufael (2006) study the causality electricity consumption and GDP for 17 African countries over the 1971–2001 period, based on the Toda

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