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Electricity consumption and economic growth: evidence from Korea

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Abstract

This paper investigates the short- and long-run causality issues between electricity consumption and economic growth in Korea by using the co-integration and error-correction models. It employs annual data covering the period 1970–2002. The overall results show that there exists bi-directional causality between electricity consumption and economic growth. This means that an increase in electricity consumption directly affects economic growth and that economic growth also stimulates further electricity consumption.

Keywords: Electricity consumption; Economic growth; Causality; Unit root; Co-integration; Error correction model

1. Introduction

In the past two decades, numerous studies have been conducted to examine the relationship between electricity consumption and economic growth. The overall findings show that there is a strong relationship between electricity consumption and economic growth. For example, Ferguson et al. (2000) has studied the issue in over 100 countries, and found that as a whole there is a strong correlation between electricity consumption and economic growth.

However, the fact that there exists a strong relationship between electricity consumption and economic growth does not necessarily imply a ‘‘causal’’ relationship. The relationship may very well run from electricity consumption to economic growth, and/or from economic growth to electricity consumption. These causality issues, therefore, suggest the need to carry out further investigations. A major question concerning this issue is which variable should take precedence over the other—is electricity consumption a stimulus for economic growth or does economic growth lead to electricity consumption?

Evidence on either direction shall have a significant bearing upon policy. If, for example, there is uni-directional causality running from electricity consumption to economic growth, reducing electricity consumption could lead to a fall in economic growth. On the other hand, if a uni-directional causality runs from economic growth to electricity consumption, it could imply that the policies for reducing electricity consumption may be implemented with little or no adverse effects on economic growth. And lastly, no causality in either direction would indicate that policies for increasing electricity consumption do not affect economic growth.

In a summary of the literature on the causal relationship between energy consumption including electricity consumption and economic growth, there are a number of evidences to support bi-directional or uni-directional causality between energy consumption and economic growth.[1] More specifically for electricity consumption, Yang (2000) found bi-directional causality between electricity consumption and economic growth in Taiwan, and Ghosh (2002) revealed that there exits uni-directional causality running from economic growth to electricity consumption in India without any feedback effect. More recently, Shiu and Lam (2004) showed that there is uni-directional causality running from electricity consumption to economic growth in China but not vice versa.

Public policy makers in Korea have shown a great deal of interest in the role that electricity consumption plays in economic growth. The electricity infrastructure of Korea is becoming an increasingly important component of the economy (Han et al., 2004). In particular, greater use of information and communications technologies (ICTs) marks a worldwide transition

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[1] A good overview of the literature is found in Table 1 given in Shiu and Lam (2004).

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towards a digital society that may profoundly affect electricity supply, demand, and delivery (Baer et al., 2002). In addition, as commonly known, electricity enhances the productivity of capital, labor, and other factors of production. To proactively cope with increasing electricity demand accompanying rapid economic growth, Korea should endeavor to uncover the causal relationship between electricity consumption and economic growth and to make appropriate electricity policy. This task has become one of the most important ones for Korea in the present and in the near future.

The purpose of this paper is, therefore, to investigate causality between electricity consumption and economic growth, and to obtain policy implications from our results. To this end, the author attempts to provide more careful consideration of the causality issues by applying modern rigorous techniques of Granger-causality to the Korean data. The methods adopted here are in the following fashion. First, stationarity and co-integration are tested; second, error-correction models are estimated to test for the Granger-causality; finally, the F- and t-tests are performed to gauge the joint significance levels of causality between the two variables. Through the analysis, instead of arbitrarily choosing a lag length, Akaike's information criterion described in Pantula et al. (1994) is employed to select the optimum lag.

The remainder of the paper is organized as follows. Section 2 presents an overview of the proposed methodology. Section 3 explains the data employed and reports the empirical findings. A summary, some policy implications and conclusions of the study are made in Section 4.

2. Methodology

2.1. Granger-causality and stationarity

The first attempt at testing for the direction of causality was proposed by Granger (1969). The Granger-causality test is a convenient and very general approach for detecting any presence of a causal relationship between two variables. The test is quite simple and straightforward. A time series (X) is said to Granger-cause another time series (Y) if the prediction error of current Y declines by using past values of X in addition to past values of Y. The Granger-causality test method is selected to be used in this study over other alternative techniques because of the favorable Monte Carlo evidence reported by Guilkey and Salemi (1982) and Geweke et al. (1983), particularly for small samples in empirical works.

In order to conduct to the Granger-causality test, a series of variables is required to be stationary. It has been shown that using non-stationary data in causality tests can yield spurious causality results (Granger and Newbold, 1974; Stock and Watson, 1989). Therefore, following Engle and Granger (1987), the author first tests the unit roots of X and Y to confirm the stationarity of each variable. This is done by using the Phillips–Perron (PP) (Phillips and Perron, 1988) test over alternative tests, in that the PP test is known to be robust for a variety of serial correlations and time-dependent heteroscedasticities. If any variable is found to be non-stationary, we must take the first difference and then apply the causality test with differenced data.

2.2. Co-integration

The concept of co-integration can be defined as a systematic co-movement among two or more economic variables over the long run. According to Engle and Granger (1987), if X and Y are both non-stationary, one would expect that a linear combination of X and Y would be a random walk. However, the two variables may have the property that a particular combination of them $Z = X - bY$ is stationary. Thus, if such a property holds true, then we say that X and Y are co-integrated.

If X and Y each are non-stationary and co-integrated, then any standard Granger-causal inferences will be invalid and a more comprehensive test of causality based on an error-correction model (ECM), should be adopted (Engle and Granger, 1987). However, if X and Y are both non-stationary and the linear combination of the series of two variables is non-stationary, then standard Granger-causality test should be adopted (Toda and Phillips, 1993; Yoo and Kwak, 2004). Therefore, it is necessary to test for the co-integration property of the series of electricity consumption and economic growth before performing the Granger-causality test. When both series are integrated of the same order, we can proceed to test for the presence of co-integration. The Johansen co-integration test procedure (Johansen and Juselius, 1990) is used for this purpose.

2.3. Error-correction model

In the error-correction modeling procedure, X Granger-causes Y, if either the estimated coefficients on lagged values of X or the estimated coefficient on lagged value of error term from co-integrated regression is statistically significant. Similarly, Y Granger-causes X, if either the estimated coefficients on lagged values of Y or the estimated coefficient on lagged value of error term from co-integrated regression is statistically significant. This procedure specifically allows for a causal linkage between two or more variables stemming from an equilibrium relationship, thus characterizing the long-run equilibrium alignment that persists beyond the short-run adjustment.