Electricity consumption and economic growth in China: Cointegration and co-feature analysis

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Abstract

This paper applies the cointegration theory to examine the causal relationship between electricity consumption and real GDP (Gross Demostic Product) for China during 1978–2004. Our estimation results indicate that real GDP and electricity consumption for China are cointegrated and there is only unidirectional Granger causality running from electricity consumption to real GDP but not the vice versa. Then Hodrick–Prescott (HP) filter is applied to decompose the trend and fluctuation component of the GDP and electricity consumption series. The estimation results indicate that there is cointegration between not only the trend components, but also the cyclical components of the two series, which implies that, the Granger causality is probably related with the business cycle. The estimation results are of policy implication to the development of electric sector in China.
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1. Introduction

In the past two decades China has achieved rapid economic growth and emerged as the second largest electricity consumption country in the world, just behind the United States. In the end of 2004 the installed generation capacity in China amounted to more than 420 GW and electricity generated is 2130.2 TWH.

However electricity supply and economic growth have never been coincided in China. Historically there was widespread electricity shortage since 60th of the last century. In 1997 with the decrease of economic growth rate there emerged electricity surplus for the first time. However electricity shortage again emerged since 2002 and worsened in 2004. In 2004, the provinces in shortage of electric power amounted to 24 and the total gap is 31 GW in China.

The disharmony between electricity supply and economic growth in China proposes some important questions: does there exist long-term equilibrium between electricity consumption and economic growth in China? How do they influence each other in the short term? Proper reply to the questions is helpful for electricity development policy in China.

The study of causal relationship between energy and economic growth started with the seminal work of Kraft and Kraft (1978), in which causality was found to run from GNP to energy consumption in the United States. Empirical studies were later extended to cover other industrial countries like the United Kingdom, Germany, Italy, Canada, France, Japan and Greece (Yu and Choi, 1985; Erol and Yu, 1987; Hondroyiannis et al., 2002). In the subsequent studies, instead of relying on the standard Granger causality test, the cointegration and error–correction models were applied to test for stationarity of the variables in the time-series. Moreover some studies (Stern, 1993) tested for Granger causality in a multivariate setting by using a vector auto-regression model.

Recently some effort has been paid to the causal relationship between electricity consumption and economic growth in China (Lin, 2003; Shiu and Lam, 2004). However contradicting results have been obtained. Lin (2003) covered the period of 1978–2001 and concluded that economic growth is the Granger cause of electricity consumption but not the vice versa. While (Shiu and Lam, 2004) covering the period of 1971 to 2000 obtained rightly the opposite conclusion that there exists unidirectional Granger causality running from electricity consumption to economic growth. In fact the Granger cause analysis is sensitive to minor changes in model structure, such as adding linear trend term in the cointegrated equation or changing lag periods from 2 to 3. So it is often criticized that Granger cause results obtained may not be the real relationship among time series but only the manipulation of Error Correction Model (ECM) (Granger and Hyung, 2004). Another root of controversy is time period. Sometimes with different periods opposite results are obtained for a same country (See the overview in Shiu and Lam, 2004). Because of the sensitivity of causal relationship analysis result to the sampling period and because that since 1978 with the reform and opening up to outside world China has gradually stepped to the regular road of economic growth, it is important to analyze the causal relationship in China after 1978. However no research has covered the period. Moreover when applying Granger causality analysis we should be cautious with the empirical results and explain them carefully. Some more detailed evidences should be provided and analyzed to validate the empirical results.

All the empirical analysis on the relationship between electricity consumption and economic growth has only studied the relationship of the trend, not the cyclical components, with the exception of (Thoma, 2004), in which the frequency Granger relationship for the United States from 1973 to 2000 is identified to operate with low frequency business cycle movement. In fact the causality between the cyclical components of the interested series is very important because it is correlated with fluctuation in output, an important phenomenon in macroeconomics. One of the objects of our work is to fill the void for China in this direction, though only a preliminary effort.

The remainder of the paper is organized as follows: Section 2 gives an overview of energy sector in China, with emphasis on electricity. Section 3 discusses the methodology and the data of the study. We report our empirical analysis in Section 4. Section 5 provides the policy implications of the empirical analysis and finally is the conclusion.