ELSEVIER

Energy Policy 32 (2004) 47–54

ENERGY POLICY

www.elsevier.com/locate/enpol

Electricity consumption and economic growth in China

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Abstract

This paper applies the error-correction model to examine the causal relationship between electricity consumption and real GDP for China during 1971–2000. Our estimation results indicate that real GDP and electricity consumption for China are cointegrated and there is unidirectional Granger causality running from electricity consumption to real GDP but not vice versa. In order to overcome the constraints on electricity consumption, the Chinese government has to speed up the nation-wide interconnection of power networks, to upgrade urban and rural distribution grids, and to accelerate rural electrification.

Keywords: Electricity consumption; China; Error-correction model

1. Introduction

In the past two decades, China has achieved rapid economic growth, and emerged as the second largest electricity consumer in the world, just behind the United States. Historically, the electric power industry was designated as a driving force of China's economic growth. In line with the rapid expansion of the Chinese economy after the late 1970s, there has been an increasing demand for electricity. In the past two decades, there has also been a growing interest in the study of the causal relationship between energy consumption and economic growth. However, it was surprising that so far there has been no empirical work on China. The purpose of this paper is to fill the gap in the empirical literature on the causal relationship between electricity and income, by studying the situation of China.

At present, the Chinese government has a policy target of achieving a sustained growth rate of 7% per year. This implies that total output will be doubled every 10 years. The study of the causal relationship between electricity consumption and GDP will help us better understand the role of electricity in China's economic growth. The results of causality tests can shed light on future electricity policies, such as conservation programs, the planning of capacity expansion and the construction of nation-wide interconnection of power networks. Therefore, it is important to understand the relationship between electricity and income, should China want to avoid the electricity shortages that occasionally hampered its economic growth in the past.

The study of the causal relationship between energy consumption 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, and Japan (Yu and Choi, 1985; Erol and Yu, 1987). In 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 (e.g. Stern, 1993; Stern, 2000) tested for Granger causality in a multivariate setting by using a vector autoregression model.

In recent years, empirical works on the causal relationship between energy consumption and economic growth have been focused on Asian economies. For example, Glasure and Lee (1997) have examined the causal relationship between energy consumption and GDP for South Korea and Singapore. The results of the cointegration and error-correction models indicate bidirectional causality for both countries. In contrast, Granger causality tests show a unidirectional

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0301-4215/04/$ - see front matter
PII: S0301-4215(02)00250-1

relationship running from energy to GDP for Singapore, but no causal relationship between energy and GDP for South Korea. The results for South Korea contrast with those of the Yu and Choi (1985) study, which showed unidirectional causality from GNP to energy consumption based on the standard Granger test.

The results of studies for Taiwan, another newly industrialized economy, are also mixed. Cheng and Lai (1997) find causality running from GDP to energy consumption without feedback, while Yang (2000) finds bidirectional causality in his study. Yang's result is consistent with the findings of an earlier study done by Hwang and Gum (1992). He attributes the difference between his result and that of Cheng and Lai to the use of different sample periods, and the choice of different price indexes in measuring real GDP. Masih and Masih (1998) have applied Johansen's multiple cointegration tests for the cointegration of the energy consumption, real income, and price levels of two less-developed Asian countries: Thailand and Sri Lanka. They find that energy consumption is itself relatively exogenous, and conclude that it plays an important role in influencing income and prices.

Recently, Asafu-Adjaye (2000) has used cointegration and error-correction modeling techniques to estimate the causal relationships for India, Indonesia, the Philippines, and Thailand. His results indicate a short-run unidirectional Granger causality running from energy to GDP for India and Indonesia, but a bidirectional relationship for the other two countries. Asafu-Adjaye's empirical results for Indonesia and the Philippines are different from other studies (Yu and Choi, 1985; Masih and Masih, 1996). Moreover, he includes energy prices in his study, and finds that energy, income, and prices are mutually causal for the Philippines and Thailand. For India and Indonesia, however, the causality is unidirectional, running from energy and prices to income. The results for India in Asafu-Adjaye's study contrasts with those obtained from Ghosh (2002). Ghosh has applied Granger causality test on the bivariate vector autoregressive model (VAR) to test for causal relationship for India. Similar to our study, he focuses on a particular form of energy, i.e. electricity. The results indicate that there is unidirectional Granger causality running from economic growth to electricity consumption without any feedback effect.

In Table 1, we summarize the empirical findings of the causality tests between energy/electricity and income for a number of Asian economies.

Despite the expanding literature on the study of causal relationships between energy and income for Asian economies, as mentioned at the beginning, there

Table 1
Empirical results from causality tests for Asian countries or economies

Country	Empirical work	Study period	Causal relationship (method used)
India	Masih and Masih (1996)	1955–1990	Energy→income (error-correction)
	Asafu-Adjaye (2000)	1973–1995	Energy→income (error-correction)
	Ghosh (2002)	1950–1997	Income→electricity (unrestricted VAR)
Indonesia	Masih and Masih (1996)	1960–1990	Income→energy (error-correction)
	Asafu-Adjaye (2000)	1973–1995	Energy↔income (error-correction)
Japan	Erol and Yu (1987)	1950–1982	Energy→income (standard Granger)
		1950-1973	Income→energy (standard Granger)
Malaysia	Masih and Masih (1996)	1955–1990	Non-cointegrated (error-correction)
Pakistan	Masih and Masih (1996)	1955–1990	Income↔energy (error-correction)
Philippines	Yu and Choi (1985)	1954–1976	Energy→income (standard Granger)
	Masih and Masih (1996)	1955–1991	Non-cointegrated (error-correction)
	Asafu-Adjaye (2000)	1971–1995	Energy↔income (error-correction)
Singapore	Masih and Masih (1996)	1960–1990	Non-cointegrated (error-correction)
	Glasure and Lee (1997)	1961–1990	Energy↔income (error-correction)
			Energy→income (standard Granger)
South Korea	Yu and Choi (1985)	1954–1976	Income→energy (standard Granger)
	Glasure and Lee (1997)	1961–1990	Energy↔income (error-correction)
			No relationship (standard Granger)
Sri Lanka	Masih and Masih (1998)	1955–1991	Energy→income (error-correction)
Taiwan	Hwang and Gum (1992)	1961–1990	Energy↔income (Granger and Hsiao)
	Cheng and Lai (1997)	1955–1993	Income→energy (Hsiao's Granger)
	Yang (2000)	1954–1997	Energy↔income (error-correction)
Thailand	Masih and Masih (1998)	1955–1991	Energy→income (error-correction)
	Asafu-Adjaye (2000)	1971–1995	Energy↔income (error-correction)