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Coal consumption and economic growth in China

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ABSTRACT

The aim of this paper is to re-examine the relationship between coal consumption and real GDP of China with the use of panel data. This paper applies modern panel data techniques to help shed light on the importance of the heterogeneity among different regions within China. Empirical analyses are conducted for the full panel as well as three subgroups of the panel. The empirical results show that coal consumption and GDP are both I(1) and cointegrated in all regional groupings. Heterogeneity is found in the GDP equation of the full panel. The regional causality tests reveal that the coal consumption–GDP relationship is bidirectional in the Coastal and Central regions whereas causality is unidirectional from GDP to coal consumption in the Western region. Thus, energy conservation measures will not adversely affect the economic growth of the Western region but such measures will likely encumber the economy of the Coastal and Central regions, where most of the coal intensive industries are concentrated.

1. Introduction

Coal is the principal primary energy source in China and it is given a strategic role in the economic growth of the country. According to the official figures from the National Bureau of Statistics, in 2009, coal accounted for 70% of the total energy consumed and 77% of the total energy produced in China. Because of its abundance in proven reserves and its stability in supply, coal will continue to be a key component of the primary energy mix in the country at least over the next few decades. However, coal also accounts for a large share of greenhouse gas (GHG) emissions generated by anthropogenic activities, and coal is the most carbon intensive fossil fuel. GHG emissions reduction in this carbon-constrained global environment will prove to be inevitable and the Chinese coal industry may experience significant impact from GHG emissions reduction policies.

The relationship between coal consumption and economic growth is an important issue regardless of the direction of causality. First, as coal is an input to production processes, the consumption of coal may influence economic growth. As noted by some other authors (e.g. Apergis and Payne, 2010), if causality flows this way, then attempts to curb GHG emissions through energy conservation may be harmful to economic growth. On the other hand, based on the theory of demand, causality can be expected to run from economic growth to coal consumption through the income effect. In this case the estimated relationship (together with GDP forecasts) may be useful for the projection of future coal consumption. If the causal relationship is bidirectional and positive, then energy conservation policies may retard economic growth and the consumption of coal may be reduced further. The Chinese leaders may well be aware of the potential negative impacts of energy conversation to economic growth—as stated in the Eleventh Five-Year Plan of the People's Republic of China, one of the targets is to reduce energy consumption per unit of GDP by 20% in five years (Yan, 2006a). A plausible interpretation of this target is that there was no plan to massively reduce energy consumption, but the efficient use of energy should be promoted. In fact, the key projects outlined in the Five-Year Plan for revitalizing China's equipment manufacturing industry showed the intention of the Chinese leaders to improve the overall energy efficiency in the country (Yan, 2006b).

Since the seminal work of Kraft and Kraft (1978), the relationship between energy consumption and economic growth has been subject to extensive and continuous scrutiny. No consensus can be reached in the huge body of empirical work regarding the causal relationship between the two variables. The relationship between energy consumption and economic growth in China has also received considerable attention at both the aggregated and disaggregated levels of energy consumption. For example, Soytas and Sari (2006) find no causal relationship between total energy consumption and GDP. Zou and Chau (2006) find unidirectional

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causality from oil consumption to GDP in the short-run and bidirectional causality in the long-run. Despite the differences in time period and detailed modeling strategy, Shiu and Lam (2004) and Yuan et al. (2007) both find unidirectional causality from electricity consumption to real GDP. Regarding the causal relationship between coal consumption and GDP in China, Li et al. (2008) and Wolde-Rufael (2010) both find Granger causality from GDP to coal consumption but not in the other direction. Yuan et al. (2008) also find unidirectional short-run causality from GDP to coal consumption, but causality is bidirectional in the long-run.

There is also an extensive literature on the relationship between coal consumption and GDP in countries other than China, including Yang (2000), Sari and Soytas (2004), Lee and Chang (2005), Yoo (2006), Hu and Lin (2008) and Apergis and Payne (2010). The conclusions from these studies are mixed. For countries being examined by more than one study (e.g. Japan, India, Korea and South Africa), the findings often appear to be conflicting. We must point out that with the exception of Apergis and Payne (2010), all of the above studies regarding the GDP–coal consumption relationship relied on the use of time-series methods.

The above brief literature review shows that the estimated relationships appear to depend on the chosen time span, geographic region and data structure as well as econometric methodology. To the best of our knowledge, no study in the literature has attempted to investigate the GDP–coal consumption relationship in China using panel data. Since China itself is a big country with different economic structures in different regions, the use of provincial level panel data for China enables us to take into consideration the presence of heterogeneity among the provinces. Panel data opens up the potential to reveal heterogeneous relationships, which will normally be "aggregated away" through the use of national level time-series data. Also, the power property of unit root and cointegration tests can be improved by bringing in a cross-section dimension to the time-series data. The results of this study will be of interest to researchers in the field because the results show that differences in the economic structure and stage of economic development may influence the relationship between energy consumption and economic growth. Also, our results may provide inputs to policymakers as they develop policies related to energy saving, emissions reduction and economic growth.

The aim of this paper is to investigate the relationship between coal consumption and GDP in China with the use of provincial level panel data. In order to shed light on the potentially heterogeneous relationships across different regions, causal relationships are examined in the overall panel as well as specific groups within the panel. The rest of this paper is structured as follows. Section 2 briefly reviews the economic structure in various regions of China. Section 3 describes our empirical methodology. Section 4 presents the empirical results. Section 5 further discusses the results and concludes.

2. Coal use and the regional structure of China

In the Seventh Five-Year Plan (1986–1990), the 31 provinces in China were grouped into three economic belts in order to promote specialization and division of labor. The Coastal region consists of Liaoning, Beijing, Tianjing, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Hainan and Guangxi. This region specializes in export-oriented industries, including steel, chemicals, engineering and textiles. The Central region consists of Heilongjiang, Jilin, Inner Mongolia, Shanxi, Henan, Anhui, Hubei, Hunan and Jiangxi. This region is less developed than the Coastal region in terms of economic and industrial development. Most of the coal and metallurgical industries, as well as agricultural production, are concentrated in this region. Finally, the Western region consists of Shaanxi, Gansu, Ningxia, Xinjiang, Qinghai, Sichuan, Guizhou, Yunnan and Tibet. This is the least developed region in the country and it specializes in animal husbandry and mineral resources industries. Also, industrialization is given a low priority in this region.

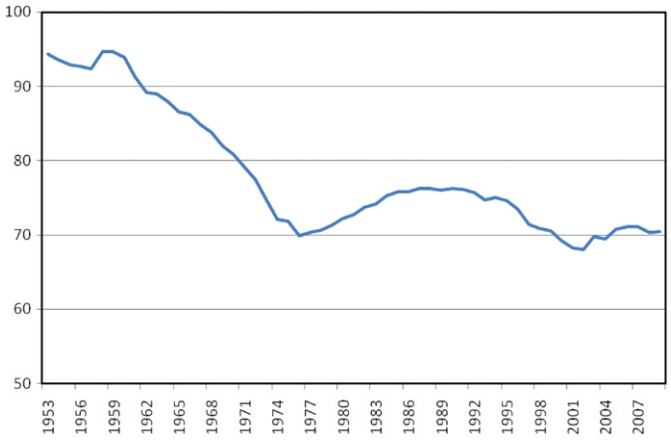

Fig. 1. Percentage share of coal in total energy consumption (1953–2009). *Source*: CEIC China Premium Database.

Coal has long been the dominant fuel of choice in China. Although the share of coal in total energy consumption has fallen from over 90% in the 1950s to around 70% in the 2000s (Fig. 1), this share still exceeds the world average by a considerable margin. In 2008, 44% of the coal in China was consumed by the manufacturing sector and 44% was consumed by the electricity, gas and water industries. As shown by the 2008 statistics from the International Energy Agency (2010), 81% of the electricity in China was produced from the combustion of coal. In the same year, the industrial sector accounted for 74% of the total electricity consumption while residential consumption accounted for only 12% (China Electricity Council, 2009). These figures reveal the importance of coal in the manufacturing and industrial sectors in China.

According to Kaldor's Laws of Growth, the manufacturing/industrial sector is the engine of economic growth (Thirlwall, 1983). Hansen and Zhang (1996) provide empirical evidence in support of Kaldor's laws in China. They found that in the period 1985–1991, growth in the Chinese industrial sector actively motivates the whole economy. Given the intensive use of coal in the manufacturing and industrial sectors in China, the growth in these sectors is naturally associated with an increase in coal consumption. Therefore, there is a higher chance that we will find causality running from coal consumption to economic growth in regions where the manufacturing and industrial sectors account for a larger share of the total output. On the other hand, in the non-industrial regions, because the manufacturing and industrial sectors do not play a significant role in the total economic output, we may not find causation from coal consumption to economic growth.

3. Empirical methodology and data description

The empirical strategy employed in this paper can be divided into three main steps. In the first step, we establish the panel unit root and cointegration characteristics of the data. In the second step, we examine short-run and long-run causalities between coal consumption and real GDP in the panel. Finally, the above two steps will be repeated for various groups within the panel. It should be noted that there is a growing literature on panel data