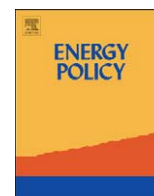




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Gradual reforms and the emergence of energy market in China: Evidence from tests for convergence of energy prices

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ABSTRACT

This study investigates the emergence of energy markets by testing for convergence of energy prices with a new dataset on energy spot prices in 35 major cities in China. Both descriptive statistics and unit root are employed to test the convergence of energy prices for each of four fuel price series. The whole study period is divided into two sub-periods in order to reconcile the gradual energy reforms. The results show the steady improvement in energy market performance in China, especially during the second sub-period, which suggests that the market appears to be playing an increasing role in determining energy prices. While panel unit root tests show energy markets are integrated in China as a whole, city-by-city univariate unit root tests suggest that there are still many regional energy markets, probably because energy reserves (especially coal) vary widely across regions. Since China's energy economy is *gradually* moving towards market-oriented mechanisms, the existing literature may become obsolete soon.

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1. Introductions

The ongoing transition of former communist countries from planned to market economies has been one of the most important economic phenomena in the last few decades. It is interesting, therefore, to consider whether liberalization of domestic trade prompts major shifts in price structures that were highly distorted under central planning (Fan and Wei, 2006). Moreover, in the context of China there is continued debate about whether gradualist reform has been successful (Lau et al., 2000; Young, 2000). Since China embarked on its economic reform and adopted an open door policy in the late 1970s, its economic development has been greatly enhanced by active participation in international trade. However, recently there has been more debate about domestic trade with China's major trading partners urging further opening of the domestic market, especially post-accession to the World Trade Organization (WTO). Moreover, even if the Chinese government removes remaining barriers to international trade, the effectiveness of this policy might be compromised by regional trade barriers within China itself (Fan and Wei, 2006; Poncet,

2003, 2005). It is thus useful to investigate whether domestic markets in China are in fact integrated.

One of the most important and potentially interesting and influential markets to investigate for evidence of integration is the energy market. China is undergoing a period of rapid increases in energy consumption which are likely to continue for some decades. Primary energy consumption in China has risen 70% in the last decade, compared with a 13% rise in OECD countries and 30% for the world as a whole. Since 1996, rising demand has turned China from a net energy exporter to a net energy importer, with consumption more than 10% above production since 2005. This switch is even more marked for petroleum products; China produced 35% more oil than it consumed in the mid 1980s, but nearly one-half of total oil consumption had to be imported in 2005. China's net imports of petroleum and products have more than doubled, from 75.8 million metric tonnes (mmt) in 2000 to 168.3 mmt in 2006 (CSY, 2007). Given the current petroleum trade situation, some have attempted to predict China's energy demand (Chan and Lee 1996; Sinton and Fridley, 2000; Crompton and Wu, 2005). Such studies rely on a link between changes in China's aggregate economy and energy use, which may be affected by ongoing energy market reforms. Hence, it may matter which economic environment, the aggregate economy or the energy economy, is used to produce predictions of energy consumption.

Another important feature of the energy market in China is the fact that energy intensity (the ratio of energy consumption to output) is high by international standards, at 0.91 ton oil

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equivalent per thousand US\$ GDP (at 2000 price base in 2005) compared with 0.32 for the world as a whole and just 0.19 in OECD countries (CESY, 2007). Given China's economic size and high energy intensity, any improvements in energy efficiency will affect world energy demand and in turn the world energy price. While a large literature has studied changes in China's energy intensity (Garbaccio et al., 1999; Zhang, 2003; Fisher-Vanden et al., 2004; Liao et al., 2007; Qi et al., 2007; Zhang and Ding, 2007; Ma and Stern, 2008), few studies have investigated whether specific features of the energy market have been playing a critical role. Yet, energy efficiency depends on the energy pricing mechanism for the allocation of energy resources, and also energy prices have a potential impact on energy intensity in China (Lam, 2004; Qi and Chen, 2006; Hang and Tu, 2007).

As argued above, despite the importance of energy prices and energy market integration in China, the literature in several key areas ignores this issue, for example, many studies investigate the potential cointegrating relationship between China's energy consumption and economic growth (Shiu and Lam, 2004; Chen et al., 2007; Yuan et al., 2007, 2008; Lee and Chang, 2007, 2008; Zou and Chau, 2006; Wang et al., 2005). However, any long-run cointegrating relationship identified by these studies is conditional on the continuation of the current energy regulation system. The cointegrating relationship would potentially change or even disappear if the current energy regulation system is changed and this would crucially affect any future predictions or forecasts. Since China's energy economy is still in transition with resource allocation *gradually* moving towards market-oriented mechanisms (Lau et al., 2000; Xu and Chen, 2006; Wang, 2007; Fan et al., 2007), the existing literature may quickly become obsolete.

A particular literature which should be concerned about energy market integration in China is that which examines the role played by the price of energy in determining economic growth and inflation rates (Adrangi et al., 2001; Asche et al., 2003; Stern, 2000; Girma and Paulson, 1999; Gjolberg and Johnsen, 1999; Shaked and Sutton, 1982). Given China's high energy intensity and economic size and global influence, it is surprising to find that little work along this line has been done in China. One reason for this lacuna may be a concern as to whether there is a market-oriented energy economy in China.

The absence of attention to energy market integration in China is also surprising as integration and the emergence of a market economy has been shown for China's agricultural commodity sector (Zhou et al., 2000; Huang and Rozelle, 2006), and in many other countries, energy market integration has been extensively investigated (Asche et al., 2002, 2006; Bachmeier and Griffin, 2006; De Vany and Walls, 1999; Narayan and Smyth, 2005; Adrangi et al., 2001; Asche et al., 2003; Gjolberg and Johnsen, 1999; Serletis, 1994). Yet, only one study, Fan and Wei (2006), considers China, and their study tests for the existence of price convergence of only gasoline and diesel, which one might expect, *a priori* to be the most likely energy sources to show market integration. Moreover, Fan and Wei (2006) did not consider the effect of gradual reforms in China. To the best of our knowledge, therefore, there has been no specific study of energy market integration using data from China, which also considers the two other key energy sources, coal and electricity.

Given the fundamental importance of understanding the emergence of an energy market to studies of China's economic growth and energy economy, this paper is concerned with testing the spatial convergence of energy prices. We use a new, high frequency, dataset on spot prices of four energy types (coal, electricity, gasoline and diesel) from 35 cities collected at 10-day intervals over a maximum of 132 months (from 1995 to 2005). We also crucially consider the impact of China's gradual energy

reforms on the formation of energy markets. We first use our data to sketch a descriptive picture of how China's energy prices converge in markets separated by long distances. Then we examine how price data points from different markets across space (but during the same period) relate to each other graphically (which is done by tracing out transportation gradients in China's coal, electricity, gasoline and diesel markets). Finally, we employ a panel unit root approach to test the convergence of energy prices as a whole (Banerjee, 1999; Maddala and Wu, 1999).

The study is organized as follows. In Section 2 we introduce and discuss the energy price data sets and preliminary analysis. This is followed in Section 3 by discussion of price trends and spatial patterns of market emergence. Section 4 presents univariate and panel unit root tests and tests for energy price convergence. Section 5 comprises a discussion of energy market from an international perspective. The final Section 6 presents conclusions and implications.

2. Data issues and preliminary analysis

2.1. Data source

The dataset comprises a panel of 10-day prices for four energy products in 35 major Chinese cities.¹ The price data are collected by the China Price Monitoring Centre (CPMC)—a division of the State Development and Reform Commission (SDRC) of the People's Republic of China. The data are spot prices and are regularly collected on a 10-day interval (the 5th, 15th and 25th of each month) from local markets by local governmental agencies.²

Unlike other market price data, the fuel price data have no missing data during the study period as fuels are extensively used in all cities. We use four major fuel products; coal, electricity, gasoline and diesel. These panel data are truly nationally representative because they cover the main fuel components, all provincial capital cities of mainland China, and the period, 1995–2005. This is to be contrasted with most other empirical studies, which use a price index of lower frequency (typically annual) data. The 10-day frequency of the data also corresponds well to the time required for domestic price arbitrage as lower frequency (monthly) price data are less likely to show any rapid arbitrage when we wish to test for price convergence with any degree of precision (Taylor, 2001). Furthermore, monthly spot prices are not as rich a data source as 10-day spot prices, particularly if one wants to measure the half-life of subsequent adjustment following the shorter time response (Bachmeier and Griffin, 2006).

The quality of Chinese data is often criticized as reporting in China is often affected by political factors (Rawski, 2001). However, we believe that the data for specific product prices collected by local government agencies under strict government mandates are unlikely to be subject to manipulation. Central government requires the collection of prices for specific products at fixed dates and locations and these price data are also available

¹ These cities are Beijing, Tianjin, Shijiazhuang, Taiyuan, Hohhot, Shenyang, Changchun, Harbin, Shanghai, Nanjing, Hangzhou, Hefei, Fuzhou, Nanchang, Jinan, Zhengzhou, Wuhan, Changsha, Guangzhou, Nanning, Haikou, Chongqing, Chengdu, Guiyang, Kunming, Lhasa, Xi'an, Lanzhou, Xining, Yinchuan, Urumqi, Qingdao, Dalian, Xiamen and Ningbo.

² The price data are collected to provide price information to the central and local governments for macroeconomic management. According to state law, the local price bureaus in 31 major cities are obligated to report price information for a specified list of products to the Price Information Center. The price information must be collected from fixed local markets. The fuel price information is collected three times a month, on the 5th, the 15th and the 25th day of the month. The fuel names are uniform across all cities, and all prices must be market prices.

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