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[*TOTAL-FACTOR ENERGY EFFICIENCY IN CHINA: A SPATIAL ECONOMETRIC PERSPECTIVE*]

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Keywords

SBM-DEA window analysis; total-factor energy efficiency; spatial lag model; spatial error model

Overview

The prominent contradiction among fast economic development, energy consumption and environmental pollution has been paid much more attention in China. China has made tremendous efforts to save energy and obtained a series of achievements. For example, China energy consumption per 10,000 yuan RMB gross domestic product (energy intensity) declined by approximately 5% per year during 1970-2001, and dropped by 46.6% during 1990-2005. However, during 2002-2005, energy intensity had an average of 3.8% increase per year. China had voluntarily set a target of reducing energy intensity by 20% for the period 2006-2010, and it was actually achieved a reduction of 19.1%. By 2006, nearly 50% of global energy demand growth was contributed by China (Zhou et al., 2010). China has become a large importer of energy and has a rapid rise in carbon dioxide (CO_2) emissions, especially in international trade (Du et al., 2011). In 2007, China produced 6 billion tonnes $CO_{2,}$ about 21% of global CO_2 emissions, and surpassed the US to become the world's largest CO_2 emitter (IEA, 2009). In 2009, China pledged to reduce carbon dioxide emissions per unit of GDP (CO_2 intensity) by 40%-45% by 2020 from 2005 level. The "12th Five-Year Plan for National Economic and Social Development" was endorsed by the National People's Congress on March 14 in 2011, in which a "green, low-carbon development concept" was established. This is the first plan committing to introducing market mechanisms to control energy consumption and carbon pollution. It includes several new carbon and energy targets from 2010 level by 2015: to increase the proportion of non-fossil fuels in energy consumption to 11.4%; to reduce energy intensity and CO_2 intensity by 16% and 17%, respectively. Therefore, energy efficiency has inevitably become a vital part of the energy strategy in China aiming at saving energy and reducing CO_2 emissions. Actually, large differences exist among China regions in energy efficiency due to large regional development imbalance. As Huang and Todd (2010) showed: apart from China's early years, energy efficiency (defined as tonnes of coal equivalent energy per 10,000 yuan RMB) in Eastern Area has been consistently much higher than that of in Western Area and Central Area. It is necessary to assess the enengy efficiency of China's regions and to obtain the impacting factors to illustrate the characteristics of China's enegy consumption and conservation.

Methods

Under a total-factor framework, this paper firstly uses a slack-based measured data envelopment analysis model (SBM-DEA) with undesirable outputs combined with DEA-window approach to investigate energy efficiencies and the maximum potential energy saving of 29 provincial-administrative regions (PAR) and eight areas in China. Then, Spatial lag model and spatial error model were also adopted to explore the spatial dependence and the impacting factors of regional energy efficience.

Results

For PARs, Fujian, Guangdong, Shanghai and Hainan performed best, while Qinghai, Shanxi, Guizhou and Ningxia did worst during the same period. Jilin, Beijing and Heilongjiang had the most rapid rise in TFEE. For areas, South Coastal Area was the most energy-efficient area, Northwest was the worst, and Northeast experienced the most increase of TFEE. From the viewpoint of energy savings, Hebei has the largest potential energy savings, followed by Shaanxi, Sichuan, Liaoning, Shandong, Henan, Inner Mongolia and Guizhou, totally accounted for 60.9% of the whole national potential energy savings. Middle Yellow River Area and Northern Coastal Area account for nearly half of national potential energy saving. Finally, taking both low energy efficiency and large potential savings into consideration, Hebei, Shaanxi, Sichuan, Liaoning, Middle Yellow River Area, Northern Coastal Area and Southwest should be paid much more attention in China. In addition, by spatial lag test and spatial error test, the spaitial correlation and dependence can be proved in this paper. Using spaial lag model and spatial error model, we can obtain some impacting factors of regional energy efficiency, such as energy price, industry strcture, administration level of local government.

Conclusions

Energy-saving policies should be implemented according to various characteristics of provinces and areas, especially for some special provinces or areas, such as Hebei, Shaanxi, Sichuan, Liaoning, and Middle Yellow River Area, Northern Coastal Area and Southwest. In addition, regional energy efficiency of China has positive dependence. That is to say, once the energy efficience is improved in one region, the energy efficiency of neiborhood region will be improved as well, which can be used to explain the change of regional energy efficiency and the impacting factors.

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