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Interprovincial transfer of embodied energy between the Jing-Jin-Ji area and other provinces in China: A quantification using interprovincial input-output model

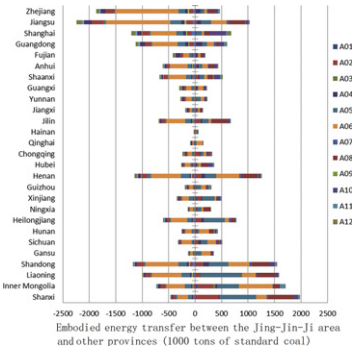
Weiming Chen [a,b], Sanmang Wu [a,b,*], Yalin Lei [a,b], Shantong Li [c]

[a] School of Humanities and Economic Management, China University of Geosciences, Beijing 100083, China
[b] Key Laboratory of Carrying Capacity Assessment for Resource and Environment, Ministry of Land and Resource, Beijing 100083, China
[c] Development Research Center of State Council, Beijing 100010, China

HIGHLIGHTS

- The embodied energy transfer between the Jing-Jin-Ji area and other provinces in China has been tracked in detail.
- In 2010, the Jing-Jin-Ji area imported 180.73 million tons embodied energy from other provinces, exported 167.26 million tons to other provinces.
- The Yangtze River Delta and Pearl River Delta tend to import more embodied energy from the Jing-Jin-Ji area.

GRAPHICAL ABSTRACT



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ABSTRACT

Commodity trade between regions implies a large amount of energy transfer. As an important economic growth pole of China, the Jing-Jin-Ji area (Beijing-Tianjin-Hebei) is also one of the areas with the largest energy consumption in China. Moreover, the primary energy consumer goods in this area are fossil fuels, such as coal. This has led to serious air pollution in the area. Therefore, the reduction of energy consumption under the premise of maintaining sustained economic growth is an important task of the Jing-Jin-Ji area. In this study, an interprovincial input-output model was applied to quantitatively estimate the embodied energy transfer between Jing-Jin-Ji area and other provinces in China. The results indicated that the Metal and nonmetal mineral processing industry and the Electrical, gas and water industry in the Jing-Jin-Ji area exported a large amount of embodied energy to the Yangtze River Delta and the Pearl River Delta. However, the embodied energy export of the Jing-Jin-Ji area mainly exported by Hebei province. Beijing and Tianjin even have some net import of embodied energy. The embodied energy transfer between Tianjin, Hebei and other provinces was mainly driven by investment, while the main media of embodied energy transfer between Beijing and other provinces was consumption. Therefore, we suggest that the Jing-Jin-Ji area should further increase the degree of dependence on other provinces' energy-intensive products and reduce the export of energy-intensive products. In addition, there should be difference in the energy and industrial policies among Beijing, Tianjin and Hebei, and the problems of high energy consumption and high proportion of heavy industry in Hebei should be first resolved.

* Corresponding author at: School of Humanities and Economic Management, China University of Geosciences, Beijing, No. 29 Xueyuan Road, Haidian District, Beijing 100083, China.
E-mail address: wusanmang@sina.com (S. Wu).

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1. Introduction

The Jing-Jin-Ji area, including the two municipalities of Beijing and Tianjin, and the large industrial province of Hebei, is China's major high-tech and heavy industrial base. It is also the location of China's political, cultural, international communication, and technological innovation centers, and the area is known as one of China's three economic growth poles; the other two are the Yangtze River Delta and the Pearl River Delta. However, compared with the Yangtze and Pearl River Deltas, the economic development of the Jing-Jin-Ji area is lagging. In 2015, the GDPs of the Jing-Jin-Ji area, the Yangtze River Delta and the Pearl River Delta were 6.9, 11.3 and 6.2 trillion yuan RMB, respectively, and the per capita GDPs were 63, 75 and 111 thousand yuan RMB (National Bureau of Statistics of China, 2016). On the other hand, due to the rapid economic growth and the high proportion of traditional heavy industry in the Jing-Jin-Ji area, energy consumption in this region has remained high in recent years. This trend has led to a shortage of energy and serious air pollution in the area.

In 2013, the total energy consumption in the Jing-Jin-Ji area was 443 million tons of standard coal equivalents, accounting for 10.36% of the total energy consumption in China. Of the total energy consumption, the usage of coal was 390 million tons, as coal has always been the primary energy source in the area (National Bureau of Statistics of China, 2014). Furthermore, the land area of the Jing-Jin-Ji area is 217,000 km^2, which comprises only 2.2% of China. Thus, the coal consumption per unit land area in Jing-Jin-Ji is much higher than the national average, as much as 2.5 times that fold higher than that of the eastern region of China and 30 30-fold higher than the global average. This is the main cause of persistent heavy fog and haze in the Jing-Jin-Ji area in recent years. According to the "2013 China Environmental Status Bulletin", among the 10 cities with the worst air quality in China, seven were in the Jing-Jin-Ji area (Ministry of Environment Protection of the People's Republic of China, 2014).

Accordingly, the Jing-Jin-Ji area needs to continue to develop its economy and give full play to the role of economic growth, but in the interim, this area is facing serious ecological and environmental pressure. Therefore, the Jing-Jin-Ji area urgently needs a development path for low carbon energy consumption that does not interfere with economic growth. Previous studies on this issue concentrated on the improvement of the energy consumption efficiency or the transformation of the energy consumption structure. However, the improvement of energy consumption efficiency relies on the optimization of the industrial structure and the improvement of production technology; however, significantly increasing energy efficiency in a short period of time is difficult. In addition, the actual situation of the current domestic energy supply market does not allow the percentage of clean energy to be significantly increased in a short period of time.

At present, China's interprovincial product trade, including intermediate and final product trade, is becoming increasingly frequent (Zhang and Li, 2013). Product transfer results in the transfer of energy consumption (the so-called embodied energy) between each province. Thus, one region can reduce its use of local energy by directly importing products from other provinces or by reducing the export of high energy consuming products (Wu et al., 2015). The amount of energy consumption in the Jing-Jin-Ji area can be reduced in this manner in a relatively short period of time and can prompt the area to raise the proportion of low-energy industry. However, the first task of industrial structure and interprovincial trade adjustment is to fully grasp the embodied energy transfer involving the Jing-Jin-Ji area.

But before we conduct this study, the actual patterns of Jing-Jin-Ji economy must be taken into consideration, which is very import to the discussion and policy analysis in this paper. Actually, even though the Jing-Jin-Ji area is one of the most developed areas in China, the industrial structure and level of development among Beijing, Tianjin and Hebei are quilt different. The most direct evidence is the quite different ratios of the tertiary industry to secondary industry among Beijing, Tianjin, Hebei (Fig. 1), the reason that the primary industry has not been considered is the proportions of the primary industry in Beijing, Tianjin, Hebei have remained low in recent years (about 1% in Beijing, 2% in Tianjin, 11% in Hebei (National Bureau of Statistics of China, 2016)).

According to the results in Fig. 1, Beijing has the highest proportion of the tertiary industry. Both Tianjin and Hebei have remained a high proportion of the secondary industry. In addition, the proportion of the tertiary industry in Beijing shown a significant increase from 2006 to 2015, while the industrial structure of Tianjin and Hebei were practically fixed in the same period.

The great difference of industrial structure and level of development among Beijing, Tianjin and Hebei have inevitably leaded to the difference in embodied energy transfer between these areas. For this reason, by using an interprovincial input-output model, not only the inter-provincial embodied energy transfer issues between Jing-Jin-Ji area and other provinces in China have been well studied in this article, but also the embodied energy transfer issues of Beijing, Tianjin, Hebei have been well studied.

2. Literature review

Since the total amount of energy consumption in an area is closely related to the area's energy intensity index, when the reduction of energy consumption in a given area, the first thought is to reduce the energy intensity. So, research on energy intensity has always been a hot topic in the research of energy issues (Wang W. et al., 2014; Wang Q. et al., 2014). Among such studies, most research has focused on the energy intensity at the national level. For example, to reduce the energy intensity

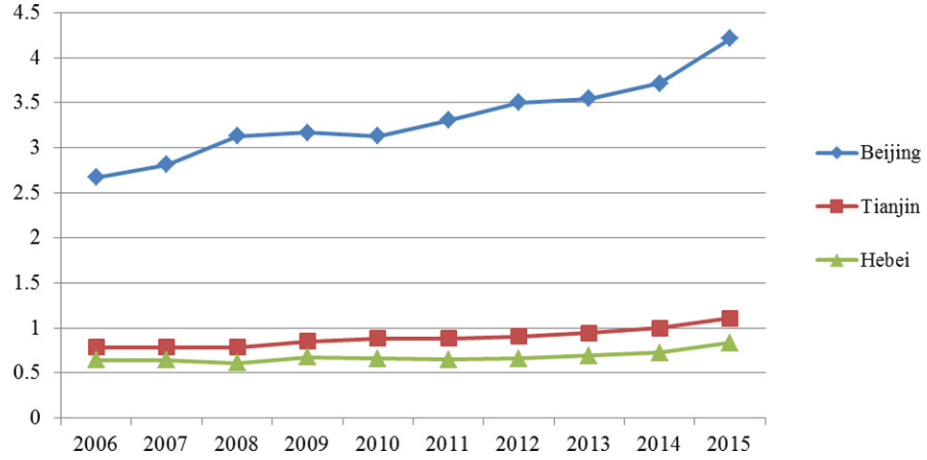

Fig. 1. The ratios of the tertiary industry to the secondary industry in Beijing, Tianjin, Hebei.