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The impact of China's Central Rise Policy on carbon emissions at the stage of operation in road sector

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ABSTRACT

The Central Rise Policy has been implemented by Chinese government since 2006, which includes a series of CO_2 emissions reduction measures for the road sector so as to give full play to the advantage of transportation hubs in central China, as well as to coordinate the development of economy and environment. However, the effectiveness of these measures is still obscure. This paper first adopts the spatial difference-in-differences (SDID) model to evaluate the effect of the Central Rise Policy on CO_2 emissions at the stage of operation in road sector in the six provinces in central China, then explores whether there is CO_2 rebound effect diminishing the effect of the Central Rise Policy based on the Linear Approximation of the Almost Ideal Demand System (LA-AIDS) model. The results show that, first, the impact of the Central Rise Policy on CO_2 emissions at the stage of operation in road sector proves relatively weak during 2006–2015. Second, the energy intensity and, total turnover of the road sector, highway mileage, fuel mixture and population density produce negative spatial spillover effect, whereas the per capita CO_2 emissions of the road sector shows the opposite. Finally, the CO_2 rebound effect is an important factor for the effect of Central Rise Policy on CO_2 emissions at the stage of operation in road sector, and the average total CO_2 rebound effect for the road sector is 8.01% in the six central provinces.

1. Introduction

With the rapid development of economy, China's energy consumption has been increasing in the past decades. According to the BP Statistical Review of World Energy (BP, 2017), China's primary energy consumption has surpassed the US since 2009, and now China is the largest energy consumer and CO_2 emitter in the world (Liu et al., 2016). Meanwhile, the transportation industry is the principal source of energy consumption in China, and its energy consumption accounts for more than 8% of the total energy consumption in China (Zhang et al., 2015). In particular, the energy consumption of the road sector plays a dominant role in transportation industry.[1] According to the data released by China's Energy Research Association, the energy consumption of the road sector respectively accounted for 47.6%, 59% and 68.1% of the total energy consumption in the national transportation in 1990, 1995 and 2000 (Chai et al., 2016). Besides, Cai et al. (2011) claimed that China's road sector produced more than 85% of the total CO_2 emissions of transportation industry.[2] Therefore, the road sector should be one of the most important sectors for China to achieve its energy conservation and CO_2 emission reduction goals.

The six central provinces in China (i.e., Henan, Hubei, Hunan, Jiangxi, Anhui, Shanxi) connect China's east with west, link the south with the north, and have become the vital transportation hubs. The road sector of the six central provinces has grown rapidly in recent years. By the end of 2015, the total road mileage in China had reached 4.5773 million kilometers, and the six central provinces accounted for 26.76% of the total mileage. Meanwhile, the operating vehicles of the road sector reached 14.7312 million units in 2015 in China, while the six central provinces owned 3.5987 million units, which accounted for 24.43%. Road transportation is a foundational and precursory industry of China's national economy, but it is also an energy intensive industry, and the rapid development of road transportation and motorization will boost the

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[1] "Road sector" mentioned in this paper refers to the public roads that are available for vehicles and checked by the competent department of road transportation in accordance with state regulations of the technical standards of road engineering construction, which include the roads in urban and rural areas as well as those between urban and rural areas. Details please see: http://zizhan.mot.gov.cn/zfxxgk/bnssj/glj/201304/t20130412_1423070.html.

[2] "CO_2 emissions in road sector" studied in this paper just refer to those at the stage of operation in road sector.

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growth of energy consumption and CO_2 emissions (Liu et al., 2015). Therefore, it is worthy to investigate how to realize the regular development of economy and transportation in the six central provinces, and reduce CO_2 emissions at the same time.

The Central Rise Policy is an important national economic development strategy after the opening of eastern coastal region, the developing of the western region and the rejuvenating of the northeastern old industrial base in China. It was first proposed by the former Premier WEN Jiabao in 2004 to take full advantage of "convenient traffic and "comprehensive economic strength" in central China, and to promote the rising of the six central provinces,[3] and then extended to the central part of the Inner Mongolia and the western part of the Guangdong.[4] Then *The Opinions on Promoting the Central Rise* was enacted by Chinese government in 2006, which demanded the six central provinces should vigorously implement the Central Rise Policy, and build the central regions into an important base of grain production, energy and raw materials, modern equipment manufacturing, high technology industries and comprehensive transport hub.[5] The Central Rise Policy is always at the center of improving the quality and efficiency of economic development, and adheres to the green, circular and low-carbon development. And some "green, recyclable and low-carbon" projects of road transportation are also included in the series of measures of the Central Rise Policy. *The Opinions on Promoting the Central Rise* in 2006 called on the central region to optimize the allocation of traffic resources and improve the network of trunk roads. And the new energy vehicles are vigorously promoted.[6] Then, the six central provinces all proposed different policies under the Central Rise Policy, but there is no difference in essence between the green development policies of road transportation system in the six central provinces; for instance, *The Plan on Promoting the Central Rise* of Henan and Anhui all required to develop new energy vehicles, including the energy-saving cars. In 2007, Chinese government proposed the construction of a resource conservative and environment friendly society (i.e., the so-called two-oriented society) as an additional policy for the Central Rise Policy. Wuhan Metropolitan Area in Hubei and Changsha-Zhuzhou-Xiangtan City Group in Hunan were chosen as the pilot areas for building the two-oriented society, which were aimed to develop the low-carbon transportation pattern. For instance, more green transportation vehicles have been introduced in Changsha-Zhuzhou-Xiangtan City Group, and the proportion of new energy vehicles would increase to 65% of all the new and updated buses by 2020.[7] Furthermore, *the 13th Five-Year Plan (FYP) for Promoting the Central Rise* was issued in 2016. It required the central provinces should continue to advance the construction of "two-oriented society" and give full play to the role of the "two-oriented society" comprehensive reform experimental region to build the national eco-civilization construction demonstration area. It also proposed to accelerate the construction of transportation infrastructure which is "safe and efficient" as well as "intelligent and green", and to promote the development and more use of new energy vehicles.

However, it is still unclear to conclude whether the Central Rise Policy can effectively enable the road sector in the six central provinces to achieve the goals of energy conservation and CO_2 emissions reduction. On the one hand, the energy consumption of road sector in the six central provinces is affected not only by the road transportation in this region, but also by that in other regions. This is due to the fact that the movement of trade and population between different regions will simultaneously increase the demand for road transportation (Hivin et al., 2015). Therefore, the effect of the Central Rise Policy on CO_2 emissions at the stage of operation in road sector in the six central provinces may receive a spatial impact from other regions. On the other hand, the measures of energy conservation and CO_2 emissions reduction in the Central Rise Policy could improve the energy efficiency of road sector in the six central provinces, thus the per-unit cost of energy service would decrease accordingly (Sorrell and Dimitropoulos, 2008). However, this may in turn lead to an increasing demand for this energy service. As a result, the expected energy savings through improving energy efficiency may not be fully realized, resulting in a phenomenon called "rebound effect" (Greening et al., 2000; Zhang et al., 2017b). For example, Matos and Silva (2011) found that the direct rebound effect for Portugal's road freight transport was 24.1%. Wang and Lv (2014) investigated the rebound effect for China's road freight transport, and showed that the long-term direct rebound effect was about 84%. Hence, it is necessary to explore whether there is rebound effect which influences the effectiveness of the Central Rise Policy on road sector in the six central provinces.

Since the Central Rise Policy was initiated in 2006, a series of measures related to low-carbon development of road sector in the six central provinces have been made, but not much attention has been paid to the effectiveness of these measures by researchers and policy makers. Under this circumstance, this paper makes three main contribution to literature. First of all, it analyzes the effect of the Central Rise Policy on CO_2 emissions at the stage of operation in road sector in the six provinces in central China. Second, it explores the spatial spillover effect of the factors affecting CO_2 emissions at the stage of operation in road sector in an attempt to enrich the empirical research on spatial econometrics for China's road sector. Finally, it investigates the impact of CO_2 rebound effect on the Central Rise Policy in the six central provinces, with a view to offer some advice for effective implementation of the new Central Rise Policy during the 13th FYP period as mentioned above.

The rest of the paper is structured as follows. Section 2 reviews related literature. Section 3 introduces the empirical methods and data definitions. Empirical results and discussions are given in Section 4, and Section 5 concludes the paper and puts forward some policy suggestions for Chinese government.

2. Literature review

With increasing attention to energy conservation and emission reduction in recent decades, the low-carbon development policies that are formulated by different countries have become a focus of scholars.

First of all, in order to develop a green and low-carbon economy, a lot of governments have made a number of CO_2 emissions reduction polices and many studies have evaluated the effectiveness of the policies. Beuuséjour et al. (1995) took Canada and the United States as research objects, and adopted the CGE model to analyze the relationship among economic growth, CO_2 emission reduction and energy taxes, and the result showed that energy taxes played an important role in reducing CO_2 emission. Miranda and Hale (2002) found that Switzerland had more advanced experience in environmental tax, so they compared the tax and environmental costs and then used the environmental tax to stimulate consumers to save energy. Li and Lin (2016) applied the Malmquist-Luenberger productivity index to explore the green productivity growth of China's manufacturing sector during the 11th Five-Year Plan Period. The research indicated that China's CO_2 emissions reduction policies played an important role in green development, but the policy objectives had not been completely achieved. Zhou et al. (2016) adopted a bottom-up simulation model to capture the effect of environment policy during the 11th and 12th Five-Year Plan periods in Urumqi of China, and the results showed that environment policy was valid only for the power industry. Chen et al. (2015) assessed the effect of the two-oriented society policy on all industries in Wuhan of China. The results revealed that the resource consumption could reach the expected conservation targets, while the effectiveness of both resource recycling and pollution control showed

[3] http://www.gmw.cn/01gmrb/2007-08/11/content_653982.htm.

[4] This paper explored the impact of the Central Rise Policy on CO_2 emissions at the provincial level, so we considered the six central provinces (i.e., Henan, Hubei, Hunan, Jiangxi, Anhui, and Shanxi) as the implementation subjects of the Central Rise Policy to conduct the research, which will be more appropriate.

[5] http://cpc.people.com.cn/GB/64162/64165/78561/79762/7244255.html.

[6] http://www.evlook.com/zhengce/guonei/content-21197.html.

[7] http://www.zgjtb.com/youzheng/2016-06/15/content_86635.htm.