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Carbon emissions quotas in the Chinese road transport sector: A carbon trading perspective

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ABSTRACT

In response to the growing need to reduce carbon emissions, it is necessary to explore the design of carbon trading mechanisms and discuss allocation options for the transport sector. This paper examines the allocation of carbon quotas with the introduction of an emissions trading scheme (ETS) in the Chinese road transport sector. Aiming to simulate the allocation of carbon emissions quotas, we forecast vehicle possession using a gray forecast model and trend extrapolation; consider the carbon dioxide (CO_2) emissions of the transport sector using a top-down approach; and design three policy scenarios. We provide the following findings. First, vehicle possession in the road transport sector and carbon emissions both display an increasing trend, reaching 180 million units and 6.6 billion tons by 2020, respectively. Second, the road transport sector has the largest carbon quota under the benchmark scenario and the smallest under a low-carbon scenario. The difference between these two scenarios is 2.7 billion tons of carbon emissions. Finally, we design a carbon emissions trading mechanism for the transport sector based on China's special development period, and provide a sensitivity analysis.

1. Introduction

In the past decade, carbon dioxide (CO_2) emissions have risen sharply, and are expected to continue to grow in the future (Chang and Lai, 2013). As the sector with the highest oil consumption and the most rapid growth in oil demand and carbon emissions, transportation is in need of improved energy efficiency and low-carbon development (Fan and Lei, 2016). Along with the economic development and rapid urbanization, transportation has grown to become one of China's fastest growing economic sectors (Hu et al., 2010). From 1990 to 2014, passenger volume in China increased from 56.28 to 300.97 billion passengers, while freight volume increased from 9.7 to 43.9 billion tons. Energy consumption and carbon emissions have increased alongside the vigorous development of the Chinese transportation industry. From 1991 to 2014, there has been a sixfold increase in the total energy consumption of the transport sector, while the manufacturing of vehicles is predicted to grow at a rate of about 5–7% per annum in conjunction with future mid/high-speed economic growth (Chai et al., 2016).

Meanwhile, transport-related carbon emissions have risen approximately fivefold compared with 1991 (Fig. 1). While market-based policy instruments for the economy as a whole would certainly reduce emissions at the lowest cost to the government, the transport sector's significant contribution to CO_2 emissions and its widely decentralized nature require special policy attention. Moreover, as China is still in an early stage of industrial development, the demand for commodities and goods transport continues to grow rapidly, and the road transport industry accounts for the largest share of CO_2 emissions in the transport sector (Fig. 1). Piecyk and Mckinnon (2010) expect that, as a result, climate change concerns will have a significant influence on freight transport operating decisions in more than 80% of transport businesses by 2020. Accordingly, the carbon emission mitigation of road transport is now facing increasing threats. This highlights the need for government and companies to understand how to measure and manage road transport emissions.

The 13th Five-Year Plan covers a critical period for China to achieve the desired reduction in CO_2 emissions per unit of GDP of 40–45% from 2005 to 2020. In response to the growing need to reduce carbon

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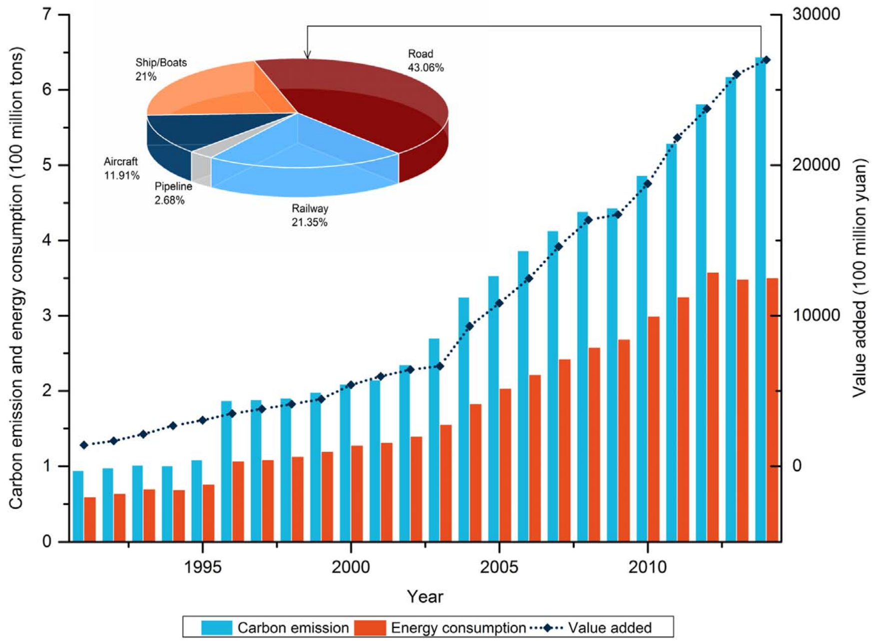

Fig. 1. Carbon emission, energy consumption and value added of transport sector from the year 1991 to 2014. Note: Proportion of carbon emissions by different means of transport in 2014 are shown in the pie chart.

emissions, an emissions trading scheme (ETS) has been identified as one of the most efficient instruments to reduce greenhouse gas (GHG) emissions. On December 26, 2013, the Chinese central government selected seven provinces/municipalities (Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong, and Shenzhen) to establish carbon emissions trading pilot projects (Provisional Regulation on Carbon Emissions Trading Management, 2014). With the experience from these pilots, China will pursue the establishment of a unified emissions trading market by 2020 (Li et al., 2012). These pilots cover highly energy-intensive industries mainly in three sectors: power and heat, cement, and chemicals (Qi et al., 2014).

Because carbon emissions by mobile point sources, as in the road transport industry, are more difficult to monitor than emissions by fixed-point sources, as in the electricity and steel industries, the road transport industry has not been included in the scope of most early carbon ETSs. However, according to Anger (2010), a binding ETS has the potential to reduce CO_2 emissions in the road transport industry. Thus, in the key period of the transition from the carbon emissions trading pilots to a national carbon emissions trading market, it is necessary to explore how we can use market-based instruments to promote energy conservation and achieve emissions reductions in the transport sector in China. Although the debate about global warming and its consequences identifies transport as an area where major changes must occur, transport emissions have fallen only slightly in recent years (Liljestrand, 2016). Mitigating climate change and making deep cuts in CO_2 emissions require transitions to new kinds of transport systems (Geels, 2012). However, there are no binding policies in place to tackle the climate change issues pertaining to the transport sector.

In the context of the goal of a unified carbon ETS, the design of a scientific and effective method to allocate carbon emissions quotas to the transport industry has become an important task for the Chinese government. Motivated by this aim, we analyze the allocation of carbon quotas in China's transport sector and address the following questions.

(1) How will vehicle possession influence the allocation of carbon quotas?
(2) How much of the carbon quota cap will be allocated to the road transport sector?
(3) Which factors contribute most to the allocation of carbon quotas?
(4) What differences in allocation arise under the different policy scenarios?
(5) How should the carbon trading mechanism for road transport be designed in light of the research results herein?

We expect that our responses to these five questions will be helpful for policy makers designing a scientific and effective approach to the allocation of carbon emissions quotas to the road transport sector and promote the development of a carbon emissions trading market in China.

The rest of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 provides the data definitions and details the methodologies used for allocating carbon emissions quotas. Section 4 discusses the allocation results and proposes a design for a carbon emissions trading mechanism for the road transport sector based on China's special development period. Section 5 presents our conclusions and the related policy implications.

2. Literature review

2.1. Carbon quota allocation mechanism

In order to mitigate climate change and achieve CO_2 reduction goals, some countries have attempted to limit CO_2 emissions through various policy instruments, including carbon taxes, command-and-control, and cap-and-trade (Hahn, 2009). Many studies have proved the theoretical superiority of carbon emissions trading compared with other policy measures. For example, Stern (2007) argues that carbon emissions trading better incentivize companies to exercise their power to reduce emissions. Liu and Wang (2009) analyze the characteristics of different emissions reduction policy tools and conclude that market mechanisms achieve better carbon emissions reductions than do administrative mechanisms. Kim and Stech (2012) discusses the performance of carbon trading in South Korea and concludes that a carbon allowance could decrease carbon emissions.

In a carbon emissions trading system, the allocation of carbon quotas has a close relationship with trading units, which in turn directly determine the cost of carbon trading (Han et al., 2016).