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Economic impacts of debottlenecking congestion in the Chinese coal supply chain

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ABSTRACT

The fast pace of development in China's coal industry created bottlenecks in its transportation infrastructure. These bottlenecks likely affected not only China's domestic coal market, but also global coal markets. In this paper, we estimate the costs and consequences of these bottlenecks using a production and multimodal transportation model. We find that coal transportation inefficiencies increased the price of Chinese domestic coal at coastal locations and thereby influenced global seaborne coal prices. According to our model results, the resulting extra costs of coal supplied to the Chinese economy totaled 228 billion renminbi (RMB) in 2011 and 105 in 2013. The subsequent debottlenecking, on the other hand, has reduced the price of Chinese domestic coal delivered to coastal regions and contributed to the reduction in global seaborne coal prices since 2011. Our analysis also suggests that current tariffs for coal transport, with their embedded taxes to cover investments in rail capacity, result in economic efficiencies similar to charging marginal transportation costs and that planners have not introduced distortions that impose significant additional costs on the Chinese economy. Many projects that expanded transport capacity delivered strongly positive rates of return. However, some have poor or negative rates of return, which can reflect either overinvestment or preinvestment in future needs.

1. Introduction to Chinese coal logistics

China's coal sector has developed rapidly, increasing annual production from 1384 million tons in 2000 to 3516 million tons in 2011 (National Bureau of Statistics, 2013). Despite yearly investment surging from RMB 211 million in 2000 to 5.4 billion in 2012 (National Bureau of Statistics, 2013), the domestic coal industry has faced a number of challenges, including the availability of coal resources, increasing production costs, and constrained logistics. Transportation capacity, in particular, had been lagging behind the rapid supply expansion until recently. This led to transportation bottlenecks, primarily in the railway sector. The resulting congestion costs drove increases in the costs of delivered coal, because of the need to use trucks, and caused supply interruptions and price fluctuations.

The structure of coal logistics in China is determined by the locations of economic coal seams and the industrial and population centers where the coal is consumed. The growing supply sources are located primarily in the Northern and Western regions of China, and consumption occurs in the East. The provincial imbalances between coal production and consumption are shown in Fig. 1 with the exporting provinces colored in shades of green and the importing provinces colored in shades of red. Transport expenses can account for up to 40% of total coal costs at the destination (Macquarie Equities Research, 2013), affecting producers' competitiveness, capacity expansion, and the overall performance of the industry. The major driver behind high coal transportation expenses was congestion costs resulting from the geographical mismatch between coal production and consumption.

Chinese coal reserves and production are mainly located in the Western and Northern inland provinces. The two provinces of Shanxi and Shaanxi, and the autonomous region of Inner Mongolia account for almost 70% of China's proven reserves and more than half of national production (China Coal Resource, 2014; National Bureau of Statistics, 2013). On the other hand, major coal-consuming centers lie in the Eastern and Southern coastal regions. The average distance coal moves have been increasing, due to continued expansion of coal production in the West (a more than threefold increase in production in Xinjiang from 2007 to 2013 — CEIC, 2014) and the dispersion of coal consumption locations in the East.

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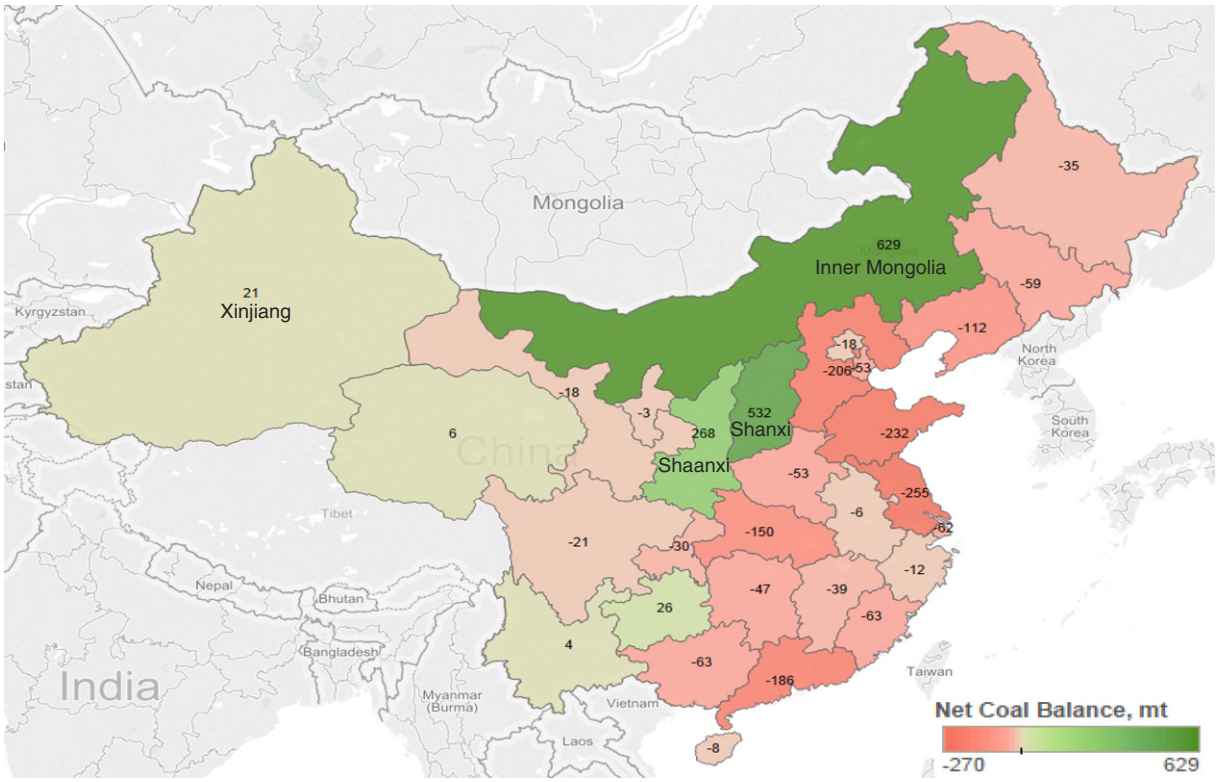

Fig. 1. Provincial coal balance (production–consumption) in 2011.
Source: National Bureau of Statistics, 2013.

Despite the increasing distances, a more than fourfold increase in coal production from 2000 to 2013, and a 2.2-fold increase in general freight turnover, the kilometers of track increased by only 50% (CEIC, 2014, National Bureau of Statistics various years). Centralized government management and lead times needed for investing in transportation projects in general and in railways in particular contributed to time lags in responding to increased transportation requirements of coal.

These disparities made transportation the crucial factor in the development of the Chinese coal industry (Tu, 2011). The costs of railway bottlenecks, in particular, were a key driver for delivered coal prices in coastal China (IHS CERA, 2013). Besides increased costs, logistical problems affected the overall stability of the coal market in China by amplifying price volatility and causing defaults on contract obligations. Beyond that, they also caused power outages and greater congestion for other types of freight.

The spot price of steam coal at Qinhuangdao (a major coal port terminal that connects inland coal production bases to Eastern and Southern coastal demand centers) provides an illustration of the costs of congestion. The average FOBT (Free On Board Trimmed) price, excluding the value-added tax (VAT), in 2011 for the 5500 kcal/kg specification was 696 RMB/t (China Coal Resource, 2014), whereas, according to our estimates, the average domestic production and transportation costs in China were only 240 and 140 RMB per ton respectively. This differential between price and average cost can be explained by congestion costs that drove marginal costs up and created room for arbitrage between consuming domestic coal and importing coal from abroad. In response to this situation, China has completed several new rail lines devoted to moving coal that have relieved the congestion.

To explore questions related to congestion in the Chinese coal supply chain, we have developed a production and multimodal transshipment model of China's domestic coal market, calibrated to 2011 data. The KAPSARC Energy Model of China (KEM-China) aggregates coal supply by mining regions, includes coal transportation by rail, sea, inland waterways, and trucking, and measures demand by province. The model finds the competitive equilibrium, which minimizes annual supply and transportation costs for meeting demand in 2011, incorporating both domestic and international supply. The modeling approach we use accounts for varying production conditions, dispersed demands, and the flexibility of the logistical network by linking transportation nodes.

In this paper we address three questions related to congestion in the Chinese coal supply chain:

- What were the costs of the bottlenecks?
- How does relieving the bottlenecks affect regional prices and the international coal market?
- To what extent is China overinvesting (or pre-investing) in railroad capacity if at all?

2. The literature on coal logistics in China

Because bottlenecks in logistics systems affect the profitability of firms, financial firms have studied China's logistics issues to understand their impact on firm and industry profits. Credit Suisse (2013), Morgan Stanley (2010), and UBS Investment Research (2013) issued reports that focused on the rail transportation of coal, while Macquarie Equities Research (2013) and JP Morgan (2011) viewed this issue within the general framework of China's coal market.

The State Planning Commission of China, in collaboration with the World Bank, developed a decision support system to analyze coal transportation and efficiency of potential investments (World Bank, 1994). Utilizing this tool, Kuby et al. (1995) built various scenarios for the coal industry, exploring the impact of transportation constraints on the country's gross domestic product (GDP). This project was path breaking in that it showed the Chinese authorities how to develop national plans for infrastructure while using market mechanisms for providing products.