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Impacts of high-speed rail on domestic air transportation in China

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ABSTRACT

This study investigates the impacts of high-speed rail (HSR) on domestic air transportation in China using a new comprehensive modeling framework utilizing both demand and supply perspectives. For the first time the assessment was conducted using an improved panel regression model by taking into account of the detailed opening schedules of various HSR services during the period 2001–2014. The research findings reveal that the deployed HSR services have a significant substitutional effect on domestic air transportation in China, but the effect varies across different HSR routes, travel distance and city type. Specifically, the research found a decrease in domestic passengers of 28.2%, in flights of 24.6% and in seat capacity of 27.9% after the introduction of HSR services. The impacts are found much stronger among those air routes that connect major hub within a distance range of 500 to 800 km. The uneven nature of the impact can be seen in the different experiences of selected cities. For example, air travel declined approximately 45% after commencement of the Wuhan-Guangzhou HSR, whereas it fell by 34% after the opening of the Beijing-Shanghai HSR.

1. Introduction

The domestic intercity transport system experienced a revolutionary transformation in China during the past decade with the development of high-speed rail (HSR) in the early 2000s. Unlike any HSR in the world, the HSR in China now has the largest network consisting of eight east-west-bound and eight north-south-bound HSR passenger dedicated lines (PDL), with a total track length of over 19,000 km. These new high-speed train services generally operate on dedicated track which can allow operating speeds of 250 km/h or even higher. Because of this high transport capacity and travel speed, the intercity travel demand may have been induced considerably. For instance, as illustrated in Fig. 1, the passenger railway demand has experienced a rapid growth from 2003 to 2013. The ridership on travel distances ranging from 101 to 501 km experienced the fastest growth. In terms of passenger-km traveled, distances over a thousand km accounted for the largest share of the total passenger-km traveled, however, it is actually the rail trip ranging from 501 to 1000 km that increased the most. These statistics confirm that passenger rail travel in China has changed fundamentally in the past decade, which may have serious consequences for air transport.

In fact, during the last decade, the operations of several HSR routes have led directly to permanent cancellations of air services. For instance, as indicated by Chen and Haynes (2015), the Air Express service between Chengdu and Chongqing was discontinued in November 2009 after nineteen years of operation following the opening of the intercity HSR serving the same corridor. One month later, the operation of the Wuhan-Guangzhou HSR led to the cancellation of the Hainan Airline's service between those two cities. One year later, the operation of Zhengzhou-Xi'an HSR also led to a cancellation of all air services between the two cities in March 2010. It is likely that the impact upon air transportation services may be felt in more services as additional HSR services are provided.

However, the interaction between HSR and air transportation is not straightforward as various factors, such as the distance between cities, and their market characteristics, can complicate the competition between the two modes. Considering an “ideal” travel time for an intercity trip can range from one to 4 hours (Givoni, 2006), HSR, which normally runs at a speed of over 250 km/h or higher, is considered competitive for trips between 160 and 800 km (Button, 2012), whereas air is preferable for a longer distance. Market characteristics reflect the values that travelers place upon travel cost and time, and also reflect the size of the cities involved in the link. These different attitudes can be felt in different levels of demand for services.

Understanding these relationships in China is complicated by two aspects of the new system. First, since most HSR services in China were opened recently (after 2010), there is a lack of sufficient data to capture the dynamic response of aviation service to the new competition Second, the assessment of the temporal and spatial evolution of the Chinese HSR system is challenging due to the complicated nature of its construction. Since the development of such a gigantic infrastructure system involves a multistage planning, financing and construction, the

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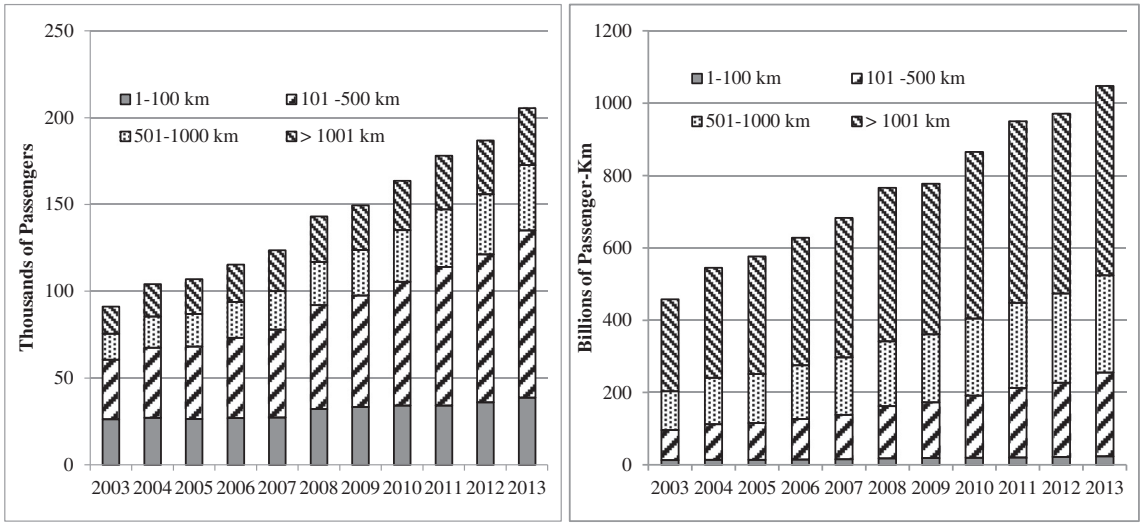

(a) Measured by Ridership (b) Measured by Passenger-km

Fig. 1. Passenger railway demand by distance traveled.
Source: National Bureau of Statistics of China.

HSR lines have been completed at different times. As a result, it is difficult to generalize about the effect of competition between HSR and domestic air transportation. To capture the completion effect more accurately, we need timelines of HSR opening schedules as well as matching air transport data to provide an informed empirical assessment of impacts, and to predict likely future effects.

This study is intended to meet that need by developing an improved evaluation method utilizing a comprehensive dataset. The study differs from previous work in a number of ways.

First, it evaluates both the national-level and regional-level impacts with a focus on two major HSR routes: Beijing-Shanghai (1318 km) and Beijing-Shenzhen (2372 km). In addition, the Wuhan-Guangzhou PDL (1039 km), which is a section of the Beijing-Shenzhen PDL and operated two years earlier than the entire line, is analyzed separately to elucidate the different spatial-temporal effects of HSR on air transportation service.

Second, the study utilizes a dataset that includes 767 domestic aviation OD pairs for the period 2001–2014 collected from the Bureau of Civil Aviation Development and Planning of China. This detailed OD data captures the entire spectrum of the development of the two major HSR routes, including the before, during and after stages. This means the assessment of competition will be more robust than previous studies because the effect of HSR on each specific air route can be related to actual opening dates.

The rest of the paper is organized as follows. Section 2 provides a literature review of the related work on HSR and air transportation, in which the gap of the existing knowledge on HSR's impact on domestic air travel is identified. Section 3 introduces the characteristics of competition between HSR and air transport in China while Section 4 introduces the conceptual modeling framework. Section 5 introduces methodology and data, which is followed by Section 6 with empirical results. Section 7 summarizes and concludes.

2. Literature review

The market interaction between HSR and air transportation has been studied extensively over recent years as can be seen in the summary of the relevant studies shown in Table 1, which was expanded upon the pioneering reviews by Albalate et al. (2015) and Wan et al. (2016). The classical approach involves an assessment from a supply perspective (Dobruszkes, 2011) or utilizing travel demand modeling (Behrens and Pels, 2012; Clever and Hansen, 2008; Cascetta et al., 2011; Pagliara et al., 2012; Park and Ha, 2006; Steer Davies Gleave, 2006), which suggest that the competition between HSR and air is limited to the medium-distance travel market. Givoni and Dobruszkes (2013) extended this thinking by suggesting the majority of the HSR demand is from induced demand and the substitution of demand from conventional trains, so that one-on-one comparisons with air are more complicated than first thought.

That approach opened up questions about the factors determine the level of competition and furthermore how the competition may vary spatially. Albalate and Bel (2012) indicated that HSR market share with respect to air transportation decreases with distance and its share becomes modest for routes beyond 650 km. On the supply side Albalate et al. (2015) conducted an econometric analysis based on a dataset of air services in Spain. Their study confirms that the supply of airline service measured in number of seats did reduce after the operation of HSR, however, when the supply of air service was measured in flight frequency, the result shows that air service did not suffer a significant reduction. On the demand side, Behrens and Pels (2012) assessed the competition between HSR and air using enplanement as a proxy. However, the issue has never been examined from both the supply and demand perspectives under a consistent modeling framework.

The burgeoning development of HSR in China has naturally attracted a rising interest from scholars who have used a variety of approaches to analyze the issue. For example, Fu et al. (2012), studied from an aggregate perspective of HSR and air, whereas Yang and Zhang (2012). Jiang and Zhang (2016) and Xia and Zhang (2016) used methodological perspectives that focused upon the socioeconomic outcomes of HSR and air competition as seen in traffic volumes, price, profits and welfare changes. In addition, some investigations were also conducted from a modal integration perspective using stated preference survey data with an objective to identify the market potential of the air and HSR integration in China (Li and Sheng, 2016).

Although these studies expanded the view on the competition between HSR and air, key questions related to the level of competition in both time and space remain unaddressed.

One step in that direction was taken by Wan et al. (2016) who used a dataset covering air transportation services in China, Japan and Korea during the period 1994–2012 using a difference-in-difference approach. Their study showed that the entries of HSR in China lead to a more significant decline in air service supply when measured by seat capacity than had occurred in Japan and Korea, after controlling for the speed of HSR. Although the result appears to be plausible, the findings are questionable due to the two issues.

First, the effect of the Chinese HSR services is likely to be