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Airlines' reaction to high-speed rail entries: Empirical study of the Northeast Asian market

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ABSTRACT

We investigate the impact of the commencement of high-speed rail (HSR) services on airlines' domestic available seats on affected routes in China, Japan, and South Korea. The study is based on a dataset covering the 1994–2012 period. We use the propensity score matching method to pair HSR affected routes with routes without HSR services. The difference-in-difference approach is used to estimate the impact of HSR entry. We find that HSR entries may, on average, lead to a more significant drop in airlines' seat capacity in China than in Japan and Korea given similar HSR service speed. In China, HSR services with a maximum speed about 200 km/h can produce strong negative impacts on medium-haul air routes but induce more air seat capacity on long-haul routes. HSR services with a maximum speed of 300 km/h have little extra impact on medium-haul routes but a strong negative impact on long-haul routes. Finally, although HSR has a strong negative impact in Japan's short-haul and medium-haul air markets, little impact is observed in its long-haul markets.

1. Introduction

Starting from the first experimental high-speed rail (HSR), Qinhuangdao-Shenyang line, China has been expanding its HSR network and has already achieved an extensive track length of 8358 km by the end of 2010. The Chinese HSR system has grown into the largest HSR network in the world within a short period of time, and according to the plan the network will continue to grow during the next decade. In the other two major Northeast Asian countries, Japan and South Korea, HSR also plays a significant role in domestic inter-city passenger transport and the HSR networks of both countries are still expanding. Such ambitious plans for the development of HSR have important implications for the domestic aviation market. Intensified competition between HSR and airlines on certain routes has been recorded, which may lead to various changes in airlines' route selections and service levels on the affected routes.

The impacts of HSR on air transport have received substantial, and increasing, attention since they have major policy implications on many aspects, such as climate change mitigation (e.g., Givoni, 2007; Ha et al., 2011; D'Alfonso et al.,

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2015, 2016), passenger welfare and social welfare (e.g., Janic, 1993; Adler et al., 2010; Rothengatter, 2011; Yang and Zhang, 2012; Roman and Martin, 2014; Álvarez-SanJaime et al., 2015), airline entry barriers and market power (e.g., Kappes and Merkert, 2013; Zhang et al., 2014), competitive and cooperative behavior of rail operators and airlines (e.g., Jiang and Zhang, 2014; Albalate et al., 2015; Xia and Zhang, 2016a, 2016b) and airport and HSR infrastructure investments (e.g., Goldman Sachs, 2010; Ollivier et al., 2014). Dobruszkes et al. (2014) provided a comprehensive review of the existing literature that investigates the ex-post intermodal impacts of HSR entry. The literature consists of both theoretical modeling and empirical studies. Most of the empirical studies do not apply econometric methods and hence rely heavily on either comparing traffic volumes or market shares before and after the HSR operation, or surveying passengers about their modal choice decisions. Studies based on econometric methods are mainly related to various European markets (see Table 1 for a list of related studies), while studies on the Northeast Asian markets, especially the Chinese markets, are rare. Fu et al. (2012) provided some descriptive analysis on the impact of HSR entry in Chinese air transport markets. Zhang and Zhang (2016) used gravity models to examine the determinants of air passenger flows in China with the HSR presence as one of the explanatory variables. Earlier, Park and Ha (2006) conducted a survey on passengers' stated preference over air and HSR to predict the impact of the entry of HSR service in South Korea.

Furthermore, existing empirical studies fall into three major streams as listed in Table 1. The first stream applies the discrete choice models, i.e. various versions of logit models, to analyze factors influencing passengers' choice between air, HSR and sometimes other modes of transport. The estimated models are then often used to predict the market share split between air and HSR. The second stream aims at quantifying how HSR service levels, such as rail travel time (Clewlow et al., 2014; Dobruszkes et al., 2014), HSR frequency (Dobruszkes et al., 2014) and HSR passenger number (Castillo-Manzano et al., 2015), relate to changes in airlines' seats, frequency or aircraft size. None of these two streams is able to measure the ex-post impact of HSR entry into a market traditionally served by airlines by comparing with the situation where no HSR service is available. The third stream addresses this issue by adding an HSR dummy variable which indicates the entry and existence of HSR services and it is most relevant to our study. However, existing studies in this stream ignore a few important issues. First, there might be some inherent differences between the HSR affected routes and unaffected routes, and hence on average these two groups of routes differ in traffic volumes. Second, the impact of HSR entry could be dynamic. For example, there might be a time lag between the entry of HSR and the impact on airline traffic. Third, traffic of both the HSR affected routes and unaffected routes can change overtime, owing to certain common factors, and hence it might be better to control for this kind of traffic change, so as to compare the traffic change of treated routes with the hypothetical situation where HSR services were not started. Finally, it would be better to measure the impacts based on benchmarking with the unaffected routes that are similar to the routes affected by HSR services.

Most of the papers in the literature recognize adverse impacts of HSR on airlines' traffic, operations and market shares, which can last for two to five years (Campos and Gagnepain, 2009), but the amount of impacts varies across routes depending on many factors. Some papers predict that HSR will mainly compete with air on routes over 500 km (e.g. Martin and Nombela, 2007; Armstrong and Preston, 2011) while others predicted that HSR is competitive to air for routes within three hours (e.g. González-Savignat, 2004). Bilotkach et al. (2010) concluded that HSR entry may impose a competition pressure on airlines to raise quality by increasing frequency but it has no impact on routes less than 550 km. However, Jiménez and Betancor (2012) found that HSR entry led to an average 17% reduction in air flights for a sample of Spanish routes (all less than 500 km). Even for routes in the same country and of similar distances, the results are not always the same. For example, De Rus and Inglada's (1997) ex-post cost benefit analysis finds the 471 km Madrid-Seville high speed train (HST) caused an almost 50% air passenger drop within four years of HST entry while Jiménez and Betancor's (2012) regression analysis suggests no impact of HSR entry on the 483 km Madrid-Barcelona route. Thus, it seems that the literature has not reached a consensus yet on measuring the impact of HSR even for the European market.

In this paper, we employ econometric methods to examine the route-based impact of HSR entry on air traffic, in particular, the air carriers' domestic available seats, by focusing on the Northeast Asia markets, in particular Japan, South Korea and mainland China. We also compare the impacts of HSR entry in China with those in Japan and Korea noting that Japan has the world's first modern HSR service – the route between Tokyo and Osaka with a maximum speed of 210 km/hour – in 1964, while the Chinese market plays a significant role during our sampling period. Moreover, in order to address the issues mentioned above, we apply the difference-in-difference (D-in-D) estimator with propensity score matching (PSM) approach. To our knowledge, this is the first paper using the D-in-D approach to measure the impact of HSR entry on air transport.[1] We find differentiated HSR impacts in the three Northeast Asian countries. In China, the strongest impact is on short-haul air routes with distance less than 500 km, while in Japan the strongest impact seems to be on medium-haul routes (between 500 km and 800 km). Overall, the HSR entry tends to have stronger impacts in China than in Japan and South Korea, especially in short-haul and long-haul markets. The HSR entry impact is also relevant to the speed of HSR services. In China, HSR services with a maximum speed about 200 km/h can cause significant reduction in airline seat capacity on medium-haul routes but induce more seat capacity on long-haul routes. The entry of higher speed HSR services (with a maximum speed about 300 km/h) do not lead to further reduction in airline seat capacity on medium-haul routes but will cause strong negative impact on long-haul routes. However, little impact is observed in Japan's long-haul markets even though its HSR services have a similar speed as those faster

[1] The D-in-D approach requires the estimation with panel data and two-way fixed effects, i.e. time and route fixed effects. To our best knowledge, either one or two of the fixed effects are missing in the existing studies when panel data is used (see Table 1 for details). Moreover, PSM has never been applied in the literature on measuring HSR impacts.