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High-speed rail and regional economic productivity through agglomeration and network externality: A case study of inter-regional transportation in Japan

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ABSTRACT

This study investigated empirically an association of high-speed rail (HSR) with regional economic productivity in the case of Japanese HSR. Empirical analyses with an econometric approach were carried out using panel data for 1981, 1986, 1991, 1996, 2001, and 2006, covering 47 prefectures in Japan. To test the effect of HSR, first, the comparative analysis showed that prefectures with HSR service in Japan tend to be more productive than those without in overall. Next, regression analyses were conducted using ordinary least squared estimation model, fixed-effects model, and instrument variable model. A number of HSR stations, the share of HSR distance, the share of HSR travel time, and agglomeration from HSR were employed along with other control variables. The results showed that the agglomeration has the significant positive association with the regional productivity while the network externalities have also positive associations although their significances are slightly weaker. They also unveiled the influence of HSR on economic productivity is higher in regions with HSR stations, particularly those located within 150–200 km radius from the largest cities rather than those neighboring the largest cities.

1. High-speed rail in Japan: "The shinkansen"

A huge population is squeezed into a small extent of habitable land in Japan, creating high-density cities along plains and shorelines. This is one of the most important factors that have shaped Japan into a rail-oriented society. To serve the huge travel demand between the three largest cities in the middle part of Japan, the Japanese HSR system, called the "Shinkansen" in Japanese, initially started operation in 1964, connecting Tokyo, Osaka, and Nagoya. The first HSR in the world, the Tokaido Shinkansen, was constructed mainly because the conventional lines connecting these cities had almost reached their full capacity owing to increasing demand brought about by rapid economic growth. The success of the first Japanese HSR encouraged the Comprehensive National Development Plan to incorporate further HSR construction as a means of encouraging regional development. A new line between Osaka and Okayama started to operate as part of the Sanyo Shinkansen in 1972 and the extension to Hakata, the economic center of Kyushu region, was completed in 1975. The next HSR lines opened in 1982, with the Tohoku Shinkansen between Omiya and Morioka in northern Japan and the Joetsu Shinkansen between Omiya and Niigata. These two lines reached Tokyo prefecture in 1984 and connected with Tokyo station in 1991. In contrary to the Tokaido and Sanyo lines, which were constructed to meet the increasing travel demand among large cities located in the Pacific coastal belt, later HSRs such as The Tohoku and The Joetsu were constructed mainly to stimulate the regional economic activity.

After the privatization of Japan National Railways into Japan Railways in 1987, a substandard HSR called "Mini-Shinkansen" started operating between Fukushima and Yamagata in 1992. A part of the Hokuriku Shinkansen between Takasaki and Nagano and another Mini-Shinkansen called the "Akita Shinkansen" between Morioka and Akita came into operation in 1997. The Yamagata Shinkansen was extended to Shinjo in 1999, and the Tohoku Shinkansen was extended to Hachinohe in 2001. A part of the Kyushu Shinkansen between Kagoshima and Yatsushiro opened in 2004 and connected to Hakata in 2011. The Tohoku Shinkansen was also extended to Aomori in 2010 and to Hakodate as the Hokkaido Shinkansen in 2016. Extension of the Hokuriku Shinkansen to Kanazawa came into operation in 2015. As for our analysis, the Japanese HSR network in 2006 and its opening year are illustrated in Fig. 1.

This study analyzes empirically an association of HSR with regional economic productivity in Japan. As the Japanese HSR system has the

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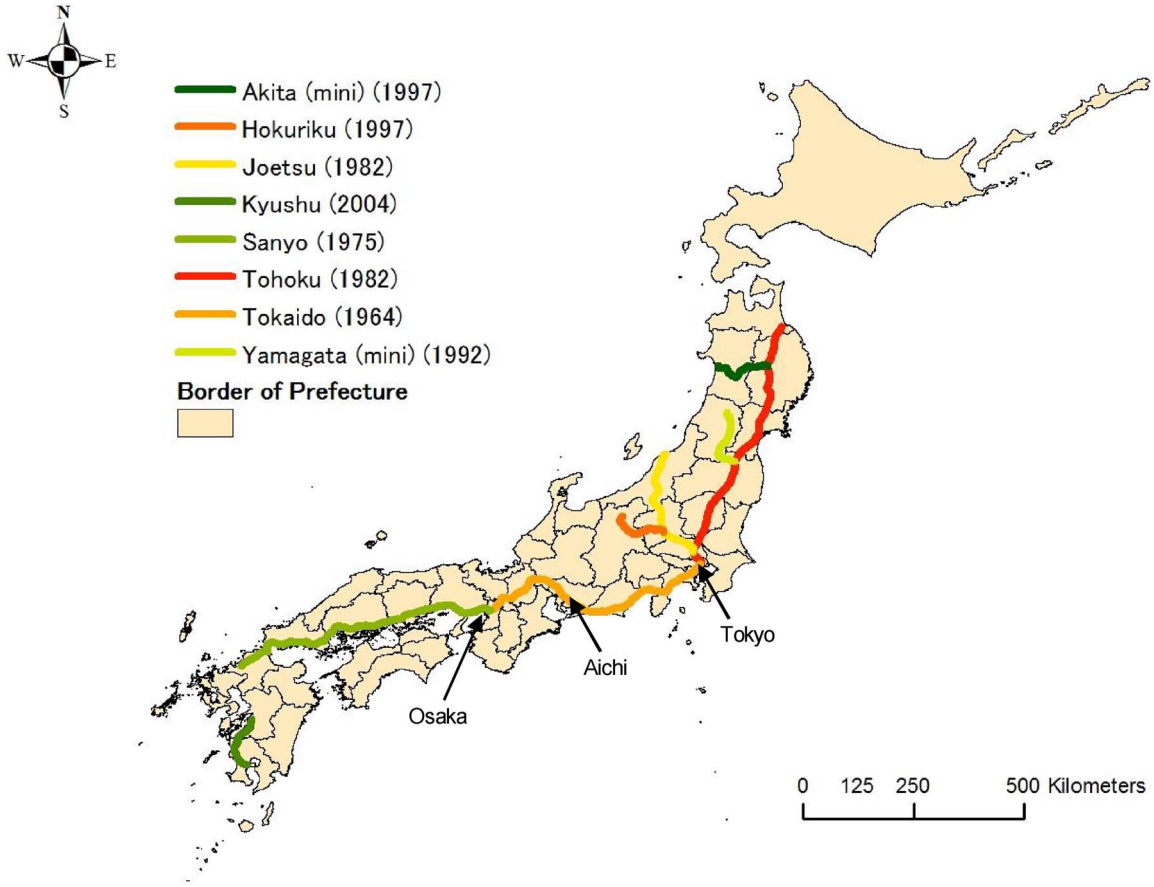

Fig. 1. The three largest cities and High-Speed Rail Network in Japan as of 2006.

longest history of HSR operation in the world, it can be expected to provide the best available historical data to reveal the long-run economic effects of HSR. This study collects data from 1981 to 2006 including regional economic productivity, HSR services related data and other competitive transportation modes in 47 prefectures (first level administrative division, approximately equivalent to European NUTS2) in Japan. The access/egress details of local transportation to and from HSR stations are incorporated into the inter-regional transportation service data.

The paper is organized as follows: the next section reviews the existing literature on the economic impacts of HSR. The dataset used for an empirical analysis is then presented. The results of the empirical analysis are shown and the findings are discussed. A comparative analysis between with and without HSR case is further presented. Finally, the paper concludes with further analysis and suggestions for future research.

2. HSR and economic development

Transportation investment is expected to enhance economic productivity and economic growth (Aschauer, 1989). Aschauer's work pioneers other researchers to investigate the effect of transportation investment to economic development although this work has been pointed out to be overestimated (Easterly and Rebelo, 1993) because of econometric error (Hurlin and Minea, 2013). Later studies have shown a positive relationship between transportation infrastructure and economic efficiency. Canning (1998) examined the impact of infrastructure stocks over 1950–1995 in various countries around the world and concluded that infrastructure stock including transportation infrastructure has a strong positive relationship with other development factors such as population, urbanization level, and GDP per capita. Also as shown in Crafts (2009) that more capital investment especially in public stock has a positive impact on economic growth. Thus, GDP growth is typically treated as one of the performance indicators of transportation infrastructure development, along with the growth of vehicle distance travel, oil usage, and other transportation data, as shown in Litman (2010).

In terms of economic productivity gains, improvement in transportation accessibility could, in the short run, directly affect industrial productivity through its impact on factors such as commercial delivery, business travel, and commuting to work and school. In the long run, it could also enlarge market areas, increase potential competitiveness, and change land-use patterns and labor markets, all of which may indirectly affect economic productivity. Banister and Thurstain-goodwin, (2011) suggested that transportation investment affects the local economy at three levels: output and productivity at the macro level, agglomeration economies and labor market effects at the meso level, and land and property market effects at the micro level. Lakshmanan (2011) gave a broader viewpoint of the economic consequences of transportation, including gains from trade, technology diffusion, coordination resulting from the "Big Push" effect, and gains from agglomeration. In particular, agglomeration economies have been highlighted recently by many studies such as Graham (2007). Chatman and Noland (2011) conducted a detailed literature review concerning the agglomeration impacts of transportation investment and concluded that public transportation improvements are capable of bringing substantial external benefits by enabling economies of agglomeration. Another possible explanation could be derived from the concept of network externalities by Katz and Shapiro (1985); expansion of transportation network also expand the size market by delivering the consumer to the new producer, which eventually increase the consumption in overall. In summary, it appears that economic impacts from transportation