A Multi-Dimensional Test of Social Effects of the Opening of High-Speed Rail in China

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Abstract. Based on previous studies, this paper innovatively summarizes the multi-dimensional social effects generated by the opening of high-speed rail, and interprets the social effects of high-speed rail from four aspects: accelerating population mobility and employment, improving land value in radiation areas, promoting regional balanced development, and optimizing industrial structure. And taking the panel data of 292 cities in China from 2007 to 2016 as samples, we constructed difference-in-difference model. Then by calculating the difference between the treatment group (cities with high-speed rail opening) and the control group (cities without high-speed rail opening) before and after the event, the net effect of the event was obtained. The study finds that: the opening of high-speed rail can accelerate population inflow and promote employment; increase the value of land in the radiation regions and increase the price of commercial housing; narrow the income gap between urban and rural areas along the route and promote balanced development among different regions; promote the optimization and upgrading of industrial structure of cities along the route.

Keywords. Opening of high-speed rail, difference-in-difference model, panel data, multi-dimensional, social effects social effects

1. Introduction

In recent years, China has made great achievements in the construction of High-Speed Rail (HSR). By the end of 2019, the length of China's HSR in operation had exceeded 35,000 km, ranking first in the world, and the close and efficient connections of HSR between major cities have realized. As a newly emerging mode of transportation, HSR are favored by the masses due to their advantages of fast, punctual and low-consumption, as well as barely affected by the weather. According to 'the Mid-Long Term Railway Network Development Program', the length of China's HSR will reach about 38,000 km by 2025, which will better ensure economic and social development. The development of HSR has had a revolutionary impact on the transportation industry, affecting the mode of national economy and shaping the economic geography of China.

Scholars have evaluated the huge effect produced by the opening of HSR from different aspects. On the one hand, the speed-raising on railways can change the pattern of urbanization, accelerate the economic connection between cities along the route and

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the process of regional integration, significantly improve the value of cities, greatly enhance the market potential of second and third-tier cities, and significantly promote the inflow of population [1]. Besides, the opening of HSR provides the direction and path for the industrial transfer. The industrial belt is formed along the HSR, which can optimize the industrial structure and narrow the regional gap [2].

Also, the opening of HSR will help cities along the route to form a agglomeration effect of the manufacturing industry, and change the structure of the labor market, also bring changes into the interaction of the internal elements of regional industry complex, contribute to balance the distribution of production factors in the region, increase the talent attractiveness of cities along the HSR, and thus promoting the technological innovation and economic development of the cities along the line [3]. In order to improve the ability to connect with the world, enterprises will give full consideration to the location of offices in the HSR network [4].

From the perspective of social environment, some scholars showed that the construction of HSR promoted the improvement of urban population scale and quality [5], affected the effect of labor resource allocation [6], and increased the demand for urban real estate and housing price [7].

Through the literature review above, we found that most scholars focus on economic aspects and discuss the effects of the opening of HSR in the existing studies. The effect of HSR, however, is not only the direct economic effect, but also derived by driving and promoting the development of other related industries and sectors. This paper mainly focuses on multidimensional social effects brought by the opening of HSR.

2. Theory and Hypothesis

The time-space compression effect of HSR enables urban development to break through its original edge, and expands the space for urban population distribution thus greatly affecting the population pattern. Specifically, it is shown as urban population converging on the cities along the HSR, especially to the dense regions of HSR. Cities, with HSR station and low population density, will also become new population centers.

What's more, the advent of HSR has created many jobs. From the perspective of demand, railway projects create a large number of jobs for railway equipment manufacturing enterprises and railway operation and management departments. According to the New Economic Geography Theory, the transportation time and price cost of enterprises in the production process are relatively low due to the opening of HSR, which can attract new enterprises to settle in. New settled enterprises and the demand for new service activities also increase the demand for labor. From the perspective of supply, the opening of HSR can improve inter-city transportation conditions and improve regional accessibility, and the location enhancement effect further enhanced will make labor factors show a trend of agglomeration and growth along the HSR. The increase of labor supply has improved the match between labor supply and demand, and the employment opportunities have been significantly improved. In a word, the opening of HSR increase the demand and supply of employment. This leads to our first hypothesis:

H1: the opening of HSR can accelerate population inflow and promote employment.

H1a: HSR can accelerate the population inflow in cities along the line.

H1b: HSR can improve the employment level in cities along the line.

As a part of transportation infrastructure, the opening of HSR will directly drive the real estate investment in cities along the route [8]. Lower transportation costs, stronger economies of scale and higher consumption share will promote the geographical agglomeration of industries, thus attracting more non-local persons. Also, the cities along the HSR line will gradually improve their living environment, and the construction level of new urban areas will be improved, which will also attract people to move from the surrounding areas to the cities. The inflow of population also promoted the rise of urban real estate prices. This leads to our second hypothesis:

H2: the opening of HSR can drive up the price of land in the radiation regions and raise the price of commercial housing.

Convenient transportation facilities are conducive to the central and western cities to attract more investment funds, high-tech talents, advanced technology and information and other factors, to enhance the inter-city economic, cultural, educational and other aspects of development, and to provide transportation conditions for achieving the development of the western region and the rise of central China. The opening of HSR improves the accessibility of central cities, promotes inter-city economic cooperation, and realizes the interaction and exchange of resources in different regions, thus actively driving the economic development of backward regions along the line and narrowing the development gap between regions. At the same time, it also provides a guarantee for the smooth implementation of targeted poverty alleviation. We state our third hypothesis as:

H3: the opening of HSR can narrow the urban-rural income gap of cities along the line, and promote the balanced development of the region.

According to the New Economic Geography Theory, the economic agglomeration effect of HSR on industries is mainly concentrated in industrial and service sectors due to the promotion effect of HSR on the flow of people, goods, capital and information. Besides, HSR mainly plays the role of passenger transport, so it has the most significant impact on the flow of people. As the factors of labor production are relatively sensitive to the development of the tertiary industry, the impact of HSR on regional industries is mainly reflected in the tertiary industry. We state our final hypothesis as:

H4: the opening of HSR can promote the optimization and upgrading of industrial structure in cities along the line.

3. Research Design

Our sample consists of 292 prefecture cities over the period 1995 to 2012.Variables were selected according to the research of Dong et al. [9] and Xu et al. The definition and measurement of all variables are shows in Table 1.

Table 1 Definition and Measurement of All Variables.

Definition	Measurement
Opening of HSR(CRH)	YES=1, NO=0
Population density (PD)	LN(Number of year-end permanent residents per unit area)
Urban output efficiency(OE)	Non-agricultural GDP/Non-agricultural employment
Investment level(INV)	LN(Fixed asset investment/Non-farm employment)
Degree of openness(OPEN)	LN(Actual level of foreign investment)
Human capital(HC)	LN(Expenditure on education/Number of students in school)
Employment density(ED)	Total number of year-end urban employment/Urban land area
Economic development level(GDP)	LN(GDP)
Investment in fixed assets(FIX)	LN(Net fixed assets)
Wage Level(WAGE)	LN(Average wage)
Ratio of urban-rural income (URIG)	Per capita disposable income of urban residents/Per capita disposable income of rural residents
Regional economic level(PERGDP)	Per capita GDP (ten thousand yuan)
Prefecture-level city scale(SIZE)	LN(population)
Industrial structure(STR)	Added value of the secondary and tertiary industries/GDP
Degree of opening to the outside world(OPEN1)	Actual utilized foreign capital (100 million yuan)
Average transaction price of commercial housing(HP)	Commercial housing sales/Sales area
Year-end population(POPU)	Year-end population
Per capita GDP(PERGDP)	Per capita GDP (ten thousand yuan)
Financial institution loan(LOAN)	LN(Financial institution loans /GDP)
Real estate development investment(EST)	LN(Real estate development investment /GDP)
Educational development level(EDU)	LN(Local financial expenditure for education)
Government expenditures (GOV)	LN(Local government's budgeted expenditures)

4. Empirical Test and Results Analysis

4.1. Basic Regression Result

Based on the variables of the above four aspects, a difference-in-difference model is built based on whether or not prefecture-level cities open high-speed trains to examine the relationship between population inflow, employment, land price, balanced regional development level, industrial structure and the opening of HSR.

- Population Inflow and Employment

Table 2. Results for H1a and H1b

	PD			ED	
CRH	0.0472***		CRH	0.0037***	
	(0.0001)			(0.0000)	
OE	0.0002**		GDP	-0.0023**	
	(0.0365)			(0.0292)	
INV	-0.0036		FIX	-0.0021***	
	(0.4386)			(0.0000)	
OPEN	0.0006		WAGE	-0.0014	
	(0.9697)			(0.1812)	
HC	-0.0001				
	(0.9908)				
Constant	5.7908***		Constant	0.0848***	
	(0.0000)			(0.0000)	
Year FE	Y		Year FE	Y	
City FE	Y		City FE	Y	
N	2598		N	1801	
R^2	0.0268		R^2	0.1994	

*, **, *** Indicate significance at the 0.10, 0.05, and 0.01 levels, respectively

From the left half of Table 2, we can see that the PD is significantly positively correlated with CRH at the level of 1%. It can be seen that when other variables remained unchanged, the average level of population aggregation caused by the opening of HSR in cities along the line is 4.72% higher than that of cities without the opening of HSR significantly. From the right half of Table 2, it can be seen that employment density (ED) and the opening of HSR(CRH) are significantly positively correlated at the level of 1%. The results further confirm that the opening of HSR has a positive effect on the employment level of the city.

- Land Value Appreciation of the Radiation Regions

- Regional Balanced Development
- Industrial Structure Optimization

Table 3. Results for H2, H3 and H4

	HP		URIG		TERGDP
CRH	0.0252**	CRH	0.0380**	CRH	0.7137***
	(0.0137)		(0.0236)		(0.0016)
POPU	0.0126	PERGDP	0.0191**	PERGDP	-0.0108
	(0.4183)		(0.0127)		(0.8448)
PERGDP	0.0163***	SIZE	0.2546**	FIX	-4.0598***
	(0.0000)		(0.0348)		(0.0000)
LOAN	0.0220*	STR	0.0048*	EDU	0.5067
	(0.0912)		(0.0803)		(0.2071)
EST	0.0196**	OPEN	0.0030	GOV	-0.9736**
	(0.0155)		(0.7115)		(0.0119)
Constant	-0.1538	Constant	1.1645	Constant	103.2179***
	(0.2738)		(0.1032)		(0.0000)
Year FE	Y	Year FE	Y	Year FE	Y
City FE	Y	City FE	Y	City FE	Y
N	2400	N	1581	N	2611
R^2	0.5128	R^2	0.5149	R^2	0.5301

Table 3 shows that the price of commercial housing (HP) and the opening of HSR (CRH) are significantly positive. When the other variables remain the same, the opening of HSR(CRH) has increased the average commercial housing price of cities along the line by 2.52%. The results further confirm that the opening of HSR has a positive driving effect on the land value, and conducive to the stable and upbeat development of China's economy.

Also, we use the DID model to further verify the relationship between the rural-urban income gap (URIG) and the opening of HSR(CRH). The middle two columns of Table 3 show that when other variables remain unchanged, the rural-urban income gap (URIG) of cities along the line is 3.80% higher than that of other cities significantly.

The two columns on the right of Table 3 report the test results of H4. It can be seen that the opening of HSR(CRH) has a positive effect on industrial structure optimization (TERGDP) at the level of 1%. This indicates that he opening of HSR can optimize and upgrade the industrial structure of the radiation area by influencing the proportion of the tertiary industry.

4.2. Robustness Test

● Population Inflow and Employment and Regional Balanced Development
Method 1: Referring to the method of Dong et al. (2016). We remove the samples of prefecture-level cities that opened HSR before and after 2011 from the whole sample (the Beijing-Shanghai high-speed rail was opened in 2011), and then based on the new samples, we use PSM-DID model to conduct robustness test for H1a, H1b and H3.

Method 2: We use PSM-DID model to conduct further test for H1 and H3.

The robustness test results are consistent with the basic regression results.

● Regional Balanced Development
Method 1: Parallel trend test.
Method 2: The opening years of the HSR in the treatment group have been advanced by one year and two years respectively.

● Industrial Structure Optimization
Method 1: Changing the measurement of the dependent variable. the index of upgrading of the industrial structure is constructed by including the primary, secondary and tertiary as shown in the formula below [10]:

$$indication = \sum_{1}^{3} x_i * i, 1 \leq indication \leq 3$$

Where, xi represents the proportion of the output value of the i industry in the total output value.
Method 2: We use PSM to eliminate sample selection bias. On this basis, the incremental DID model proposed by Li [11] is used for further test.
Similarly, the robustness test results still support the basic regression results.

5. Conclusions

The rapid development of HSR has made an important contribution to China's economic development and exerted a wide and profound impact on all aspects of China's economy and society. Based on previous studies, we discuss the social effects of the opening of HSR from four aspects. The results show that the opening of HSR speeds up the flow of resources, brings the growth of population and employment to the cities along the line, and promotes the land value in the radiation regions. It also drives the increase of resident income to some extent and contributes to narrow the gap between rich and poor regions. In addition, the construction of HSR is conducive to the effective allocation of resources and professional cooperation, which will optimize the industrial structure in the radiation regions, and further promote the development of China's economy and society. In a word, the construction of HSR has maintained national security and social stability, enhanced national strength and international influence, and improved people's sense of gain, security and happiness.

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