The Impact of High-Speed Rail Opening on Urban Economy

-- Empirical Evidence from China

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Abstract: The business scale of China's high-speed railroad is increasing, which has brought important impact on the economy of the cities passing along the high-speed railroad. High-speed railroad has faster speed, safer, and stronger ability to transport goods compared with train, which provides a better choice for people's transportation, tourism, etc., and also has a great impact on the economic development of the cities along the route. This paper is based on the Wuhan-Guangzhou high-speed railway along Hunan Province.To ensure accurate empirical results, we specifically choose Hunan Province as the basis for data analysis, as it is the only province in the area and eliminates potential interference from other municipalities. We collect data from 2005 to 2019, specifically from prefectural-level cities and above. The empirical analysis is conducted using the double difference model (DID). An analysis is conducted on the effects of high-speed railroads on the growth rate of GDP, per capita GDP, the total employment at the end of the year, and the urban development along the lines. The findings indicate that high-speed rail has a discernible bias in its economic impact on cities along its route. Specifically, it has a substantial influence on the employment and urbanisation development of these cities. However, it does not have a significant effect on the short-term per capita GDP and its growth rate.

Keywords: New economic geography, Siphon effect, Accessibility, High-speed rail, Double-difference modeling

1. Introduction

The economic effects of the introduction of high-speed rail networks on cities are highly intricate, with the nature and magnitude of these effects varying significantly and being influenced by numerous factors.[1]. Primarily, the city's effect is determined by its geographical location. Furthermore, the magnitude of urban development and the disparities in development levels within the city will also result in varying effects. [2].The inauguration of a high-speed railway will significantly reduce the distance between different cities, thereby enhancing the convenience of communication and reducing transportation costs. This will also improve the accessibility of the region, leading to a notable acceleration in the speed and frequency of the movement of talents, capital, and other significant flows between cities. Without a doubt, the introduction of a high-speed railway will have a substantial influence on the economies of the cities located along its route. The

introduction of a high-speed railroad has the clear advantage of enhancing the connectivity of areas with stations along the line. This results in a reduction in travel time from each city to the centre of the major city, providing a significant opportunity for development in the city centre. Consequently, there is an increase in the influx of various forms of capital and factors, leading to diverse impacts on the economic growth of these regions.[3]. On the other hand, for the small and medium-sized cities along the high-speed railway, due to the existence of the siphon effect, after the high-speed railway opens, the advantageous enterprises in the small and medium-sized cities will be more willing to gather in the center big cities due to the reduction of the cost and time between cities after the high-speed railway opens. Therefore, the opening of high-speed railroad may have some negative effects on small and medium-sized cities[4].

However, in contrast, small and medium-sized cities located along the high-speed railway experience the syphon effect. This means that after the high-speed railway is established, the successful businesses in these smaller cities are more inclined to relocate to larger central cities. This is because the reduced cost and travel time between cities provided by the high-speed railway make it more convenient for these businesses to gather in the larger cities. Hence, the commencement of a high-speed railway could potentially yield adverse consequences for small and medium-sized cities.[5].Hence, it is imperative to analyse the effects of the introduction of high-speed rail on the local economy. Studying the effects of high-speed rail on the city's economy is beneficial for the development of high-speed rail in our country with better planning, and helps address the issue of determining the locations for high-speed rail stations. When selecting the location for high-speed railway stations in cities along the route, it is important to consider the economic impact of the railway. This will help in making informed decisions and planning the station areas effectively. By leveraging the advantages of high-speed railways and minimising any negative effects, we can stimulate regional economic development.

2. Literature Review

Several scholars have examined the impact of high-speed rail on regional economic growth. Pol argues that high-speed rail has two effects on regional economies. The first effect is a catalytic one, meaning that it can provide a new impetus for regions experiencing slow economic growth or undergoing economic transformation. The second effect is a promotional one, meaning that it can further develop the economy of already prosperous regions. Another factor to consider is the enabling impact, which refers to the enhancement of the economy in an already well-established region following the introduction of high-speed rail.[6]. Perroux [7] presents the growth pole theory, which posits that it serves as the basis for regional economic development and contributes to the uneven economic growth across different regions. Friedman[8]put forward the core-edge theory, which focuses on the development of the spatial system, the development of the core area will lead the development of the edge area, so as to form new core area in the edge area, so that the chain of development will lead to the development of the core area, and the core area will lead to the development of the edge area. core area, so that the development of the core area will lead to the development of the edge area, thus forming a new core area in the edge area, so that the development of the whole region will be driven by the development of the core area. Xu Yuping elucidates the favourable impacts of high-speed rail on the area economy, focusing on three key aspects: augmenting local demand, stimulating employment and economic expansion, and underscoring the significance of high-speed rail development. Lu Siyu outlined the mechanism of high-speed railroad construction on urban economic growth from the perspective of aggregated ren[9]Li Hong-chang and his colleagues asserted that the centre city engages in the exchange of resources or products with the outlying regions through the economic domain, resulting in a continuous expansion of its influence..[10].According to Wang Degen et al., the transportation network is spatialized, meaning

that the construction of high-speed railroads has an impact on the accessibility not only between the two cities directly connected by the rail line, but also between these two cities and a third city.[11].

Hu Shun-xiang illustrated the effect of high-speed rail role through the mechanism of spatio-temporal compression[12], and Lin Shan-Zhang et al. explored which type of cities high-speed railroads have a positive effect and a negative effect on which type of cities from the perspective of urban heterogeneity[13]. Luo Jing-qiu systematically introduces the favorable impact of the opening of high-speed railways by taking the development of Shinkansen in Japan as an example[14].

3.   Methods and variables

The twofold difference model (DID) is commonly employed in econometrics to statistically assess the effectiveness of governmental initiatives or programmes. The DID model is primarily employed to analyse the disparities between individuals in the initial and subsequent periods, in order to isolate the effects of policy impacts. This is because it is not possible to ensure absolute randomization in the allocation of public policies between the control and experimental groups.The double difference model was set up as follows:

$$Y_{it} = \beta_0 + \beta_1 period_{it} + \beta_2 connect_{it} + \beta_3 period_{it} \times connect_{it} + X_{it} + \alpha_i + \varepsilon_{it}$$

where Y city's economic development level, $period_{it}$ denotes the time dummy variable, which takes the value of 0 in the early period and 1 in the late period; $connect_{it}$ denotes the change from the early period to the late period of the city under study, i.e., the time effect; β_2 denotes the regional dummy variable, which takes the value of 0 if there is no high-speed rail in operation, and takes the value of 1 if there is high-speed rail in operation; the coefficient of $period_{it} \times connect_{it}$ is the relationship between each city and the commissioning of high-speed rail or not, i.e., the regional effect; the product of the two dummy variables, β_3 is the cross-multiplication term of the regional dummy variable with the time dummy; and the coefficient of e denotes the impact of the high-speed rail's opening on the level of city's economic development, i.e., high-speed rail effect.

In order to fully reflect the content of urban economic development and examine the conductive, lagging and phased impact characteristics of high-speed railroads on urban economic development, this paper draws on the research design of Xu Yuping[15], and uses GDP growth rate (ggdp), per capita GDP(rgdp) and employment ratio (labor) as the explanatory variables, respectively, in terms of economic growth, employment status of residents, and urban construction were analyzed empirically. In addition, urbanization rate (u), government financial expenditure (f), fixed asset investment (c), and total population at the end of the year (p) are chosen as control variables.

The statistics in this study are sourced from the 2005-2019 Hunan Provincial Statistical Yearbook. For data that is not accessible in the provincial statistical yearbook, information is obtained from the statistical yearbook of each city. A total of thirteen prefecture-level cities and higher administrative divisions in Hunan Province were chosen as representative examples.

4.   Empirical analyses

4.1.   Impact of high-speed railroads on the GDP growth rate of cities along the routes

Table 1: Regression estimates of the impact of high-speed railroads on GDP growth rate

VARIABLES	(1)	(2)	(3)	(4)	(5)
	ggdp	ggdp	ggdp	ggdp	ggdp

Table 1: (continued).

T	-0.00265***	-0.00201***	-0.000143	-0.000138	0.00187**
	(0.000427)	(0.000473)	(0.000599)	(0.000597)	(0.000740)
D	0.00121*	0.00185**	0.00224***	0.00221***	0.00128*
	(0.000726)	(0.000745)	(0.000711)	(0.000710)	(0.000714)
TD	-0.00125	-0.00121	-0.00117	-0.00103	-0.00142*
	(0.000889)	(0.000872)	(0.000827)	(0.000832)	(0.000802)
u		-0.00611***	-0.000143	-0.00221	0.00803**
		(0.00209)	(0.00236)	(0.00283)	(0.00362)
f			-0.00175***	-0.00267***	-0.00394***
			(0.000371)	(0.000801)	(0.000822)
c				0.000850	0.000209
				(0.000651)	(0.000641)
p					0.00307***
					(0.000718)
Constant	0.113***	0.115***	0.120***	0.120***	0.106***
	(0.000349)	(0.000848)	(0.00133)	(0.00134)	(0.00349)
Observations	195	195	195	195	195
R-squared	0.252	0.284	0.359	0.365	0.422

Note: Values in parentheses are parameter standard deviations. ***, **, and * indicate t-tests passed at 0.001, 0.05, and 0.10 significance levels, respectively.

4.2. Impact of high-speed rail on GDP per capita

From the second row in Table 2, the analysis is conducted on the influence of the time factor on gdp per capita. The impact coefficient of the time factor T is positively and significantly significant at the 1% level in the absence of any control variables.

From the third row in Table 2, the geographical factor D has a positive and statistically significant impact coefficient at the 1% level, even when no control factors are included.From the fourth row of the table,The impact coefficient of high-speed railway is positive, however it is not statistically significant when no control factors are included. Even after systematically incorporating the control variables, the impact of the high-speed rail factor remains statistically insignificant.From the fifth to the eighth rows of the table,The positive and significant relationship between the coefficient of urbanisation rate, government financial expenditure, fixed asset investment, and per capita gdp is

evident. In other words, government fiscal expenditure, investment in fixed assets, and urbanisation rate positively impact gdp per capita.

Table 2: Regression estimates of the impact of high-speed railroads on GDP per capita

VARIABLES	(1)	(2)	(3)	(4)	(5)
	rgdp	rgdp	rgdp	rgdp	rgdp
T	0.980***	0.448***	0.337***	0.338***	0.121**
	(0.0793)	(0.0343)	(0.0443)	(0.0430)	(0.0499)
D	0.488***	-0.0403	-0.0634	-0.0687	0.0316
	(0.135)	(0.0541)	(0.0526)	(0.0511)	(0.0481)
TD	0.0368	-0.00153	-0.00395	0.0217	0.0639
	(0.165)	(0.0633)	(0.0612)	(0.0599)	(0.0541)
u		5.062***	4.706***	4.311***	3.203***
		(0.152)	(0.174)	(0.204)	(0.244)
f			0.104***	-0.0733	0.0638
			(0.0274)	(0.0577)	(0.0554)
c				0.163***	0.232***
				(0.0469)	(0.0432)
p					-0.332***
					(0.0484)
Constant	9.404***	7.528***	7.231***	7.272***	8.774***
	(0.0647)	(0.0616)	(0.0983)	(0.0962)	(0.235)
Observations	195	195	195	195	195
R-squared	0.562	0.936	0.941	0.944	0.955

Note: Values in parentheses are parameter standard deviations. ***, **, and * indicate t-tests passed at 0.001, 0.05, and 0.10 significance levels, respectively.

4.3. Impact of high-speed rail on employment ratios

From the second row of data in Table 3,The impact coefficient of the time factor T is positively and significantly associated with employment at a 1% level of significance, indicating that employment increases as time increases when no control factors are included.From the third row in Table 3,The regional component D has a negative impact coefficient, which is statistically negligible. In Table 3, the fourth row indicates that the coefficient for high-speed rail is positively and significantly correlated at a 5% level of significance. By systematically introducing control variables, the statistical significance of the high-speed rail factor progressively rises, reaching a significant level of 1%. It suggests that the introduction of a high-speed railway contributes to a rise in the employment rate.

Table 3: Regression Estimates of the Impact of High-Speed Rail on Employment Ratio

VARIABLES	(1)	(2)	(3)	(4)	(5)
	labor	labor	labor	labor	labor
T	0.0823***	0.0773***	0.0437***	0.0438***	0.0239**
	(0.00595)	(0.00669)	(0.00816)	(0.00808)	(0.0102)
D	-0.00660	-0.0116	-0.0185*	-0.0192**	-0.00999
	(0.0101)	(0.0105)	(0.00969)	(0.00960)	(0.00986)
TD	0.00971**	0.00935**	0.00862**	0.0117***	0.0155***
	(0.0124)	(0.0123)	(0.0113)	(0.0112)	(0.0111)
u		0.0479	-0.0595*	-0.106***	-0.208***
		(0.0296)	(0.0321)	(0.0383)	(0.0500)
f			0.0314***	0.0103	0.0229**
			(0.00505)	(0.0108)	(0.0114)
c				0.0194**	0.0257***
				(0.00880)	(0.00886)
p					-0.0304***
					(0.00992)
Constant	0.564***	0.546***	0.456***	0.461***	0.599***
	(0.00486)	(0.0120)	(0.0181)	(0.0181)	(0.0482)
Observations	195	195	195	195	195
R-squared	0.579	0.585	0.655	0.664	0.680

Note: Values in parentheses are parameter standard deviations. ***, **, and * indicate t-tests passed at 0.001, 0.05, and 0.10 significance levels, respectively.

5. Conclusions and insights

The research conclusions of this study are as follows:

The opening of high-speed trains has a negligible effect on the economic growth rate of cities and per capita GDP. This finding diverges somewhat from the research findings of other countries and regions. The potential explanation for this phenomenon is that the implementation of high-speed rail projects in China involves extensive coverage across a vast territory within a very brief timeframe. Consequently, a significant number of small and medium-sized cities are included in the route network of the Chinese high-speed rail system. Using the sample area used in this study in Hunan Province, China as an illustration, the high-speed rail route traverses major provincial capital towns like Changsha, as well as smaller cities such as Yue-yang and Hengyang. In the case of small and medium-sized cities, particularly small ones, the "transit effect" and the "syphon effect" may have a more prominent influence, thereby making the introduction of high-speed rail less impactful on the overall economic development of the city.

The inauguration of a high-speed railway has a profoundly advantageous impact on the employment rate in the city where it is introduced. Upon completion of the high-speed railway station, the catering, logistics, commerce, tourism, and other industries in this area can experience substantial development. Furthermore, the completion of the high-speed railway can effectively attract individuals to seek employment in the newly established region, thereby generating a multitude of job opportunities. The inauguration of the high-speed railway will directly generate the anticipated employment opportunities in the vicinity. Furthermore, the advantageous location will attract other industries, resulting in the establishment of a new economic zone near the high-speed railway station. This, in turn, will significantly stimulate employment growth and infrastructure development in the area.

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