How Do High-Speed Rail Affect the Economic disparity of Chinese Cities?

Yuqian Luo

1. Introduction

With rapid economic growth following the opening-up policy, regional economic disparity has become a major challenge in China (Jian et al., 1996).[1] For example, there is an emergence of trend of regional disparity of China since 1990s which is mainly due to the increase of disparity between the coastal area and provinces in the hinterland. The huge economic disparity has a potential risk to the social stability and economic sustainability. To address these challenges caused by uneven economic growth, the Chinese central government launched a series of policies to promote a coordinated regional economic development. One of these policies was to expand its High-speed rail (HSR) networks.

China began to build its HSR network in 2007 which initially lagged behind some developed countries by several decades (Qin, 2017).[2] However, the phenomenal growth of HSR network in China has astonished the rest of the world in terms of the speed and size of constructed HSR trams and stations. By the end of 2023, China operates about 159 thousand kilometers of railway in track length; out of which 45 thousand kilometers are HSR track.[3] As one of the most advanced ground transportation modes, HSR is able to be operated at a speed of 250 km per hour or higher, hence inter-regional travel time can be greatly reduced. For example, the travel time between Beijing and Shanghai has been shortened from approximately 10 h with the conventional rail service to 4.5 h with the Beijing-Shanghai HSR line. In the future, China

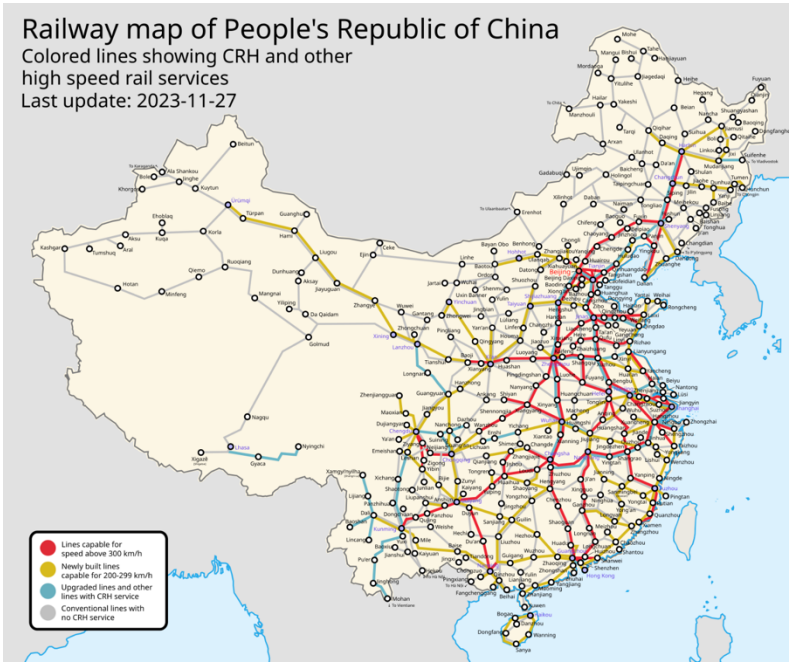
[1] Jian, Tianlun, Jeffrey D. Sachs, and Andrew M. Warner. "Trends in regional inequality in China." China economic review 7, no. 1 (1996): 1-21.

[2] Qin, Yu. "'No county left behind?'The distributional impact of high-speed rail upgrades in China." Journal of Economic Geography 17, no. 3 (2017): 489-520.

[3] China Railway, 2024, http://www.china-railway.com.cn/xwzx/zhxw/202401/t20240112_132652.html

will continue to expand its HSR network. According to the Medium and Long-term Railway Network Plan, China's HSR networks are expected to reach a rail network dubbed 'eight vertical and eight horizontal' is expected to be developed by 2030. HSRs are believed to be a driving force for economic growth in China owing to their advantages in reducing travel time and cost, improving capacity utilization and reliability, increasing accessibility, and raising productivity (Meng et al., 2018).[4] HSRs can also be a tool to improve regional economic disparity and uneven population distribution by connecting China's underdeveloped and developed areas.

Fig.1. Railway Map of China by the end of year 2023 (https://en.wikipedia.org/wiki/List_of_high speed_railway_lines_in_China#/media/File:Rail_map_of_PRC.svg)



The structure of the latter paper is organized as follows: The first part is a literature review that will summarize the methods used and the findings of the existing literature. The second part is

[4] Meng, Xuechen, Shanlang Lin, and Xiaochuan Zhu. "The resource redistribution effect of high-speed rail stations on the economic growth of neighbouring regions: Evidence from China." Transport Policy 68 (2018): 178-191.

methodology, which formulates the research hypotheses, describes the data sources and processing methods, and introduces the model used in this paper. The third part is the empirical analysis and statistical findings, which contains correlation analysis and regression analysis, exploring the impacts of HSR on economic disparities. In addition to these, this paper lists the limitations of the empirical analysis to provide direction for future in-depth research. At last，it will conclude with a summary of the research findings and propose some policy recommendations.

2. Literature Review

2.1. Effects of HSRs on economic growth

Although HSRs are believed to be an important factor of economic growth, many studies identify both positive and negative effects of HSR networks on economic growth. Most studies find a positive effect on the local economy. For instance, Chen et al. (2016) suggests that investments in HSRs positively stimulate economic growth, primarily through induced demand and output expansion, using a computable general equilibrium model.[5] Using county-level panel data from 2006 to 2014, Meng et al. (2018) verify that one HSR station can promote local economic growth by 14%.[6] Using Difference-in-Difference model, Li et al. (2020) confirms that the development of HSR has a positive and significant impact on

[5] Chen, Zhenhua, Junbo Xue, Adam Z. Rose, and Kingsley E. Haynes. "The impact of high-speed rail investment on economic and environmental change in China: A dynamic CGE analysis." Transportation Research Part A: Policy and Practice 92 (2016): 232-245.

[6] Meng, Xuechen, Shanlang Lin, and Xiaochuan Zhu. "The resource redistribution effect of high-speed rail stations on the economic growth of neighbouring regions: Evidence from China." Transport Policy 68 (2018): 178-191.

urban economic efficiency, which is explained as Chinese HSRs intends to connect all types of cities rather than certain major cities or regions.[7]

However, some studies suggest Chinese HSR networks have a negative impact on economic development. For example, Gao et al. (2018) find that HSRs have hampered the economic growth of cities within the Yangtze River Delta region by about 10% and that peripheral cities have suffered more significant negative effects than central cities close to provincial capitals.[8] Besides, HSRs have led to a reduction in GDP per capita for connected peripheral prefectures which is driven by significant contractions in capital input, industrial output, and skilled labor outflow (Yu et al., 2019).[9]

2.2. Effects of HSRs on economic disparity

In addition, as HSRs may create both convergence and divergence effects between remote locations and economic growth centers, several studies focus on its role in regional economic disparity. With the construction of HSR network, cities at the top-rank of China's city network by centrality had moved from the core hubs in the CR network (e.g. Nanjing, Shanghai and Suzhou) to cities (e.g. Zhengzhou and Zhuzhou) with dense populations and

[7] Li, Yan, Zhenhua Chen, and Peng Wang. "Impact of high-speed rail on urban economic efficiency in China." Transport Policy 97 (2020): 220-231.

[8] Gao, Yanyan, Shunfeng Song, Jun Sun, and Leizhen Zang. "Does high-speed rail really promote economic growth? evidence from China's Yangtze River delta region." Evidence from China's Yangtze River Delta Region (April 8, 2018) (2018).

[9] Yu, Feng, Faqin Lin, Yihong Tang, and Changbiao Zhong. "High-speed railway to success? The effects of high-speed rail connection on regional economic development in China." Journal of Regional Science 59, no. 4 (2019): 723-742.

developed economies (Jiao et al., 2017).[10] Chen et al. (2017) used three indexes: Gini index, weighted coefficient of variation, and Theil index, confirming that regional economic disparity is reduced due to a convergence during the period 2000–2014.[11]

On the contrary, Jin et al. find that HSRs make a significant positive contribution to economic growth in large-mega cities but insignificant effects on economic growth in small-medium cities, which means HSRs have aggravated economic disparity in China (2020).[12]

Overall, previous studies have not reached a consensus about the impact of HSRs on China's economic disparity, so the topic requires further research.

3. Methodology

3.1. Main Hypothesis

HSR improves travel times not only for the cities located on HSR lines but also for the non-HSR cities. It can be seen that HSR can stimulate consumption to a certain extent and thus promote economic development. Besides, HSR makes it easier and cheaper to get around, and the movement of people between regions or cities has become more frequent as a result. Based on the above theories, the research hypothesis of this paper is proposed:

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[10] Jiao, Jingjuan, Jiaoe Wang, and Fengjun Jin. "Impacts of high-speed rail lines on the city network in China." Journal of Transport Geography 60 (2017): 257-266.

[11] Chen, Zhenhua, and Kingsley E. Haynes. "Impact of high-speed rail on regional economic disparity in China." Journal of Transport Geography 65 (2017): 80-91.

[12] Jin, Mengjie, Kun-Chin Lin, Wenming Shi, Paul TW Lee, and Kevin X. Li. "Impacts of high-speed railways on economic growth and disparity in China." Transportation Research Part A: Policy and Practice 138 (2020): 158-171.

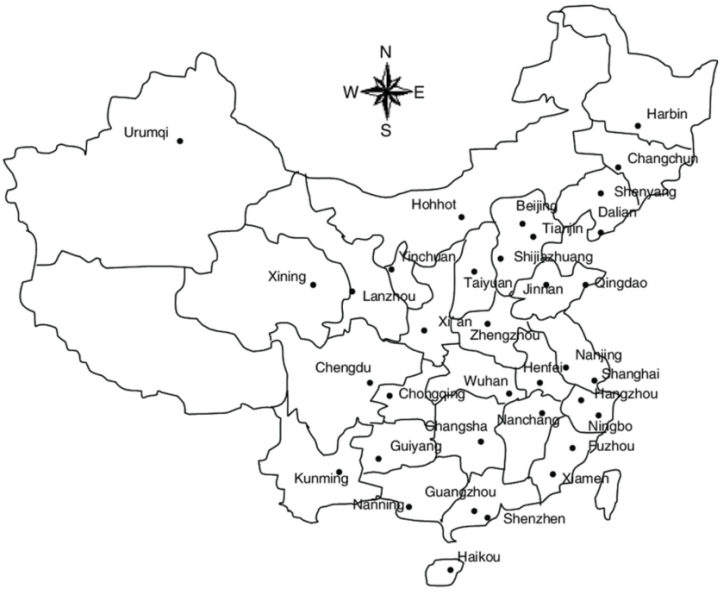
HSR leads to economic growth and decrease the economic disparity in China.

3.2. Data Source and processing

This paper choses 36 major cities as the basic geographical unit in empirical analysis. These cities are located in various provinces of China and are representative of the region. The data of variables below were derived from National Bureau of Statistics of China and cover the period 2005-2023.[13]

Raw data such as GDP and the year of commissioning of HSR for each sample city are processing into time-series dataset. In specific, this paper calculates the standard deviation of sample cities' GDP every year in order to measure the economic disparity. Besides, the variable of HSR has been measured by calculating the share of HSR in each sample year by collecting the years in which HSR was available in each city. In addition to this, this paper has chosen the average population size of the sample cities, population density and domestic tourist as control variables.

Fig.2. Distribution of sample cities in China



[13] National Bureau of Statistics of China, https://data.stats.gov.cn/english/easyquery.htm?cn=C01

3.3. Model Specification

This paper uses OLS model to analyze the impacts of HSR on economic growth and economic disparity. The estimation equation of an OLS model can be expressed as:

$$GDP_t = \alpha_0 + \alpha_1 \cdot HSR_t + \alpha_2 POP_t + \alpha_3 POPDensity_t + \alpha_4 Tourists_t + \epsilon_{1t} \quad (1)$$

$$STDGDP_t = \beta_0 + \beta_1 \cdot HSR_t + \beta_2 POP_t + \beta_3 POPDensity_t + \beta_4 Tourists_t + \epsilon_{2t} \quad (2)$$

Where: GDP_t is GDP in year t which measures the economic growth during sample period. $STDGDP_t$ is the standard deviation of GDP in year t which is chosen to measure economic disparity. HSR_i is the share of HSR in year t which equals the number of cities with high-speed rail divided by the number of cities in the sample. POP_t, $POPDensity_t$ and $Tourists_t$ are a set of control variable respectively representing the average population among sample cities, population density across the country and domestic tourists in year t. ϵ_{1t} and ϵ_{2t} are the error term.

4. Empirical analysis and Statistical Findings

4.1 Correlation Test

Fig.3. and Fig.4. show the correlation test results between two implicit variables and HSR share. The coefficient between GDP and HSR is 0.877 which suggests that HSR coverage strongly and positively correlates to the GDP, indicating a potential economic growth of HSR expansion. The coefficient between STDGDP and HSR is -0.948 which indicates that HSR share also strongly but negatively correlates to the STDGDP. The results demonstrate a significant correlation between variables, which can be further analyzed in a regression analysis.

Fig.3. Correlation Coefficient: GDP

	GDP	HSR	POP	POPDensity	Tourists
GDP	1				
HSR	0.877***	1			
POP	0.989***	0.827***	1		
POPDensity	0.811***	0.763***	0.813***	1	
Tourists	0.690***	0.804***	0.606***	0.560**	1

Fig.4. Correlation Coefficient: Standard Deviation of GDP

	STDGDP	HSR	POP	POPDensity	Tourists
STDGDP	1				
HSR	-0.948***	1			
POP	-0.954***	0.827***	1		
POPDensity	-0.830***	0.763***	0.813***	1	
Tourists	-0.761***	0.804***	0.606***	0.560**	1

*** p<0.01, ** p<0.05, * p<0.1

4.2 Regression Result

Fig.5. Regression Results

	(1)	(2)
VARIABLES	GDP	STDGDP
HSR	0.104*	-3.605***
	(0.056)	(0.480)
POP	5.561***	-29.827***
	(0.300)	(2.548)
POPDensity	-0.020	-0.225
	(0.032)	(0.272)
Tourists	0.023**	-0.185**
	(0.009)	(0.080)
Constant	-3,443.323***	31,277.335***
	(175.687)	(1,494.267)
Observations	19	19
R-squared	0.993	0.993
Adjusted R-squared	0.991	0.991

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The table below shows the regression results of OLS model. Result 1 is the regression test of GDP and result 2 is the regression test of STDGDP. From the results, HSR has a

positive impact on GDP with a coefficient of 0.104 which suggests as more cities open high-speed railways, national GDP increases. Besides, in the second result, HSR has a negative coefficient of -3.605 which suggests that HSR expansion could significantly decrease the GDP standard deviation. It is implied that as more and more cities have high-speed railways, the economic disparities between regions are gradually shrinking.

To sum up, these results are consistent with the previous hypothesis that HSR leads to economic growth and decrease the economic disparities in China.

5. Limitations

Despite providing meaningful insights, this study has several limitations. The first one is data limitations and sample size. Because of the data availabilities, the analysis is only based on 36 major cities over the period from 2005 to 2023, which may not fully capture the heterogeneity of HSR effects across all regions of China, especially in less developed or rural areas. Besides, all data were consolidated into time-series data, resulting in only 19 observations for the regression analysis which may bias the results. The second one is model construction. This paper uses OLS model that may suffer from omitted variable bias. And in reality, infrastructure investments like HSR often have lagged impacts, which are not captured in the empirical study.

6. Future Research

Based on the current study and limitations, future research can be directed in the following ways: First, Employe methods such as Difference-in-Differences (DID), use panel data and

introduce dummy variables to identify the causal effects of HSR on economic growth and disparity. Second, economic disparities between regions can be measured by constructing index from like Gini Index and Theil index. Third, future research can analyze how HSR affects different industrial sectors and whether the benefits of HSR are distributed evenly across economic activities.

7. Conclusion

By conducting an empirical test on the data collected, this study examines the impact of high-speed rail (HSR) development on economic growth and regional economic disparity across Chinese from 2005 to 2023. Based on OLS regression results, the findings suggest that the expansion of HSR coverage is significantly associated with GDP growth and reduced disparities in economic performance among major cities. These findings are consistent with the proposed hypothesis that HSR development promotes economic growth and contributes to narrowing the economic gaps between cities.

Overall, this study highlights the vital role of infrastructure investment, particularly HSR, in promoting balanced regional development in China. Based on the findings, the following policy recommendations are proposed: First, continue expanding the HSR network to underdeveloped regions. Given that China's HSR not yet been popularized throughout the country, further expanding the coverage of HSR is conducive to further reducing regional disparities. Second, integrate HSR development with urban and regional planning. China is carrying out modernization reforms, and including HSR construction in the reforms can effectively accelerate the modernization and reform process.

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