Analysis on the Influence of High-speed Railway Construction on Regional Economic Growth

-- An Empirical Study based on Panel Data of Anhui Province

Miaomiao Mao, Zhihong Wang

Anhui University of Finance and Economics, Bengbu, Anhui 233030, China

Abstract

High-speed rail is an important type of transport infrastructure in contemporary China, and its related infrastructure construction has a significant impact on the industrial layout and economic growth of the region along the way. Based on the panel data of various prefecture-level cities in Anhui Province from 2005 to 2018, this paper uses the difference-in-differences model and carries out the econometric test. The results show that the opening and construction of High-speed rail has a significant positive impact on the GDP of the opened areas in Anhui Province. The economic development of different regions in the same region is affected by High-speed rail differently, and finally provides relevant suggestions for the sustainable development of Anhui economy.

Keywords

High-speed Rail; DID; Regional Economy.

1. Introduction

China's High-speed railway, which is proud of the Chinese people, has gone out of the innovative road of socialism with Chinese characteristics from line engineering to operation control system and train development. At the same time, compared with traditional railway transportation, High-speed railway has the advantages of fast speed and good comfort. On the other hand, compared with aircraft, High-speed railway has the characteristics of relatively affordable price and high punctuality, which not only creates a new way of living and travelling for us, but also provides high-quality public services for the whole society, and has become a huge driving force for economic and social development.

China's High-speed railway started late but developed rapidly. Since the opening of China's first High-speed railway in 2008, China's High-speed railway mileage has reached 29,000 kilometers in a short period of 10 years, ranking first in the world, exceeding the total High-speed railway of other countries in the world. In September 2020, China's independent research and development of 600 km /h High-speed maglev turnout successfully passed the factory acceptance, which means that the world's highest speed maglev turnout will be officially launched. Anhui Province is geographically close to the Yangtze River Delta Economic Zone, and the Yangtze River and Huaihe River run across it. It is an inland province near the Yangtze River and the sea. As a transitional zone between north and south, its geographical location is very important. However, the radiation scope of the ordinary railway era is limited and cannot bring too much effect to the economic development of the province. The introduction of *"Development Planning of Urban Agglomeration in Yangtze River Delta"* in 2016 has made Anhui integrate into the Yangtze River Delta, and its positioning is more clear. Hefei, as the junction point on the High-speed rail line, has broken the situation of traffic inconvenience, and its hub position has been greatly strengthened. At present, there are High-speed rail networks woven by multiple passenger dedicated lines in Anhui Province, such as Hening, Hewu, Beijing-

Shanghai, Hefu, Hebeng, Ning'an and Zhengfu. The railway operation mileage of the province is 5100 kilometers, and its density ranks first in East China. This paper mainly analyzes the impact of the opening of High-speed railway on the economic growth of prefecture-level cities in Anhui Province, and whether there is a development imbalance between the opening and non-opening cities, which has important research value and significance.

The economic effect of High-speed rail on the region has always been an economic problem concerned by scholars at home and abroad. With the increasing achievements of High-speed rail in China, the literature on relevant topics has also risen. There are both theoretical and empirical studies. Xiaoyan Lin and Xiaojun Chen et al. designed the evaluation index system based on the three effects of accessibility, industrial structure optimization and employment. They predicted the social and economic development index value without Beijing-Tianjin intercity railway and compared it with the actual value. Finally, they concluded that Beijing-Tianjin intercity High-speed railway had a positive effect on stimulating the local railway passenger market, reducing freight pressure and improving the transport capacity of railway freight lines [1]. Yanmei Dong and Yingming Zhu add the new factor of High-speed rail construction in the research framework of new economic geography, and analyze whether the construction of High-speed rail can reshape China's economic spatial layout from different aspects of employment, wages and economic growth. Finally, it confirms the initial speculation that High-speed rail construction can affect the economic growth space of the region [2]. Xu Wen and Xu Han analyzed the spatial pattern of China's regional economic development after the opening of High-speed rail by using gravity model and location advantage potential model qualitatively and quantitatively. The study found that the opening of High-speed rail made cities closer, and put forward suggestions on the imbalance of regional economic development in China [3]. Based on the panel data of Jiangxi Province, Yaobin Liu studied the successive opening of Chang-Ji High-speed railway and Shanghai-Kunming High-speed railway, and discussed whether they had an impact on the economic development of the province. The results showed that the opening of Chang-Ji High-speed railway strengthened the communication between production factors and the amount of economic connection, while the Shanghai-Kunming High-speed railway showed a negative effect [4]. Yonghui Yang et al. started with the existence of High-speed rail stations along the line in Fujian Province, and used the difference method to estimate the differences caused by the construction and operation of High-speed rail. The study found that the influence of High-speed rail construction and operation on the county and county-level cities along the line was significantly different, and the development of county-level cities was more significant [5]. By constructing Cobb-Douglas growth function and establishing spatial Durbin model, Lijin Chen and Guoli Ou analyzed the spatial panel data of 101 county-level cities from 2006 to 2015. It was found that the operation period of High-speed rail had stronger economic impetus than the construction period, and the spillover effect of 'horizontal' High-speed rail line was more obvious than 'vertical'[6]. Xin Song et al. focused on the changes of passenger flow point intensity and inter-city connection intensity in more than 40 cities in the Yangtze River Delta region of the railway network to construct the production function model [7]. Around the results of the measurement of urban agglomerations, Xin Qi et al. drew the morphological structure change diagram and econometric model analysis by means of network analysis method. It was found that the construction of High-speed railway played an important role in promoting the coordinated development of urban agglomeration economy, but there were also individual cities whose economic development did not benefit from the construction of High-speed railway [8]. By constructing a theoretical analysis framework containing High-speed rail and environmental factors, Xuetao Sun and others take the era of High-speed rail as the background, and combine theory with empirical analysis to analyze the impact and effect of High-speed rail opening on economy and environment [9]. Fenglong Chen and others studied the network effect of High-

speed rail construction on economic growth in different cities based on the frequency of High-speed rail traffic and night lighting data in more than 100 cities in China. The analysis shows that the effect is related to different cities and urban agglomerations [10]. In summary, there are abundant studies on the impact of High-speed rail on regional economy at present. However, due to the inconsistent development status of cities in various regions in China, the impact of High-speed rail on different regions may be different. In addition, there are few empirical studies on Anhui Province. In summary, there are abundant studies on the impact of High-speed rail on regional economy at present. However, due to the inconsistent development status of cities in various regions in China, the impact of High-speed rail on different regions may be different. In addition, there are few empirical studies on Anhui Province. Therefore, this paper selects and establishes a new panel data, uses econometric knowledge to construct a DID to explore whether the opening and construction of High-speed rail has an impact on the economic growth of Anhui Province, and then provides relevant suggestions for the future economic development plan of the province, and supplements relevant empirical evidence for the study of the economic effect of High-speed rail.

2. Empirical Analysis of the Impact of High-speed Rail Construction in Anhui Province on Regional Economic Growth

2.1. Construction of the Model

Difference-in-Difference(DID), as one of the tools in econometrics that can effectively evaluate the effect of policy implementation, is often used by academic scholars to study the impact of High-speed rail construction on economic growth. The Difference-in-Difference model is different from other models that it can treat the samples as the experimental group and the control group, and effectively distinguish the impact of different results brought by the two groups. Therefore, this paper selects the DID as a mature method to apply the panel data of Anhui Province, and establishes the following model:

$$GDP_{it} = \beta_1 did_{it} + \beta_2 Second_{it} + \beta_3 FDI_{it} + \beta_4 Gov_{it} + \beta_5 Pop_{it} + \beta_6 Edu_{it} + \beta_7 Doc_{it} + \beta_0 + \varepsilon_{it}$$

2.2. Variable Description and Data Selection

In the above expression, the explained variables, explanatory variables and control variables constitute the type of variables. Among them, the explained variable selects economic development, namely the local GDP, which indicates the impact of High-speed rail construction on economic development in Anhui Province, and the symbol is GDP. The opening of High-speed rail is selected as an explanatory variable, and the value is assigned to 1 after the opening of High-speed rail in the city. Otherwise, the value is assigned to 0, and the symbol is did. The control variables include the level of industrialization (Second), FDI, fiscal expenditure (Gov), population (Pop), education level (Edu), and medical level (Doc). The variable meanings are the output value of the secondary industry/regional GDP*100, the amount of foreign direct investment, the total amount of government fiscal expenditure, the total population at the end of the year, the number of students in universities, and the number of health personnel in hospitals and health centers. In addition, i represents different cities, t represents different time, β_1-β_7 is the coefficient value of the variable, β_0 is the constant term (intercept term), and ε_{it} is the random disturbance term.

In order to better study the impact of High-speed rail construction in Anhui Province on regional economic growth, this paper selects 16 prefecture-level cities in Suzhou, Huaibei, Bengbu, Fuyang, Huainan, Bozhou, Hefei, Lu'an, Chuzhou, Anqing, Huangshan, Wuhu, Ma'anshan, Tongling, Xuancheng and Chizhou in Anhui Province as the research objects. The

economic data used are from the " *Anhui Statistical Yearbook* " of the official website of Anhui Provincial Bureau of Statistics from 2005 to 2018 and its collation.

3. Empirical Results and Analysis

3.1. Descriptive Statistics

Table 1 is the descriptive statistics of variables, including the mean, standard deviation, minimum, maximum and sample number of variables. The statistical results in the table show that the standard deviation of each variable is still different, and the standard deviation of the level of industrialization (Second) is the largest, indicating that there is a big difference between the economic development and the level of industrialization in Anhui Province.

Table 1. Descriptive statistics

variable	mean value	standard deviation	minimum value	maximum value	Number of samples
GDP	5.861	0.927	4.008	8.677	164
did	0.354	0.48	0	1	164
Second	49.783	11.907	29.61	75.18	164
FDI	9.488	1.453	5.46	12.466	164
Gov	4.144	0.947	2	6.498	164
Pop	4.705	0.57	3.739	5.639	164
Edu	10.416	1.038	8.294	13.158	164
Doc	7.744	0.689	6.242	9.678	164

3.2. Analysis and Testing

Before the regression analysis of the DID, it is necessary to analyze and test the data. Firstly, the correlation coefficient is analyzed. By analyzing the correlation coefficient between the explained variable economic development (GDP) and the core explanatory variable High-speed rail opening (did), it is found that the correlation coefficient is positive and significant at 1% significance level, indicating that there is a certain positive correlation. From the correlation coefficient between explanatory variables and control variables, it can be found that most of the correlation coefficients are small, but there are also individual correlation coefficients with absolute values greater than 0.8, so it is impossible to determine whether there is multiple collinearity between variables. Since the correlation coefficient analysis can not determine whether the variables selected in this paper have multiple collinearity problems, then further calculate the variance expansion factor value of the variables to determine whether there are multiple collinearity problems between variables. The following table is the variance expansion factor value of the variables. From the table, it can be found that the maximum variance expansion factor value of the medical level (Doc) is 9.33, the minimum variance expansion factor value of the High-speed rail opening (do) is 1.61, and the average variance expansion factor value of the variable is 4.6, which is less than the critical value of the measurement 10. Therefore, the variance expansion factor of the variable can be calculated to determine that there is no multiple collinearity between variables.

3.3. Baseline Regression

The benchmark regression of the model is carried out, and the results are shown in Table 3. In the regression results, N represents the number of samples, R represents the goodness of fit, and the standard deviation is given in brackets. *, * *, * * * represent the significance levels of 10 %, 5 % and 1 %, respectively. The first column in the table is the regression result without control variables, and the second column is the regression result with control variables.

Table 2. Variance Expansion Factor

Variable name	variance inflation factor	1 / variance expansion factor
Doc	9.33	0.107231
Edu	6.2	0.161192
Gov	5.13	0.194952
FDI	4.98	0.200649
Pop	3.23	0.309816
Second	1.71	0.584077
did	1.61	0.620242
Mean variance expansion factor	4.6	

Table 3. Baseline regression results

	(1)	(2)
	GDP	GDP
did	0.994***	0.254***
	[0.120]	[0.064]
Second		0.007**
		[0.003]
FDI		0.132***
		[0.037]
Gov		0.395***
		[0.058]
Pop		0.128*
		[0.076]
Edu		0.005
		[0.058]
Doc		0.276**
		[0.107]
_cons	5.424***	-0.333
	[0.071]	[0.338]
N	164	164
R^2	0.297	0.882

Note : *, * * and * * * represent the significance levels of 10 %, 5 % and 1 %, respectively

From the perspective of the impact of the opening of High-speed rail on the GDP of the region, the coefficient is 0.994 at the 1 % significant level without the control variable, and the coefficient is still positive and significant at the same significant level with the coefficient of 0.254. Although the coefficient has declined, it just shows that the construction of High-speed rail is only one of the necessary ways of economic development in Anhui Province, not a sufficient and necessary condition. On the other hand, the control variables added at the same time passed the significant test at different significant levels, which not only shows that increasing government expenditure and foreign direct investment have a positive role in promoting the GDP of Anhui Province, but also shows that the opening of High-speed rail can save people's time and energy between different cities, accelerate the exchange of production factors, and effectively promote the economic development of the province.

3.4. Heterogeneity Analysis

This paper further divides the panel data of Anhui Province into three regions: northern, central and southern Anhui. The specific division of northern Anhui includes Suzhou, Huaibei, Bengbu,

Fuyang, Huainan, Bozhou six prefecture-level cities. The central Anhui region includes four prefecture-level cities: Hefei, Lu'an, Chuzhou and Anqing. Southern Anhui includes Huangshan, Wuhu, Maanshan, Tongling, Xuancheng, Chizhou six prefecture-level cities. Through further division and analysis of the samples, we can know the effect of High-speed rail construction on the economic promotion of different regions in the province, so as to better provide suggestions for the construction and development of High-speed rail.

Table 4 below shows the results of regional heterogeneity analysis in Anhui. From the regression results, it can be found that the coefficients of did of High-speed rail opening in northern Anhui, southern Anhui and central Anhui are 0.384, 0.628 and 0.002, respectively. In other words, the High-speed rail opening has a significant positive effect on the economic discovery in northern Anhui and southern Anhui, but has a general effect on the economic development in central Anhui. Moreover, the opening of High-speed rail has the most obvious pulling effect on the economic development of southern Anhui. This coincides with the relatively excellent economic development conditions in southern Anhui. Wuhu, Ma'anshan and other places have a good industrial foundation. In addition, as one of the core cities of "*Nanjing Metropolitan Circle*", their geographical location is excellent. Huangshan, Xuancheng and Chizhou are rich in tourism resources. Relying on the development of the vast tertiary industry, they have become important tourist attractions in Anhui Province. With the continuous acceleration of the construction of High-speed rail, new opportunities have been brought to the economic development of southern Anhui.

Table 4. Results of heterogeneity analysis in Anhui Province

	(1)	(2)	(3)
	northern anhui	central region of anhui	southern anhui
did	0.384***	0.002	0.628***
	[0.035]	[0.120]	[0.096]
Second	0.008***	-0.011	0.021***
	[0.002]	[0.008]	[0.004]
FDI	0.025	0.004	0.114*
	[0.019]	[0.069]	[0.061]
Gov	0.401***	0.639***	0.479***
	[0.029]	[0.091]	[0.085]
Pop	-0.120	-0.731***	0.144
	[0.108]	[0.152]	[0.124]
Edu	0.017	0.336***	-0.370***
	[0.043]	[0.102]	[0.080]
Doc	0.106*	0.570***	0.384**
	[0.061]	[0.194]	[0.174]
_cons	3.006***	-1.145	1.652***
	[0.512]	[0.709]	[0.606]
N	62	44	58
R^2	0.970	0.975	0.920

Note : *, * * and * * * represent the significance levels of 10 %, 5 % and 1 %, respectively

3.5. Robustness Test

The robustness test can ensure the reliability of the research conclusion and exclude the influence of variables that may exist but not found on the results. Therefore, the per capita GDP (PGDP) is selected to replace the GDP to measure the economic development of the region. The robustness test of regional heterogeneity analysis in Anhui is also conducted, and the results

are shown in Table 5 and Table 6. The baseline regression results after replacing variables in the table show that there is no significant difference between the direction of the do coefficient after replacement and the level of significance, which is consistent with the baseline regression conclusion above, indicating that the model is robust and effective.

Table 5. Standard regression robustness test results

	(1)	(2)
	PGDP	PGDP
did	0.859***	0.286***
	[0.116]	[0.061]
Second		0.003
		[0.003]
FDI		0.160***
		[0.035]
Gov		0.341***
		[0.055]
Pop		-0.725***
		[0.073]
Edu		0.060
		[0.055]
Doc		0.210**
		[0.102]
_cons	9.955***	8.241***
	[0.069]	[0.324]
N	164	164
R^2	0.253	0.876

Note : *, * * and * * * represent the significance levels of 10 %, 5 % and 1 %, respectively

Table 6. Robustness test results of Anhui regional heterogeneity analysis

	(1)	(2)	(3)
	northern anhui	central region of anhui	southern anhui
did	0.325***	0.005	0.652***
	[0.040]	[0.085]	[0.086]
Second	0.008***	-0.003	0.005
	[0.003]	[0.005]	[0.003]
FDI	0.021	0.042	0.072
	[0.021]	[0.049]	[0.055]
Gov	0.429***	0.487***	0.446***
	[0.033]	[0.064]	[0.076]
Pop	-1.114***	-1.502***	-0.393***
	[0.121]	[0.107]	[0.111]
Edu	0.019	0.398***	-0.175**
	[0.048]	[0.072]	[0.072]
Doc	0.126*	0.502***	0.264*
	[0.069]	[0.137]	[0.156]
_cons	11.959***	6.789***	9.105***
	[0.574]	[0.500]	[0.544]
N	62	44	58
R^2	0.970	0.982	0.898

4. Conclusions and Recommendations

4.1. Conclusion

Taking Anhui Province as an example, based on the panel data from 2005 to 2018, this paper uses the DID to analyze the impact of the construction of High-speed railway on the province, and uses the robustness test to prove the rationality of the model. The empirical results are as follows:

First, the construction of High-speed rail has a significant positive effect on the GDP of the regions that have been opened in Anhui Province. However, compared with before and after the addition of control variables, the coefficient of did of High-speed rail construction has become smaller, and the economic speed has slowed down after the addition of variables, indicating that the construction of High-speed rail is only one of the necessary conditions for local economic development. At the same time, fixed asset investment, fiscal expenditure, education level and medical level have all played a promoting role in the economic growth of Anhui Province.

Secondly, the construction of High-speed rail has a significant role in promoting the GDP per capita in Anhui Province. Traffic is the lifeline of regional economic development, and High-speed rail has unique price and speed advantages compared with other transportation tools. The opening of High-speed rail not only enriches and expands people's travel mode and scope, but also indirectly increases the employment opportunities of job seekers, and then improves people's income.

Third, as a whole, the construction of High-speed rail has a positive impact on the economic development of Anhui Province. Through the empirical analysis of the three regions of northern Anhui, central and southern Anhui, it is found that the construction of High-speed rail has different effects on different regions. Due to the differences in natural resources, scientific and technological conditions and labor population, the impact of High-speed rail construction on the three regions is southern Anhui, followed by northern Anhui, and finally central Anhui.

4.2. Recommendations

In order to maximize the positive effect of High-speed rail construction and better play a leading role in the economic development of Anhui Province, the following suggestions are put forward :

First, continue to promote the planning and construction of High-speed rail in Anhui Province, play a positive role in the economy. Considering the unbalanced development of the three regions in northern Anhui, central Anhui and southern Anhui, if Anhui wants to reduce the economic gap between the three regions and increase the total amount of regional GDP, it is necessary to scientifically plan the High-speed railway network and increase investment in High-speed rail construction. Each city's own advantages are connected with the current situation of economic development, and a comprehensive and reasonable plan is made to promote the development of each city.

Second, improve the construction of related facilities in Anhui Province. The construction of High-speed rail has strengthened the communication links between different cities, but in order to give full play to the maximum degree of High-speed rail to promote economic development, it is necessary to lack the assistance of relevant basic supporting measures in Anhui Province, such as improving the service construction of hotels and restaurants around High-speed rail stations as soon as possible, increasing the supply of buses and taxis and standardizing service standards, which can not only greatly facilitate people and improve travel efficiency, but also leave a good image of the city, so as to attract more people to the region and promote the development of regional economy.

Third, strengthen government policy guidance, promote regional industrial structure adjustment and upgrading. The construction of High-speed railway will bring a series of

spillover effects, leading to the outflow of regional human resources. At this time, the government and its relevant departments should play a guiding and supporting role in economic development, formulate strategies for attracting talents, increase regional employment opportunities, attract high-quality human resources, create more vitality for high-tech industries, promote the adjustment and upgrading of capital, human resources, production factors and technology in the regional industrial structure, and make the development of the whole High-speed railway economic network more robust.

Acknowledgments

References

[1] Lin Xiaoyan, Chen Xiaojun, Baiyunfeng, Han Xinmei. Quantitative analysis of the impact of Beijing-Tianjin intercity High-speed railway on regional economy [J]. Railway economic research. 2010,1-7.

[2] Dong Yanmei, Zhu Yingming. Can the construction of High-speed rail reshape China's economic spatial layout-based on regional heterogeneity of employment, wages and economic growth [J]. China's industrial economy. 2016,1-17.

[3] Wenzhi, Hanxu. Impact of High-speed rail on urban accessibility and regional economic spatial pattern in China [J]. Human geography. 2017,1-10.

[4] Liu Yaobin, Zheng Weiwei. The impact of different grades of High-speed railways on regional economic disparities - - An empirical analysis of Jiangxi Province based on DID model [J]. Journal of Nantong University. 2019, 1-10.

[5] Yang Yonghui, Zheng Wei, Chen Yue.Difference in the contribution of High-speed railway construction and opening to Fujian county economy [J].Journal of Fuqing Branch of Fujian Normal University.2020,1-13.

[6] Chen Lijin, European. High-speed railway, spatial spillover and regional economic growth — urban spatial panel data analysis based on 101 county-level High-speed railway stations [J]. Journal of Zhengzhou University. 2019, 1 – 6.

[7] Song, Sun and Wang. Spatial-temporal evolution pattern of High-speed rail network in the Yangtze River Delta and measurement of regional economic impact. [J] Resources and environment in the Yangtze River Basin. 2020, 1 – 14.

[8] Qi Xin, Wang Lijun, Zhang Jiaxing, and Wang Feiyue. Research on the spatial association pattern and economic growth effect of urban agglomeration under the influence of High-speed rail. [J] Geography. 2021, 1–10.

[9] Sun Xuetao, Zhang Guangsheng.The opening of High-speed rail, environmental pollution and urban economic development [J].soft science.2021,2-10.

[10] Chen Fenglong, Wang Meichang. Heterogeneous effects of High-speed rail on urban economic growth [J]. Modern economic discussion. 2020, 1-7.