Impact of Chengdu Chongqing High-Speed Railway on Regional Economic Development Along the Line Based on DID Method

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Abstract—Chengdu Chongqing high-speed railway will have a far-reaching impact on the economic and social development of the areas along the line. Based on the data of the regions along the Chengdu Chongqing high-speed railway from 2009 to 2019, taking the added value of the secondary and tertiary industries and the level of urbanization rate in each region as the explanatory variables, taking 2016 as the policy time node, this paper empirically tests the impact of the opening and operation of Chengdu Chongqing high-speed railway on the regional economic development along the railway by using the did double difference model estimation method. The results show that the opening and operation of Chengdu Chongqing high-speed railway has a significant negative impact on the secondary industry output value and urbanization rate along the line, reflecting the agglomeration effect of high-speed railway economy. Therefore, when formulating policies, small and medium-sized areas should strive to amplify the diffusion effect of high-speed railway.

Keywords-High speed railway; Regional economy; Economic impact

1 Introduction

High-speed railway is an important achievement of contemporary science and technology inheritance and innovation. According to the research of foreign scholars, high-speed railway, as a new mode of transportation, on the one hand, as a new mode of transportation, can weaken the barrier between regions and accelerate the movement of labor between regions. On the other hand, the completion and operation of high-speed railway network has gradually solved the problems of large-scale and long-distance rapid transportation through the completion and operation of high-speed railway, enhanced the mobility of product elements, and further improved regional accessibility and communication efficiency.

By the end of 2020, the operating mileage of China's high-speed railway was 38000 kilometers, ranking first in the world. With the improvement of high-speed rail, it will gradually become one of the most common transportation infrastructure, and by 2030, China can basically achieve the connectivity of major cities and regional coverage [1]. The investment and operation of high-speed rail will enable China to enter a real "high-speed rail era". According to the research and practice experience of scholars and organizations in various countries on high-speed railway, this will change China's transportation layout and residents' travel mode, and will also have an impact on the economic development and factor flow of regions along the high-speed railway [2].

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Intercity high-speed railways, intercity expressways and transportation hubs built along the route can make the industrial ties of cities along the route closer and realize the division of labor, expand the development space of central cities, and improve their economic agglomeration capacity. The "Chengdu-Chongqing Urban Agglomeration Development Plan" released in 2016 pointed out that Chongqing and Chengdu need to give full play to the dual-core driving function, and build the main axis of Chengdu-Chongqing development, along the Yangtze River and Chengdu Deyang Mianyang Leshan urban belt, so as to help the rapid development of urban dense areas such as southern Sichuan, Suining, and Dazhou, improve the spatial utilization efficiency of urban agglomerations, and build a spatial development pattern of "one axis, two belts, dual cores and three zones".

The Chengdu-Chongqing high-speed railway has 12 stations throughout the whole process, starting from Chengdu East Railway Station, going east through Jianyang South, Ziyang North, Zizhong North, Neijiang North, Longchang North, and then entering the territory of Chongqing City, passing through Rongchang North, Dazu, Yongchuan East, Bishan and Shapingba on the way, and finally arriving at Chongqing Railway Station, with a total length of 308 kilometers and an operating speed of 300 kilometers per hour. The opening of the Chengdu-Chongqing high-speed railway has connected the two central cities in the west, and the development of cities along the route has also had clearer goals, improved the economic construction capacity along the Chengdu-Chongqing Railway, supported and led the formation of the spatial pattern of the "one axis, two belts, dual cores and three zones" urban agglomeration, and is a part of the great significance and value of improving the cooperation results of the Chengdu-Chongqing Economic Zone for the construction of the "Belt and Road" regional economic cooperation.

Based on the above background, this paper studies the economic impact of Chengdu-Chongqing high-speed railway on some cities along the line, so that the necessity of exerting the efficiency of high-speed railway transportation can be more fully explained from theory and empirical evidence, which has important practical significance for improving the economic development and factor flow of the regions along the Chengdu-Chongqing high-speed railway.

2 Literature Review

Researchers at home and abroad have different opinions on the socio-economic development and social effects brought by high-speed railways. From the research status at home and abroad, Strauss found that in addition to better accessibility, high-speed rail is positively correlated with GDP growth in cities along the route, and the economic benefits of high-speed rail are much higher than its fixed costs, depreciation and subsidies [3]. Zhou Hao used the doubling method to investigate the economic growth after railway acceleration and before the speed increase, and found that railway acceleration can significantly promote the economic growth of regions along the line, and the acceleration effect has a positive relationship with the length of time [4]. Wang Xiaodong used the Feder model to analyze China's provincial data and found that transportation infrastructure can have positive spillover effects and spatial effects on economic growth, but there are regional differences [5]. Li Hongchang studied the problems of high-speed railway and urban economic agglomeration, and found that high-speed rail can obviously promote the balanced development of China's regional economy by promoting the economic agglomeration in the western region [6]. The research of Wang Yufei and Ni Pengfei shows that high-speed rail

has a spillover effect on interregional economic growth, and it mainly has a structural effect on economic development by changing the regional spatial structure, distribution structure and hierarchical structure [7]. Liu Zhihong and others used the panel data of Zhengzhou Xi'an high-speed railway to find that Zhengzhou Xi'an high-speed railway can not only improve the accessibility and economic connection strength of the areas along the line and have an indirect effect on the economic growth of the areas along the line, but also significantly enhance the economic connection strength between Shandong and Shaanxi provinces [8].

However, some scholars have opposite attitudes towards the impact of high-speed rail on regional economic development and factor flow along the route. Puga argue that the completion of high-speed rail will tilt the economy and resources towards large cities with better networked services, resulting in economic damage to small cities, and regional development will become more unbalanced [9]. Wang Yao and Nian Meng argued through empirical analysis that high-speed rail has the characteristics of high input cost and long payback period, which not only fails to promote the development of the local economy, but further exacerbates the decline of the local economy [10]. Zhang Kezhong and Tao Dongjie used prefecture-level city panel data and two-way fixed-effect models from 2001 to 2012 to confirm that high-speed rail will produce a "siphon effect", so that the economic factors of high-speed rail transit areas will shift to large cities, and the closer to large cities, the more likely prefecture-level cities are to receive the negative impact of the opening and operation of high-speed rail [11].

Compared with international research results, China's research on high-speed railway lags behind. After entering the fourth wave of high-speed railway construction, China began to set off a research upsurge on high-speed railway. At present, the research on the relationship between high-speed railway and regional economic growth mainly revolves around the Yangtze River Delta, Pearl River Delta, Beijing-Tianjin-Hebei and other regions, which are all economically developed places, while the research on the economic impact of high-speed railway on the central and western regions is relatively insufficient, so this paper chooses to explore the Chengdu-Chongqing railway located in the southwest region.

3 An empirical analysis of the impact of the operation of Chengdu Chongqing high-speed railway on regional economic development along the line

3.1 Model Setting

In view of the characteristics of the research question and the research object, the double difference model will be selected for empirical analysis. The double difference method is mainly used to distinguish between different groups of public projects or policies, and is a quantitative evaluation method. The difference in difference method (DID) is often used to evaluate whether one policy has had an impact on the economy, and its advantages can be tested individually by using controlled trials to control other situations. The specific method is to select an experimental group and a control group, in which the experimental group has a policy change at a certain point in time, while the control group does not produce similar policy changes at the same point in time. Therefore, we can verify the effect of the policy by comparing the experimental group and the control group and observing the changes before and after the

policy, that is, when the change in the experimental group is significantly greater than that of the control group, it means that the policy has produced obvious effects.

Based on the previous analysis of the impact of high-speed rail on regional economic development, combined with the double difference model, this paper constructs the following empirical equation:

$$y=\alpha+b_1gt_i+b_2time_i+b_3gt_i\times time_i+\beta X+\varepsilon \quad (1)$$

In the model, y is the explained variable, gt_i is the virtual variable of the high-speed railway, indicating whether the city will build a high-speed railway. The area along Chengdu Chongqing high-speed railway (experimental group) is taken as 1, and other nonareas along the railway (control group) are taken as 0. $time_i$ is a dummy variable of time, which is taken as 1 after Chengdu Chongqing high-speed railway operation (after 2016) and 0 before operation (before 2016). $gt_i\times time_i$ indicates the cross term between the dummy variable of whether to build a high-speed railway and the dummy variable of high-speed railway construction time. X represents a matrix of control variables that can also affect economic development. ε represents a random error term.

In the above equation b_1, b_2, b_3 is the coefficient of the dummy variable, where b_3 is the most important variable coefficient, which is the influence passing coefficient of an economic index in the whole region along Chengdu Chongqing high-speed railway b_3 reflect. According to model settings, if b_3 is not 0 at a certain significance level, it means that the opening and operation of the Chengdu-Chongqing high-speed railway has a significant impact on this index.

3.2 Data Sources

According to the regional planning of Chengdu Chongqing Economic Zone, this paper selects 6 prefecture-level cities in Sichuan Province (including Chengdu, Ziyang, Neijiang, Zigong, Luzhou and Mianyang) and 6 districts and counties in Chongqing (including Dazu District, Yongchuan District, Shapingba District, Qianjiang District, Nan'an District and Nanchuan District) as samples. The relevant economic indicator data from 2009 to 2020 are derived from the National Bureau of Statistics, Sichuan Statistical Yearbook, Chongqing Statistical Yearbook, etc., and the software analysis uses Stata14.

3.3 Variable Selection

The main research content of this paper is about the impact of the opening of the Chengdu-Chongqing high-speed railway on the economic development of the regions along the line. According to the classification of the previous study, the sample cities are divided into an experimental group (open city) and a control group (other cities). The experimental groups were Chengdu, Ziyang, Neijiang, Dazu, Yongchuan and Shapingba. The control group selected areas where the scale and trend of economic development were closer to the experimental group, but high-speed rail was not opened, including Zigong, Luzhou, Mianyang, Qianjiang district, Nan'an district and Nanchuan district. In the selection of high-speed rail time nodes, 2016 is selected for measurement and demonstration. December 26, 2015 is the opening time of Chengdu Chongqing high-speed rail, so it is more accurate to select 2016.

Referring to the empirical experience of other authoritative literature and taking into account the availability of data, the explanatory variable y of this paper is the added value of secondary industry (lnd2), the added value of tertiary industry (lnd3) and the level of urbanization rate (urbrate) of each region from 2009 to 2019.

According to the above model settings, the explanatory variables in this paper include: group dummy variable (gt), time dummy variable (time), and interaction term (did).

The explanatory variables included in the control variable X are regional investment in fixed assets (invit), regional general fiscal expenditure (finit) and regional resident population (POP), representing the proxy variables of factor input, policy and regional development level respectively. In order to reduce data fluctuations and eliminate the influence of heteroscedasticity, the variables except the urbanization rate level in this paper are logarithmic.

3.4 Econometric regression results

According to the model setting and variable selection, the empirical results of this paper on the impact of the opening and operation of the Chengdu-Chongqing high-speed railway on the economic development of the regions along the line are shown in Table 1.

From the results in Table 1, the added value of the tertiary industry and the urbanization rate were negatively affected by the opening and operation of the Chengdu-Chongqing high-speed railway at the significant levels of 10% and 5%, respectively, and the elasticity coefficients were -0.801 and -0.450, respectively. However, the impact of regional per capita GDP growth rate and secondary industry added value was not significantly affected.

This result shows that the proportion of tertiary industry in cities after the operation of the high-speed railway in 2015 has increased slowly. As far as China's current situation is concerned, China's high-speed railway is in the initial stage of construction, mainly focusing on passenger service. It still needs a certain development process to realize the transportation of bulk goods soon. Therefore, the completion of high-speed railway in China is generally reflected in the development impact of the flow of talents, information, capital, technology and commerce.

Table 1. Impact of Chengdu Chongqing high-speed railway on regional economic development along the line

Varia-ble	(1) ln_lnd2	(2) ln_lnd2	(1) ln_lnd3	(2) ln_lnd3	(1) urbrate	(2) urbrate
gt	0.573**	0.0677	0.557**	0.0842**	4.905	0.188
	(0.232)	(0.0651)	(0.241)	(0.0971)	(4.301)	(3.705)
did	0.0134	-0.0140	-0.801*	-0.862*	-0.450**	-2.546**
	(0.376)	(0.0914)	(0.426)	(0.465)	(0.193)	(1.039)
time	0.331	-0.110	1.565***	0.982*	7.029*	-1.955
	(0.255)	(0.0780)	(0.588)	(0.572)	(4.521)	(4.535)
ln_invit		0.596***		0.741***		26.88***
		(0.0931)		(0.171)		(4.899)

ln_finit		0.165		0.311		-10.27
		(0.138)		(0.218)		(7.038)
ln_pop		0.321***		-0.0138		-16.56***
		(0.0709)		(0.138)		(3.944)
Cons-tant	5.513***	-0.342	5.041***	-0.651	52.72***	23.58**
	(0.155)	(0.220)	(0.130)	(0.491)	(2.970)	(10.71)
N	132	132	132	132	132	132
R2	0.093	0.946	0.132	0.469	0.045	0.392

According to the analysis of the new economic geography theory, the improvement of interregional transportation infrastructure has an economic distribution effect, that is, the construction of transportation infrastructure can promote the spatial transfer of economic resources and labor resources. Since different factors will produce different transfer directions, the economic distribution effect can be divided into agglomeration effect and diffusion effect, which comprehensively determine the net impact of the opening of the Chengdu-Chongqing high-speed railway on the economy of prefecture-level cities along the route. Among them, the rapidly developing central cities in the region make the net impact manifest as agglomeration effect, while the more mature central cities in the region make the net impact manifest as diffusion effect, that is, the relative size of agglomeration effect and diffusion effect depends on the development stage of regional central cities.

The resource endowments, economic scale and further development focus of each region along the Chengdu-Chongqing high-speed railway are different. Most underdeveloped regions do not have the basic conditions for rapid development of tertiary industry, while the developed regions with perfect supporting system of tertiary industry do not have significant driving effects due to small marginal improvement space. The results show that the central cities along the Chengdu Chongqing high-speed railway are still in the stage of rapid development. The operation of the Chengdu Chongqing high-speed railway makes the elements such as talents and materials gathered in the central cities. Therefore, the opening and operation of the high-speed railway have a negative impact on the tertiary industry and urbanization rate along the line.

From the impact of control variables on the regional economy along the line, the regression coefficients of regional fixed asset investment are almost positive and significant at the level of 1%. It shows that after the opening of the Chengdu Chongqing high-speed railway, the more the corresponding fixed asset investment, the higher the urbanization rate, and the more the increase of secondary and tertiary industries along the line. By expanding the openness among regions and optimizing resource allocation, we can maintain a long-term and stable state of regional economic development, so as to promote the coordinated growth of the regional economy along the line. The role of the regional resident population on the regional per capita GDP growth rate and the added value of the secondary industry is significantly positive. According to the neoclassical growth theory, labor is the main factor to promote economic growth. The separation of work and residence may not be obvious in Chengdu and Chongqing, so the increase in the permanent population means the increase in the labor force, and the abundant labor resources can promote the development of the regional economy.

4 Conclusions and policy recommendations

In order to study the impact of the opening and operation of the Chengdu-Chongqing high-speed railway on the economic development of the regions along the line, this paper uses the panel data of the areas along the Chengdu-Chongqing high-speed railway from 2009 to 2019, combined with the traditional DID method, and sets the experimental group and control group in the area respectively, so as to test the effect of the opening of the high-speed railway on the economic indicators of the two groups of regions, and finally conclude that the opening and operation of the Chengdu-Chongqing high-speed railway has a negative impact on the economy of the regions along the line.

According to the above research results, this paper puts forward the following suggestions:

First, strengthen the construction of basic transportation facilities related to high-speed railways in the western region, and implement corresponding fiscal transfer payments and tertiary industry policies, deepen the connection and combination of high-speed rail and other modes of transportation, so as to reduce the agglomeration effect of high-speed rail, and lay the foundation for the coordinated development of small cities and central cities along the route in the future. Second, as a large-scale transportation facility, high-speed rail needs to consider the endogenous needs of local economic development, which cannot exceed the potential affordability of the regional economy, and should also be matched with fiscal policies such as taxation to protect and support backward areas to weaken the agglomeration role of developed areas. Third, for small and medium-sized cities along the high-speed rail, it is necessary to use high-speed rail to actively contact central cities, play their role as a link and amplify the diffusion effect it may bring. It is always necessary to compare its own development direction with that of central cities, give play to its comparative advantages, and form dislocation and complementarity with central cities by optimizing industrial layout, so as to promote the coordinated economic development of small and medium-sized prefecture-level cities and regional central cities along the route. Third, for small and medium-sized cities along the high-speed rail, it is necessary to use high-speed rail to actively contact central cities, play their role as a link and amplify the diffusion effect it may bring. It is always necessary to compare its own development direction with that of central cities, give play to its comparative advantages, and form dislocation and complementarity with central cities by optimizing industrial layout, so as to promote the coordinated economic development of small and medium-sized prefecture-level cities and regional central cities along the route.

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