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Study on the Impact of the Opening of High Speed Rail on the Development of Urban Tertiary Industry

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Abstract

As the mileage of China's high-speed rail continues to rise, China's high-speed rail has become a business card that is gradually going global. Although the topic of the impact of the opening of high-speed rail has been discussed more in academic circles, there are still some controversies. For example, will the opening of high-speed rail intensify the competition in tourism and thus have different impacts on the development of tertiary industries in different regions? Is there a competitive relationship between high-speed rail and flights, and is there a complementary effect? To address the question of the impact of high-speed rail opening on the tertiary industry, this paper collects relevant data from 297 cities in China from 2009 to 2019 and uses the Difference-in-difference method to explore the extent of the impact of high-speed rail opening on the output value of the tertiary industry and the labor productivity of the tertiary industry. At the same time, this paper establishes a regression model with reference to scholars' conceptions of "air-rail intermodal transport" to investigate whether the current impact of "air-rail intermodal transport" on the development of tertiary industry in cities is significant, and proposes reasonable policy suggestions based on the model results.

Keywords

High-speed Rail Economy; Air-rail Intermodal Transport; Difference-In-Difference Model.

1. Introduction

In 2008, China's first high-speed railway, the Beijing-Tianjin intercity high-speed railway, was officially opened to traffic, marking the arrival of the "high-speed railway era". The mileage of high-speed rail has increased rapidly in the past decade or so, reaching 19,000 km in 2016. China's ambitious goal for high-speed rail construction can be seen in the "four horizontal and four vertical" adjustment to "eight horizontal and eight vertical" in the Medium and Long-Term Railway Plan introduced in 2016. 2021, China's high-speed rail mileage has exceeded 40,000 km, and in the "In the 14th Five-Year Plan, the mileage of domestic high-speed rail is expected to exceed 50,000 km in 2025. After more than ten years of development, China's high-speed rail has grown from nothing to something, from little to much, showing a continuous "explosive growth" trend. At the same time, with the strategy of "going global", the brand of "China high-speed rail" has gradually become a "business card" of China on the world stage, showing the "China Speed" and "Made in China".

2. Literature Review

While China's high-speed rail industry is developing rapidly, the academic community has never stopped studying the concept of "high-speed rail economy". In fact, as early as the 1990s, scholars already saw the huge economic benefits brought by the construction of high-speed railroads in Japan and France, and in 1991, the former Ministry of Railways issued a notice on

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the feasibility study of the Beijing-Shanghai high-speed railroad, which led to a discussion on whether China should follow the example of Japan and France in the construction of high-speed railroads. Around 2009, based on the newly opened Beijing-Tianjin Intercity High Speed Railway and Wuhan-Guangzhou High Speed Railway, there was another boom in academic circles to study the economy of high speed rail. The third major discussion on high-speed rail took place around 2016. With the introduction and promotion of China's "One Belt, One Road" strategy, China's high-speed rail began to go global, and the focus of academic circles also turned to the role that China's high-speed rail could play in the international arena. In fact, we found that academic papers related to high-speed rail have been emerging beyond the three discussion booms, so much so that a scholar conducted a study on the "number of papers related to high-speed rail economy" based on the Zhiwang database in 2019 (Lu Jian, Liu Jingjing) and combed through nearly two thousand papers in total, a staggering number.

During the discussion of the economic issues related to high-speed rail, the construction mileage of high-speed rail in China has been increasing and continues to play a good role, and most scholars affirmed the important value of high-speed rail in promoting economic growth, regional development, and industrial upgrading, especially for the development of the tertiary industry. As an emerging mode of transportation itself, high-speed rail enables the rapid transfer of various resources-especially human resources-between two points of distance, which has a greater impact on the allocation of resources on a national scale. From this perspective, Zhong (2015) argued that the development of high-speed rail networks have increased the accessibility level of central cities and can significantly reduce the spatial and temporal distances between cities. Kong (2019), on the other hand, suggested that the actual situation should be fully considered, with the proposal of actively building hourly economic circles in eastern cities, making every effort to compress economic distances in central cities, and maximizing the avoidance of the siphoning effect in western cities. Some scholars have also conducted empirical studies, for example, Lin (2015) suggested that HSR generates the highest social utility for the region when regional GDP per capita is below 20,000 yuan and tertiary employment and structure is more average; Sun (2021) analyzed that HSR has a significant contribution to total factor productivity and technological progress in tourism.

Although the discussion related to the economy of high-speed rail continues to be fully developed, there are still many issues related to the "economy of high-speed rail" that have not been unified or even have completely opposing views in the academia. For example, Zhao (2006) argued that the construction of high-speed railroad passenger lines would cause serious damage to China's economy. Yang (2020), on the other hand, based on the current situation in Anhui Province, believed that high-speed rail would accelerate the loss of talent, capital, and other resources from backward cities, and that the new situation of shorter travel time brought about by high-speed rail would intensify the competition in tourism, posing the problem of how to coordinate tourism resources in some regions.

Another topic related to high-speed rail is "air-rail linkage", that is, the relationship between high-speed rail and flights. Many scholars believe that there is competition between high-speed rail and civil aviation, for example, Hu (2020) believed that "the competition between airlines and high-speed rail will be a long-term situation", and as the construction of high-speed rail accelerates, the airline industry should integrate resources to provide better services. But at the same time, some scholars believe that high-speed rail and civil aviation have complementary relationships, for example, Huang (2018) thought that China should explore "air-rail intermodal transport" and "air-rail integration" to achieve complementary advantages based on the real situation in Jinan. This paper investigates whether the current "air-rail intermodal transport" in China has an impact on the development of the tertiary industry by means of empirical evidence to address such differences.

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In conclusion, with the steady progress of China's high-speed railway construction, the high-speed railway economy has also developed at the same time, with a large number of relevant theoretical studies, and the focus of discussion has been changing with the times. However, at the same time, some issues remain inconclusive and there is room for further in-depth inquiry. Accordingly, this paper focuses on the following questions: How big is the impact of high-speed rail opening on the tertiary industry of cities? How does the opening of high-speed rail affect the labor productivity of urban tertiary industry? Has the "air-rail linkage" been formed in China and has it significantly improved the tertiary industry in cities?

3. Variable Selection and Model Setting

3.1. Sample Selection and Data Sources

In this paper, after removing some samples with serious missing data, the panel data of 297 cities above prefecture level from 2009 to 2019 are selected, covering all regions and provinces in China, which are more representative.

The data on the opening time of high-speed railways in this paper are obtained manually from the data released by China Railway Corporation; the data on the number of employees in tertiary industry, the scale of fixed asset investment, the output value of tertiary industry, and the gross regional product of each city are obtained from the China City Statistical Yearbook and the China Tertiary Industry Statistical Yearbook from 2010 to 2020. For cities with individual missing data, this paper uses the interpolation method to fill in. For cities with changes in some administrative districts or more serious missing data, this paper has conducted data screening and deletion process according to the actual situation, so this paper uses unbalanced panel data.

3.2. Variable Selection

(1) Explained variables: Y_1 (output value of tertiary industry), Y_1 (output value per capita of tertiary industry)

First, Y_1 (unit: billion yuan, logarithmically) is used as the explained variable to measure the prosperity of the tertiary industry in each city. At the same time, in order to describe the productivity of the tertiary industry in a city, the output value per capita of the tertiary industry Y_2 (unit: billion yuan, logarithmically treated) is used as the explained variable in this paper.

(2) Main explanatory variable: H (opening of high-speed rail)

This paper adopts the dummy variable of high-speed railway opening as the explanatory variable, and the cities that have opened high-speed railway in the current year are recorded as 1, and those that have not opened are recorded as 0. Moreover, this paper takes into account that the impact of high-speed railway on the economy takes some time to play out, so it refers to the practice of He(2020) and other scholars, and treats the high-speed railway lines officially opened before June 30 of each year as opened in the current year, and those opened after June 30 opening of high-speed rail is done as the opening of the next year.

(3) Controlled variable matrix X

To address the endogeneity problem caused by omitted variables, this paper sets up a controlled variable matrix. X_1 represents the number of employees in the tertiary industry of the city (unit: person, taking logarithmic treatment), which is used to measure the scale of the tertiary industry labor force of the city; X_2represents the amount of fixed asset investment of the city (unit: million yuan, taking logarithmic treatment), which is used to measure the scale of investment of the city, but because some data are not disclosed, the X_3 denotes the total regional economy of each city (unit: million yuan, logarithmically processed), which is used to measure the level of economic development of the city; X_4denotes the general public budget expenditure of each city in each year (unit: million yuan, logarithmically processed), which is

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used to measure the degree of government intervention in the local economy; X_5denotes the amount of general public budget expenditure of each city, which is used to measure the level of government intervention in the local economy. expenditure on science and technology (unit: million yuan, logarithmically processed), which is used to measure the local government's role in supporting technological progress.

(4) Explanatory variable A (airports)

This variable indicates whether each city opened an airport in that year, again in the form of a dummy variable. If the airport has been opened, then A=1, if not, then A=0.

(5) "Air-rail" interaction variable ($H \times A$)

This variable is the interaction term between high-speed rail and airport. When a city has both high-speed rail station and airport in a year, the value of the variable is 1, otherwise it is 0.

(6) Regional interaction variable ($H \times D_i$)

D_i is a dummy variable indicating the region where the city is located, including North China, East China, South China, Central China, Northwest China and Southwest China. $H \times D_2$-$H \times D_7$ is the interaction term between the opening of high-speed rail and the region, which is used to measure the impact of the opening of high-speed rail in different regions.

3.3. Model Construction

Since the time of opening high-speed rail varies among cities in China, and there is a large difference in the level of economic development of the tertiary industry before and after the opening, and also to avoid endogeneity due to omitted variables, this paper adopts the Difference-in-difference model to study the impact of high-speed rail opening on the development of the tertiary industry, and conducts an empirical analysis. The model for this project is as follows.

$$Y_{1it} = \beta_0 + \beta_1 H_{it} + \beta_2 X_{it} + \beta_3 A_{it} + \lambda_i + \mu_t + \epsilon_{it} \quad (1)$$

$$Y_{1it} = \beta_0 + \beta_1 H_{it} + \beta_2 X_{it} + \beta_3 A_{it} + \beta_4 H_{it} \times A_{it} + \lambda_i + \mu_t + \epsilon_{it} \quad (2)$$

$$Y_{1it} = \beta_0 + \beta_1 H_{it} \times D_{it} + \beta_2 X_{it} + \beta_3 A_{it} + \lambda_i + \mu_t + \epsilon_{it} \quad (3)$$

$$Y_{2it} = \beta_0 + \beta_1 H_{it} + \beta_2 X_{it} + \beta_3 A_{it} + \lambda_i + \mu_t + \epsilon_{it} \quad (4)$$

$$Y_{2it} = \beta_0 + \beta_1 H_{it} \times D_{it} + \beta_2 X_{it} + \beta_3 A_{it} + \lambda_i + \mu_t + \epsilon_{it} \quad (5)$$

where Y_{1it} denotes the output value of the tertiary industry in city i in year t and is taken as logarithm; Y_{2it}denotes the output per unit of labor in the tertiary industry in city i in year t and is taken as logarithm; H_{it} denotes whether high-speed rail is opened in city i in year t; X_{it} denotes the matrix of control variables, but models (4) and (5) remove the number of workers representing the number of workers due to changes in the explained variablesX_1 and X_3 representing the regional GDP of the city in that year; λ_i and $\mu_t$denote individual and year control effects, respectively; and ϵ_{it} denotes the random disturbance term. The descriptive statistics table of the sample is shown in Table 1.

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Table 1. Descriptive Statistics Results

Variable Name	Variable Meaning	Sample size	Mean	Min	Max
Y_1	Output value of tertiary industry (unit: billion yuan)	3185	6.4379	3.36117	15
Y_2	Labor productivity of tertiary industry (unit: Yuan per person per year)	3185	9.7823	6.8044	14.9809
H	High-speed rail opening variable	3185	0.3912	0	1
X_1	Number of employees in tertiary industry (unit: person)	3185	12.1229	9.3588	15.7340
X_2	Fixed asset investment amount (unit: million yuan)	2282	16.0090	12.7942	19.2187
X_3	Gross regional product (unit: billion yuan)	3185	7.3658	12.7942	19.2187
X_4	Government expenditure (unit: million yuan)	3185	14.7180	11.5437	18.2405
X_5	Government expenditure on science and technology (unit: million yuan)	3185	10.1900	6.6241	15.5293
A	Airport opening variable	3185	0.4688	0	1

4. Analysis of Empirical Results

4.1. Parallel Trend Test

Difference-in-difference method, as an important method to measure the effect of the policy, needs to be used before first ensuring that the trend of the experimental group and the controlled group before the experiment remains the same. Therefore, in order to ensure the rigor and accuracy of the Difference-in-difference method, this paper conducted the parallel trend test through the event study method and made images.

From Figure 1, it can be seen that the effects of variable H (opening of high-speed rail) are not significant in the five years before the opening of high-speed rail; in the second year after the opening of high-speed rail, the variable is significant at the 1% level, and in the third year after the opening, the variable is significant at the 10% level. Therefore, it can be seen that this paper passed the parallel trend test.

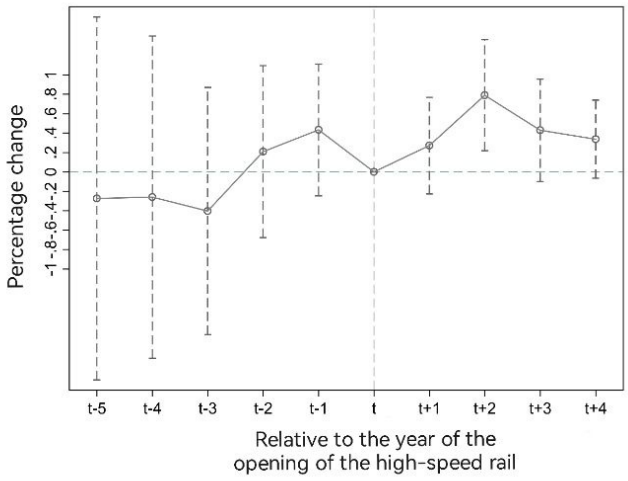

Figure 1. Parallel Trend Test Results

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4.2. Model Regression Results

Table 2. Regression Results of the Output Value Model

Explanatory variables	Explained variable		
	(1)Y1	(2)Y1	(3)Y1
H	0.0775***	0.0633**	-
	(0.0156)	(0.0249)	-
City fixed effect	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
X1	0.210***	0.208***	0.213***
	(0.0179)	(0.0176)	(0.0189)
X2	-0.0652***	-0.0647***	-0.0566***
	(0.0134)	(0.0133)	(0.0126)
X3	0.850***	0.849***	0.849***
	(0.0198)	(0.0196)	(0.0192)
X4	0.00528	0.00549	0.00702
	(0.0201)	(0.0200)	(0.0197)
X5	0.0780***	0.0776***	0.0725***
	(0.0086)	(0.00875)	(0.00987)
A	0.0817***	0.0729***	0.0774***
	(0.0122)	(0.0113)	(0.0108)
H×A	-	0.0330	-
	-	(0.0289)	-
H×D2	-	-	0.0925***
	-	-	(0.0174)
H×D3	-	-	0.0741***
	-	-	(0.0126)
H×D4	-	-	0.116***
	-	-	(0.0204)
H×D5	-	-	0.00622
	-	-	(0.0625)
H×D6	-	-	0.0832*
	-	-	(0.0429)
H×D7	-	-	-0.0315
	-	-	(0.0326)
Constant term	-2.433***	-2.407***	-2.569***
	(0.21)	(0.206)	(0.235)
Sample size	2282	2,282	2282
R-squared	0.937	0.937	0.937

Note: Figures in parentheses are standard errors; *, **, *** denote significant at the 10%, 5%, and 1% levels, respectively, as follows.

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The regression results of model (1) (2) (3) are given in Table 2.

Table 3. Regression Results of Productivity Model

Explanatory variables	Explained variable	
	(1)Y2	(2)Y2
H	0.0512***	-
	(0.0209)	-
City fixed effect	Yes	Yes
Year fixed effect	Yes	Yes
X2	0.241***	0.269***
	(0.0198)	(0.0209)
X4	-0.377***	-0.358***
	(0.0258)	(0.0260)
X5	0.232***	0.207***
	(0.0142)	(0.0146)
A	0.0662***	0.0540***
	(0.0172)	(0.0171)
H×D2	-	-0.0622*
	-	(0.0346)
H×D3	-	0.126***
	-	(0.0306)
H×D4	-	0.142***
	-	(0.0357)
H×D5	-	-0.174***
	-	(0.0339)
H×D6	-	-0.171***
	-	(0.0610)
H×D7	-	-0.259***
	-	(0.0939)
Constant term	2.253***	1.781***
	(0.254)	(0.258)
Sample size	2282	2282
R-squared	0.477	0.497

From the regression results, we can find that after controlling the variables, the opening of high-speed rail is significant at the 1% level, and the opening of high-speed rail boosts the output value of the tertiary industry by 7.75%. Meanwhile, we also get the regression results of each control variable: the number of employees in the tertiary industry, the level of local economic development, the scale of government expenditure on science and technology, and whether to open the airport all show significance at the 1% level, and the coefficients of the control variables are all positive. And fixed asset investment is significant at the 1% level with a negative coefficient. After adding the interaction variable between high-speed rail and airport, we find that the results of the interaction variable are not significant. It can be seen that the

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phenomenon of "air-rail linkage" expected by scholars has not been formed yet, or the impact on the tertiary industry is not significant.

Meanwhile, in order to study the efficiency of the development of the tertiary industry in the city, the model (4)(5) was established and regressed with the labor productivity of the tertiary industry as the explanatory variable, and the results are shown in Table 3.

As shown in Table 3, the opening of high-speed rail is significant at the 1% level, and the opening of high-speed rail increases the labor productivity of the tertiary industry by 5.12%. The regression results of the remaining control variables are also obtained: fixed asset investment scale, government science and technology expenditure, and airport opening variables are significant at the 1% level and all are positively correlated. And general public budget expenditure is significantly and negatively correlated with tertiary industry labor productivity at the 1% level. From the results, we can see that the opening of high-speed rail can have a positive effect on the productivity of the tertiary industry, which in turn leads to a larger scale increase in the output value of the tertiary industry.

Combined with the above analysis, we find that the opening of high-speed rail firstly improves the labor productivity of the tertiary industry in the city, which in turn leads to the result of higher output value.

4.3. Robustness Test

Table 4. Robustness Test Results

Explained variable	Explanatory variables	
	(1)Y1	(2)Y2
Highway	0.0575**	0.0792***
	(0.0260)	(0.0228)
City fixed effect	Yes	Yes
Time fixed effect	Yes	Yes
X1	0.181***	-
	(0.0206)	-
X2	-0.0808***	0.238***
	(0.0142)	(0.0236)
X3	0.883***	-
	(0.0215)	-
X4	0.0172	-0.375***
	(0.0234)	(0.0299)
X5	0.0711***	0.214***
	(0.00998)	(0.0160)
A	0.0614***	0.0831***
	(0.0130)	(0.0197)
H×A	0.049	-
	-0.0307	-
Constant term	-2.193***	2.565***
	-0.229	(0.304)
Sample size	1,716	1,716
R-squared	0.927	0.410

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After arriving at the results, this paper tests the results by removing the data before 2011 and after 2016, and the results are shown in Table 4.

Based on the test results, we find that the impact of HSR on tertiary output decreases after removing some data, but it is still significant at the 5% level. Meanwhile, the interaction term between HSR and airport remains insignificant. As for the labor productivity of the tertiary industry, the effect of HSR on it remains significant after removing some data.

Therefore, the conclusions obtained in the previous paper are highly significant, indicating that the findings of this paper are robust.

5. Conclusion and Recommendations

First, we find that the impact of high-speed rail on labor productivity of tertiary industry is very significant, which is reflected in both the direct increase of output value of tertiary industry and the increase of labor productivity. It can be seen that the impact of opening high-speed rail on the output value of the tertiary industry in cities is long-term. Therefore, local governments can consider the economic value brought by the opening of high-speed rail to the tertiary industry and thus formulate appropriate policies.

Second, after adding the airport variable, the impact of high-speed rail on the tertiary industry remains significant, while the airport variable also shows significance, but the interaction term is not significant. This indicates that the "air-rail linkage", as expected by scholars, has not shown the effect of promoting the tertiary industry for the time being. Therefore, local governments should reduce the expectation of "air-rail linkage" to promote the development of tertiary industry. At the same time, considering that the two variables are significant, we find that both high-speed rail and airports are necessary, but local governments do not need to overemphasize the direct physical connection between airports and high-speed rail stations when planning them, and should choose the optimal location for each.

Again, based on the regression results of the interaction term between high-speed rail and regions, we find that the opening of high-speed rail has a significant positive effect on the output value of tertiary industry for cities in northern, eastern, southern, and northwestern China, while the effect on other regions is not significant. However, it is worth noting that for central, northwest, and southwest China, the opening of high-speed rail significantly reduces urban tertiary industry labor productivity. This finding is consistent with Yang (2020) that there is a negative effect of high-speed rail on tourism in Anhui Province. This paper verifies his view through empirical analysis. This finding reminds us that in the situation of lower travel costs brought by high-speed rail, we need to focus on building local special tertiary industries to avoid the decline of industrial productivity.

In conclusion, we find that the opening of high-speed rail has a good effect on the development of urban tertiary industries in general, but we still need to pay attention to avoid the influence of industrial competition and create special industries.

References

[1] Lv Jian, Liu Jingjing. Status,Evolution and Trend of High-Speed Rail Economic Research in China [J]. Review of Industrial Economics,2019,18(03):87-113.

[2] Zhong Yexi, Huang Jie, Wen Yuzhao. Analysis of the impact of high-speed rail on the accessibility pattern of Chinese cities[J]. Geoscience,2015,35(04):387-395.DOI:10.13249/j.cnki.sgs.2015.04.001.

[3] Kong Lingzhang, Li Xiaodong, Bai Yang. High-speed rail impact on the underdeveloped area accessibility and its spatial development strategy -A case of Lanzhou-Xinjiang high- speed rail [J]. Journal of Northwest Normal University (Natural Science) ,2019,55(03):112-117. DOI:10. 16783/ j.cnki. nwnuz.2019.03.019.

ISSN: 2688-8653

[4] Lin Xiaoyan, Luo Sun, Zhu Zhihang. Relationship between Regional Quality and HSR Social Utility:A Study on How to Choose Construction Opportunity of HSR [J]. China Soft Science, 2015 (04): 76-85.

[5] Sun Zhaoxian, Gu He. Research on the impact of HSR opening on total factor productivity of tourism industry--an experience based on panel data of 276 prefecture-level cities in China [J].China Circulation Economy,2021(25):134-138.DOI:10.16834/j.cnki. issn1009-5292.2021.25.044.

[6] Zhao Jian. Risks facing the construction of high-speed railroad passenger lines [J]. COMPREHENSIVE TRANSPORTATION, 2006(Z1):52-55.

[7] Yang Xu, Li Yadong, Zhang Manli. Research on high-quality economic development of Anhui cities under high-speed railway economy[J]. CO-Operative Economy & Science, 2020 (21): 3637. DOI: 10. 13665/ j.cnki.hzjjykj.2020.21.012.

[8] Huang Jin, Wang Min, Guo Jianmin. Research on air-rail integration planning in the era of high-speed rail--Jinan East Railway Station and Yaohua Airport as an example[J]. Urban Roads and Bridges and Flood Control,2018(02):1-6.DOI:10.16799/j.cnki.csdqyfh.2018.02.001.

[9] Hu Yiping. Competitive relationship between airlines and high-speed rail from a supply chain perspective [J]. Air Transport & Business,2020(07):29-32.

[10] Lin Xiaoyan. High-speed Rail Economy Research and its Basic Theory Trend: A Review [J]. Journal of Beijing Jiaotong University (Social Sciences Edition),2018,17(04):20-37.DOI:10.16797/j.cnki.11-5224 /c.20181026.011.

[11] He Lingyun, Tao Dongjie. Measurement of the Impact of High-speed Rail Opening on Knowledge Spillover and Urban Innovation Level [J]. The Journal of Quantitative & Technical Economics, 2020, 37 (02):125-142.DOI:10.13653/j.cnki.jqte.2020.02.007.