High-speed Railway's Opening and Commercial Development: A Test Perspective of Multi-period Difference-in-difference

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ABSTRACT

The high-speed railway's opening will bring huge consumer groups for the commercial development of the city where the high-speed railway station is located. Based on the panel data of 233 prefecture-level cities in China from 2006-2017, this paper explores the impact of the high-speed railway's opening on local commercial development and its internal mechanism by using multi-period difference-in-difference method. It is found that the high-speed railway's opening significantly promotes the development of local commerce, especially in the third tier and lower cities; the higher the investment in local real estate development, the stronger the promotion effect of high-speed railway on local commerce. This paper shows that policymaker should do a good job in supporting commercial operation facilities, guide high-speed rail groups to expand consumption and dialectically understand the rationality of real estate development.

Keywords: High-speed railway's opening, Commercial development, Aggregate effect, Multi-period difference-in-difference method, Moderating variables.

1. INTRODUCTION

The most direct impact of the opening of high-speed rail is to achieve a large number of population flow across regions in a short period of time, promote the population agglomeration and economic development of cities along the high-speed rail, and form the economic belt along the line. Since the opening of Hefei Nanjing section of Nanjing Chengdu Railway, Jiaoji passenger dedicated line and Beijing Tianjin Intercity Railway in 2008, 188 cities in the Chinese mainland have opened high-speed rail at the end of 2017, accounting for 64.16% of 293 prefecture level cities in China. The high-speed rail business mileage has reached 25 thousand km, covering almost all the Chinese mainland provinces. High speed rail has gradually become one of the important tools for national cross city commuting, which effectively promotes the extension of passenger travel radius

and the expansion of the radiation scope of urban economic circle, and gradually occupies an important position in the development of national economy. In real economic life, the impact of high-speed rail on the areas along the line is multifaceted, including economic growth, industrial development, surrounding real estate prices, the formation of urban agglomeration, resource allocation and other aspects. At present, the research results on the impact of high-speed rail on a specific industry category are mostly concentrated in the manufacturing industry, service industry and other industries, and the further detailed research on service industry is mainly concentrated in tourism. The impact of high-speed rail on manufacturing industry mainly includes industrial agglomeration (Sun et al., 2017)[1], enterprise performance (Charnoz et al., 2018)[2]. The impact of high-speed rail on service industry mainly includes industrial agglomeration (Shao et al., 2017)[3] and

employment level (Hensher et al., 2014) [4]. On the impact of the opening of high-speed railway on the development of tourism, it mainly focus on the spatial distribution of tourism resources (Wang et al., 2014) [5], and the structure of tourism products (Masson & Petiot, 2009)[6],etc. However, although the large number of people brought by the opening of high-speed railway not only directly promotes the development of local tourism, but also provides a broader market for the growth of local business volume and the improvement of local business level, few scholars have directly studied the impact of the opening of high-speed railway on the development level of local business and its internal mechanism. With the popularization and application of multi-period difference-in-difference empirical analysis method, it gradually occupies the mainstream position in the empirical research in the field of high-speed rail's opening. This paper will use the panel data samples of 233 prefecture level cities in China from 2006 to 2017, set up the virtual variables of high-speed rail's opening through manual collection, build a multi-period difference-in-difference econometric analysis model, and try to explore the mechanism of high-speed rail's opening affecting local business development.

The possible innovations of this paper are as follows: first, the multi-period difference-in-difference method is used to explore the impact of high-speed rail's opening on local commercial development. Compared with the single period difference-in-difference method which needs to select a certain period as the time node of policy implementation, the multi-period difference-in-difference method is closer to the setting of random natural experiment, which makes the empirical model more effective in dealing with endogenous problems. Secondly, divide the first and new first tier cities, the second tier cities, the third tier cities and below into three types, and deeply explore the heterogeneity characteristics of high-speed rail's impact on local business development, so as to provide theoretical basis for the formulation of targeted regulatory policies; thirdly, select the population density and real estate investment in this year as the regulatory variables, respectively, and make further research on its moderating effect in the process of high-speed rail's opening affecting commercial development.

The rest of this paper is arranged as follows: the second part is the research hypothesis and econometric model. Based on the research hypothesis, it constructs the corresponding multi-period difference-in-difference econometric model;

the third part is the variable selection and data description, which describes the data source, selected variables and data processing process in detail; the fourth part is the empirical analysis results, including parallel trend test, benchmark regression, robustness test, grouping heterogeneity test and further analysis; The fifth part is the conclusion and policy implications, which summarizes the above research results, puts forward targeted policy recommendations, and summarizes the shortcomings of the current research results and the future direction of improvement.

2. RESEARCH HYPOTHESIS AND ECONOMETRIC MODEL

2.1 Theoretical Analysis and Research Hypothesis

The opening of high-speed railway mainly realizes the function of passenger transport, which will bring a lot of passenger flow to the cities with high-speed railway and greatly enhance the market capacity of local commercial consumption demand. The opening of high-speed railway has an obvious role in promoting the development of local commerce in a short period of time. In addition, from the perspective of urban differences, compared with cities with good economic development level, high population stock and saturated local consumption demand market stock, cities with poor economic development level and low population stock, the impact of high-speed rail's opening on their commercial development will be more prominent. Moreover, the impact of the opening of high-speed rail on commercial development will be mainly reflected through population gathering and other channels. As the opening of high-speed rail brings about the improvement of the surrounding real estate valuation, it will attract a large number of developers to settle in and carry out real estate investment activities. A large number of supporting commercial facilities will provide physical space for local commercial development, and residential properties will retain more space for local businesses permanent population. Population agglomeration and real estate investment play an important role in the process of high-speed rail's impact on local business development. Therefore, this paper puts forward the following research hypotheses:

H1: the opening of high-speed railway significantly promotes the development of local business in a statistical sense.

H2: the opening of high-speed railway significantly promotes the development of local business, especially in the third tier and below cities.

H3: the opening of high-speed railway promotes the development of local business, and this positive role increases with the increase of population density.

$$Y_{it} = \alpha + \beta(Railway_i \times Time_i) + \delta X_{it} + \lambda_t + \varepsilon_{it} \qquad (1)$$

Here, Y_{it} represents the explained variable. $Railway_{it}$ represents the dummy variable of whether i city belongs to the experimental group (if the high-speed railway is opened in a certain year, the value is 1, otherwise it is 0). $Time_t$ represents the dummy variable of whether i city is in the experimental period (if the high-speed railway is opened for the first time and after, the value is 1, otherwise it is 0). $Railway_i \times Time_t$ represents whether i city belongs to the experimental group and the year is in the experimental period of dummy variable. X_{it} is the control variable, λ_t is the time fixed effect, and ε_{it} is the random error term. The opening time of high-speed railway is starting from the Hefei Nanjing section of Ning Rong railway, Jiaoji passenger dedicated line and Beijing Tianjin Intercity Railway in 2008.

3. VARIABLE SELECTION AND DATA DESCRIPTION

The annual data in 233 prefecture-level cities were taken online from Statistical yearbook of Chinese cities and statistical yearbooks of local cities. Because Beijing, Tianjin, Shanghai and Chongqing belong to the municipalities directly under the central government, the administrative level and the available policy resources are far away from other prefecture level cities, and a large number of research results compare the municipalities directly under the central government with other provincial administrative regions, so the research samples selected in this paper do not include the above four municipalities directly under the central government.

In this paper, the explained variable is the level of business development. The total retail sales of consumer goods and the growth rate of the total retail sales of consumer goods are selected to depict from the two aspects of total volume and growth

H4: the opening of high-speed railway promotes the development of local business, and this positive role is enhanced with the increase of the real estate development investment in this year.

2.2 Metering Mode Setting

Referring to the research results of (Beck et al., 2010)[7], this paper constructed a multi-period difference-in-difference measurement model , as shown in equation (1)

rate respectively. This paper selects the wholesale and retail sales above quota and the growth rate of wholesale and retail sales above quota and the number of wholesale and retail trade enterprises above quota and the growth rate of wholesale and retail trade enterprises above quota as alternative variables for robustness test. The core explanatory variable is the virtual variable of high-speed railway's opening. If the city has high-speed railway station opening in a certain year or before, the value is 1, otherwise it is 0. The control variables include GDP, population density, real estate development investment in this year, freight volume, passenger volume and per capita GDP, science and technology expenditure of local general public budget expenditure, education expenditure of local general public budget expenditure, total collection of public libraries, number of bus (electric) vehicles operating in municipal districts at the end of the year. The missing values were interpolated with the average values of the two periods before and after the variables. In this paper, taking 2006 as the base period, this paper use the consumer price index of various cities to deflate the total retail sales of consumer goods, the growth rate of total retail sales of consumer goods, the wholesale and retail sales above quota, the growth rate of wholesale and retail sales above quota, the number of wholesale and retail enterprises above quota, the growth rate of wholesale and retail enterprises above quota, GDP, the completed amount of real estate development investment in this year, per capita GDP, science and technology expenditure of local general public budget expenditure, education expenditure of local general public budget expenditure and other variables. This paper uses the standardized method to analyze the total retail sales of consumer goods, the growth rate of total retail sales of consumer goods, the wholesale and retail sales above quota, the growth

rate of wholesale and retail sales above quota, the number of wholesale and retail trade enterprises above quota, the growth rate of wholesale and retail trade enterprises above quota, GDP, population density, the completed amount of real estate development investment this year, etc. The descriptive statistical analysis of dimensionless variables is shown in "Table 1".

Table 1. Variable index description and descriptive statistical analysis

Variable	Description	Obs	Mean	Std. dev	Min.	Max.
RET	Total retail sales of consumer goods	2796	0.0004	0.9554	-1.4748	1.7357
RRET	Growth rate of total retail sales of consumer goods	2796	0.0016	0.9375	-1.9705	2.3688
SALE	Wholesale and retail sales above quota	2796	0.0029	0.9450	-1.6470	2.0379
RSALE	Growth rate of wholesale and retail sales above quota	2796	0.0008	0.9482	-1.8823	2.8810
NO	Number of wholesale and retail enterprises above quota	2796	0.0014	0.9478	-1.6898	1.9812
RNO	Growth rate of wholesale and retail enterprises above quota	2796	0.0024	0.9482	-1.4929	2.9661
GT	Virtual variables of high speed railway's opening	2796	0.3133	0.4639	0.0000	1.0000
GDP	Gross domestic product	2796	0.0005	0.9546	-1.7242	1.5769
PGDP	Per capita GDP	2796	0.0004	0.9536	-1.7333	1.5871
PD	Population density	2796	0.0002	0.9440	-2.0625	1.9257
INV	Completed amount of real estate development investment in this year	2796	0.0030	0.9425	-1.6660	2.1959
FT	freight volume	2796	0.0023	0.9430	-1.7330	1.9692
PT	Passenger volume	2796	0.0018	0.9428	-1.6860	2.0537
TE	Science and technology expenditure	2796	0.0006	0.9455	-1.9906	2.3296
EDU	Education expenditure	2796	0.0010	0.9501	-1.7334	1.6743
BOOK	Total collection of public libraries	2796	0.0003	0.9384	-1.7601	2.5483
BUS	Number of bus (electric) vehicles operating in municipal districts	2796	0.0013	0.9452	-1.8561	2.5114

4. RESULTS AND DISCUSSION

4.1 Rallel Trend Test

According to the research results of (Beck et al., 2010) [7], this paper conducts parallel trend test on the basis of controlling individual fixed effect and time fixed effect. In this paper, the total retail sales of consumer goods after dimensionless treatment is selected as the variable to measure the total amount of local commerce. At the same time, the wholesale and retail sales above quota and the number of wholesale and retail trade enterprises above quota are selected as the alternative variables for robustness test. The selection of variables to measure the growth rate of local commerce is the same. As shown in "Figure 1", the policy effect of the opening of high-speed railway on the total amount of local business has passed the parallel trend test, while the policy effect of the opening of high-speed railway on the growth of local business has failed the parallel trend test, which indicates that the opening of high-speed railway is more reflected in the impact on the total amount of local business in the statistical sense. This paper will build a multi-period difference-in-difference model as shown in equation (1) to further analyze this inspection.
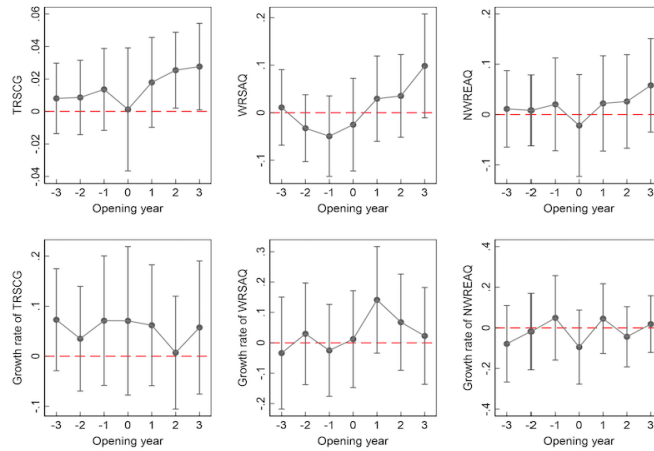
Figure 1 Parallel trend test results of the impact of high speed rail's opening on commercial development.

4.2 Benchmark Regression and Robustness Test

The regression results are shown in "Table 2". The explained variables of model (1) and model (2) are the total retail sales of consumer goods after dimensionless treatment, the explained variables of model (3) and model (4) are the wholesale and retail sales above quota after dimensionless treatment, and the explained variables of model (5) and model (6) are the number of wholesale and retail trade enterprises above quota after dimensionless treatment. As shown in "Table 2", the benchmark regression results show that the estimated coefficient of high-speed rail's opening affecting local business development is positive, and the significance level is less than 1%, and after

adding control variables, R^2 in the group increases significantly, and the regression results are more reliable; the regression results of robustness test are basically consistent with the benchmark regression.

The regression results in "Table 2" show that the opening of high-speed railway has a significant promoting effect on local commercial development, and the research hypothesis H1 is valid. In real economic life, after the opening of the high-speed railway, the accessibility of urban traffic will be greatly improved, more foreign passenger flow will flow into the city where the high-speed railway station is located, or transfer to other places in the city where the high-speed railway station is located, and the consumption expenditure on catering, shopping and living will also increase, thus driving the increase of the total amount of local business.

Table 2. Impact of high speed rail on commercial development

	Benchmark regression		robustness check			
	(1)	(2)	(3)	(4)	(5)	(6)
GT	1.6528***	0.1591***	1.4631***	0.0893**	1.4928***	0.1016***
	(0.0115)	(0.0317)	(0.0295)	(0.0355)	(0.0268)	(0.0345)
control variable	exclude	include	exclude	include	exclude	include
Constant	-0.5175***	-0.0495***	0.4613***	0.0308***	0.4691***	0.0334***
	(0.0036)	(0.0099)	(0.0092)	(0.0111)	(0.0084)	(0.0108)
Obs	2796	2796	2796	2796	2796	2796
R^2	0.4189	0.9241	0.3356	0.7921	0.3473	0.8142

a   Note: ***, **, and * indicate that the significance level is less than 1%, 5% and 10% respectively; the clustering robustness error is in brackets.

4.3 Group Heterogeneity Test

Referring to the latest commercial charm ranking of cities published on the official website of China first finance and economics, this paper divides all the city samples into three types: first-line and new first-line cities, second-line cities, third line and below cities, and makes a group heterogeneity test and analysis. The regression results of grouping heterogeneity test are shown in "Table 3". The explained variables of model (1), model (3) and model (5) are the total retail sales of consumer goods in the whole society after dimensionless treatment. Model (2), model (4) and model (6) are the robustness tests of model (1), model (3) and model (5) respectively. The explained variables are the number of wholesale and retail trade enterprises above quota after dimensionless treatment. As shown in "Table 3", the impact of high-speed rail's opening on commercial development in first tier and new first tier cities and second tier cities is not statistically significant, while the impact of high-speed rail's opening on commercial development in third tier and lower tier cities is positive, and the significance level is less than 1%; the regression results of robustness test are basically consistent with the benchmark regression results.

The regression results in 'Table 3" show that: (1) the impact of high-speed rail on local commercial development is the most prominent in the third tier and below cities, and the research hypothesis is valid. This may be due to the limited consumption capacity of the local permanent residents in the third tier cities and below, the imbalance of supply and demand in the commercial market, the low income level of the local permanent residents, and the room for optimization and upgrading of the consumption expenditure structure. At this time, the opening of high-speed rail will help to attract more tourists from cities with higher economic development level and residents who work in cities along the line but can't buy a house in the city where they work. The entry of these groups, on the one hand, expands the demand capacity of local business, on the other hand, drives the adjustment and optimization of the local consumption expenditure structure, and ultimately improves the development level of local business. (2) The estimated coefficient reflecting the impact of high-speed rail's opening on local commercial development in first tier and new first tier cities and second tier cities is not significant. This may be because, compared with the third tier cities and below, the first tier cities and the new first tier cities and the second tier cities themselves have enough population stock, their commercial market is relatively saturated, and the passenger flow brought by the opening of high-speed railway has a limited stimulating effect on the whole market.

Table 3. Regression results of grouping heterogeneity test

	First tier and new first tier cities		second-tier cities		Third tier and below cities	
	(1)	(2)	(3)	(4)	(5)	(6)
GT	0.0328	0.0223	0.0083	0.0619	0.2011***	0.1292***
	(0.0584)	(0.1249)	(0.0422)	(0.1008)	(0.0369)	(0.0388)
control variable	include	include	include	include	include	include
Constant	-0.0219	-0.0126	-0.0059	-0.0371	-0.0507***	-0.0342***
	(0.0383)	(0.0827)	(0.0230)	(0.0552)	(0.0093)	(0.0098)
Obs	168	168	336	336	2292	2292
R^2	0.9695	0.8361	0.9736	0.7794	0.9174	0.8237

a   Note: ***, **, and * indicate that the significance level is less than 1%, 5% and 10% respectively; the clustering robustness error is in brackets.

4.4 Further Analysis

The moderating variables selected in this paper are population density and completed amount of real estate development investment in this year. The regression results are shown in "Table 4". The explained variable of model (1) and model (4) is the total retail sales of consumer goods after dimensionless treatment, the explained variable of model (2) and model (5) is the wholesale and retail sales above quota, and the explained variable of model (3) and model (6) is the number of wholesale and retail trade enterprises above quota. Model (2) and model (3) are the robustness tests of model (1),

and model (5) and model (6) are the robustness tests of model (2). When the population density is selected as the moderating variable, the moderating effect of high-speed rail's opening on commercial development is positive but not significant, and the research hypothesis H3 is not tenable; when the completed amount of real estate development investment is selected as the moderating variable, the moderating effect of high-speed rail's opening on commercial development is positive and significant, and the research hypothesis H4 is tenable. The regression results of robustness test are basically consistent with the benchmark regression results.

Table 4. Regression results after adding regulatory variables

	Adjusting variable:: PD			Adjusting variable:: INV		
	(1)	(2)	(3)	(4)	(5)	(6)
GT	0.1501***	0.0910**	0.0924***	0.1311***	0.0927**	0.0839**
	(0.0345)	(0.0383)	(0.0351)	(0.0392)	(0.0394)	(0.0383)
GT×PD	0.0377	0.0073	0.0382			
	(0.0255)	(0.0310)	(0.0323)			
GT×INV				0.0685**	0.0084*	0.0433*
				(0.0318)	(0.0370)	(0.0438)
control variable	include	include	include	include	include	include
Constant	0.0515***	0.0304***	0.0354***	0.0529***	-	-
	(0.0096)	(0.0108)	(0.0109)	(0.0092)	0.0304***	0.0355***
					(0.0111)	(0.0111)
Obs	2796	2796	2796	2796	2796	2796
R²	0.9243	0.7921	0.8144	0.9247	0.7821	0.8144

a   Note: ***, **, and * indicate that the significance level is less than 1%, 5% and 10% respectively; the clustering robustness error is in brackets.

The regression results in "Table 4" show that: (1) the moderating effect of population stock is not statistically significant, and the positive effect of high-speed rail on local business development is not affected by local population stock. This may be because the local population stock often means the size of local demand market capacity, and this kind of consumer groups prefers daily consumption expenditure. After the opening of high-speed railway, the vast majority of the population entering the city are transit or short-term overnight "passers-by" population. These groups prefer entertainment consumption expenditure, and there is no mutual exclusion between these two groups relationship. (2) The moderating effect of real estate

development investment activities is statistically significant positive. The positive impact of high-speed rail on local commercial development is directly proportional to the local real estate development investment activities, that is, the higher the real estate development investment, the stronger the positive impact on local commercial development. This may be because, first of all, the development of residential property stimulates potential consumer groups in cities along the high-speed railway to buy houses, which directly improves the consumption expenditure level of commercial housing in cities with high-speed railway's opening; secondly, the development of office property will attract more enterprises to settle

in, and enterprises need to pay relevant business consumption expenses to receive customers, and the opening of high-speed rail just provides convenient transportation for these business groups, increasing the probability of their business activities in the cities with high-speed rail. Finally, there is an interactive relationship between the development of commercial operation facilities and the opening of high-speed railway. The large number of consumer groups brought by the opening of high-speed railway solves the problem of insufficient consumption for the operators of commercial operation facilities, and the supporting construction of commercial operation facilities solves the problem of "where to consume" for the consumer groups brought by the opening of high-speed railway.

5. CONCLUSION

The impact of the opening of high-speed railway on local commercial development is obvious, but it may be the reason that the more common problems are, the easier to be ignored. At present, few scholars have conducted systematic and scientific empirical tests on its impact effect and mechanism. This paper selects 233 cities prefecture level city in China from 2006-2017 and constructs a multi-period difference-in-difference measurement model. The population density and the investment volume of real estate development are introduced to discuss the above problems. The results show that the opening of high-speed rail can significantly promote the development of local business, and this positive effect is mainly concentrated in the third tier and below cities; the promotion effect of high-speed rail on the development of local business is not affected by the population stock factor; on the contrary, the higher the investment in local real estate development, the stronger the promotion effect of high-speed rail on the development of local business.

The policy implications of this paper are as follows: the first is to do a good job in supporting commercial operation facilities. After the opening of high-speed railway, cities will face the influx of a large number of passenger flow, which will bring new market demand capacity for local commercial development. At this time, the contradiction between the insufficient total supply of commercial market and the substantial increase of local consumption demand capacity after the opening of high-speed railway will become one of the main bottlenecks hindering the development of local

commerce. To deal with this bottleneck, the local government should, on the basis of market research, do a good job in supporting commercial operation facilities, and promote the supply side structural reform in the commercial field. The second is to guide high-speed rail groups to expand consumption. Although the empirical test results show that the opening of high-speed rail in first tier and new first tier cities and second tier cities has no significant impact on their commercial development, it can not prove that the opening of high-speed rail has no impact on the commercial development of cities with better economic development level, and the above-mentioned city governments can not ignore the strategic significance of the opening of high-speed rail. The impact of the opening of high-speed rail on the commercial development of the above cities is not significant, which may be because the total amount of local consumption demand is very large, and the proportion of consumption demand increment brought by the opening of high-speed rail is too small, which leads to the regression result is not significant in the statistical sense. At this time, the local government should create and provide more targeted commercial formats, develop more high-quality commercial projects, guide the high-speed rail group to stay more time and expand the level of consumer spending according to the consumption preference and consumption behavior characteristics of the high-speed rail group. The third is to dialectically understand the rationality of real estate development activities. The results show that some public opinions criticize the investment activities of real estate development and attribute the rise of house prices to excessive investment. This is a one-sided view in itself. No matter whether the rise of house prices is caused by consumer behavior, developer behavior or local government regulation behavior, there is still no consensus at present. According to the research results of this paper, it is found that in the process of high-speed rail's opening affecting local commercial development, real estate development and investment activities play a positive regulatory role. It is essential to dialectically understand the rationality of real estate development activities and realize the good development of real estate development in an appropriate range.

Although the impact of high-speed rail on the commercial development of first-line and new first-line cities and second-line cities is not statistically significant, it only shows that the opening of high-speed rail has no statistical impact on the total

commercial volume. The tourist groups with diversified consumption habits and preferences brought by the opening of high-speed rail may also have a negative impact on the upgrading of local consumption structure Influence effect. However, limited by the available data samples, there is no empirical test for this possible inherent law, which may be the biggest deficiency of this study. The follow-up research will strive to obtain more detailed data samples or make further improvement and innovation in research methods, quantify the upgrading of local consumption structure, and further explore its possible internal development law.

AUTHORS' CONTRIBUTIONS

Danqi Li is responsible for paper design and wrote the paper, Ling Dai analysed data, Siying Gong collected the literature and wrote the manuscript.

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