Study on the Impact of High-Speed Railway on China's Urban Industrial Upgrading

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Abstract: The industrial structure often reflects the level of economic development of a country. After experiencing rapid economic development, China has revealed the problems of unreasonable industrial structure and low overall level of economic structure. Therefore, the transformation and upgrading of industrial structure must be put on the important agenda of economic reform as a core issue. High-speed railroad has a significant responsibility in regional development because of its significant externality. Will high-speed railroad, as a sign of the times in transportation development, have an impact on the optimization and upgrading of regional industries? Based on this question, this paper constructs a quasi-natural experiment using high-speed railway opening as the core explanatory variable, and selects panel data of 277 cities in China from 2010-2019 to assess the impact of high-speed railway opening on industrial optimization and upgrading using a double difference model. The results show that the opening and operation of high-speed railways play a significant positive role in promoting industrial structure upgrading, i.e., the effect of industrial optimization and upgrading in cities with high-speed railways is greater than that in cities without high-speed railways. Moreover, under different regions and city groupings, the effect of high-speed rail opening on industrial upgrading has produced some heterogeneity. The above findings have some implications for promoting industrial transformation and upgrading and achieving sustainable economic development in China.

1. Introduction

In the process of China's economic development, Zhang Ming [1] found that optimizing industrial structure is an important channel for China to achieve stable and sustainable economic development, improve economic efficiency, expand employment, and improve people's lives. However, at this stage, the comparative advantage of labor force, on which China's labor-intensive industries depend, tends to weaken, and the development of capital-intensive industries is constrained by the environment, so that industrial upgrading is imperative if China wants to maintain high growth. Fu Linghui [2] argues that industrial structure upgrading is conducive to pushing up the efficiency of resource utilization and improving the efficiency of economic growth, and while paying attention to economic growth and industrial structure upgrading drive, industrial structure upgrading should not be neglected. Wang Chunyang [3] argues that high-speed rail construction triggers human capital migration between high-speed rail cities and between high-speed rail cities and non-high-speed rail cities by reducing trade costs between regions, which in turn affects the evolution of regional innovation spatial structure.

This paper uses the opening of high-speed rail as a quasi-natural experiment, based on panel data of 277 prefecture-level cities from 2010-2019, and adopts the multi-period double difference method to exhibit the effect of high-speed rail in industrial structure upgrading for an empirical study, based on which, this paper assesses the heterogeneous characteristics of the impact of change between regions and between different cities, and the relevant research findings have certain reference value.

2. Theoretical Mechanisms

The arrival of high-speed railway era can make different industries in the region spatially distributed in steps and realize the synchronous development within the region. High-speed railway will have many economic effects on the economy due to its remarkable externality, and high-speed railway can be associated with logistics, transportation, service, commerce and other industries to accelerate the rapid transfer of production factors, thus forming industrial agglomeration[4]. In addition, high-speed rail greatly saves journey costs and increases passenger traffic, which is bound to boost local consumption growth, which will arise from tourism, catering and accommodation industries[5]. The better the industrial development, the more attractive it will be to tourists, which will further drive the increase of passengers, forming a positive cycle of high-speed rail opening and operation - passenger volume increase - tertiary industry development - passenger volume increase. Conversely, high-speed rail shortens the spatial and temporal distance between cities and regions, bringing great convenience in transportation along the way, while it may also mean that more talents, resources and capital will be single-phase, rapid transfer trend to the more mature development of large cities, thus leading to the plight of small and medium-sized cities along the route facing improper allocation of resources and backward development[6]. So does the opening of high-speed rail play a positive role in promoting the optimization and upgrading of industries? Or does it hinder the optimization and upgrading of industries instead?

Based on the above mechanism analysis, the following hypotheses are proposed.

First, the opening and operation of high-speed rail can promote the flow of talents, capital, technology, information and other factors, strengthen the connection between regions, and thus have a positive impact on industrial upgrading.

Secondly, the opening and operation of high-speed rail will promote the one-way and transfer of talents, resources and capital to the big cities with more mature development, which will in turn be detrimental to the regional industrial optimization and upgrading.

3. Empirical Models and Data

3.1 Model Construction and Variable Setting

Using the opening of the HSR as a “quasi-natural experiment”, the data are divided into an experimental group with the opening of the HSR and a control group without the opening of the HSR. As an instrumental method for estimating treatment effects, the double difference method is often used to assess the intertemporal effects of policy implementation. Based on the above conditions a double difference model is constructed to test the net effect of HSR opening on industrial upgrading is constructed as follows:

$$ISU_{it} = \alpha + \beta \times HSR_{it} + \lambda \times A_{it} + \mu_i + \nu_t + \varepsilon_{it} \quad (1)$$

where is the industrial structure of the ith city in year t; denotes whether the ith city in year t is the treatment group for the opening of high-speed rail, yes takes the value of 1, and vice versa takes the value of 0; considering the different resource possession of each region, this paper adds the control variable , which is the coefficient of the control variable, the control variables introduced in this paper are the level of government intervention, human capital, the level of scientific and technological development, the level of economic development and The five variables of prefecture-level city size. denotes year fixed effects, denotes city fixed effects; is the random error term. The core coefficient we are most concerned about is , and its positive or negative reflects whether the opening and operation of high-speed rail will have an impact on the upgrading of industrial structure, if the opening of high-speed rail will have a positive impact on the upgrading of industrial structure, it should be significantly positive, if it is significantly negative, the opening of high-speed rail will have an impeding effect on the upgrading of regional industrial structure.

3.2 Selection of Variables

Explanatory variable: industrial structure upgrading. This paper focuses on the impact of

high-speed rail on industrial upgrading. The industrial structure index is constructed as an index to measure industrial upgrading, and the specific formula is as follows:

$$isu = \sum_{i=1}^{3} I_i \times i = I_1 + I_2 \times 2 + I_3 \times 3 \tag{2}$$

The larger the index, the higher the level of industrial structure development, and the higher the level of advanced industrial structure in the region.

Explanatory variable: the opening of high-speed rail. If a city opens high-speed railway for the first time in year t, and the year is year i, then the variable of opening of high-speed railway in that year and the year after will be taken as 1, and the year before the first opening will be taken as 0. Considering that the effect of opening of high-speed railway on industrial upgrading usually takes some time to appear, the high-speed railway opened in June and before will be taken as the opening of that year, and the high-speed railway opened in the second half of the year after June will be taken as the opening of the next year. The year before the first opening is taken as 0.

$$hsr = \begin{cases} 1 & i \geq t \\ 0 & i < t \end{cases} \tag{3}$$

Control variables: the degree of government involvement (gov): the ratio of general budget expenditure to GDP is used to measure the degree of government intervention. The size of the general public budget often reflects the tendency of government policy choices, and the government can have some influence on the development of the economy and the change of industrial structure through the adjustment of the quantity or direction of fiscal expenditure. Human capital (edu): The larger and higher quality the regional human capital stock is, the more it is conducive to promoting technological progress and improving marginal productivity levels, so human capital plays an important role in industrial structure upgrading. The level of economic development (pgdp): the natural logarithm of per capita gross product is used to measure it. The level of science and technology development (te): a key part of the progress of science and technology lies in industrial upgrading, and the establishment of a technology system that matches each industry can promote industrial upgrading more efficiently. The number of patents granted can better reflect the technological capability of each region, and this paper adopts the natural logarithm of the number of patents granted to measure the level of scientific development of cities. The scale of prefecture-level cities (pop): population gathering is the result of industrial gathering, and the increase of city scale means the improvement of social and economic activity, employment opportunities, labor force and other aspects, which affects the upgrading of industrial structure to a certain extent.

3.3 Data Source and Processing

In the international and domestic urban research discourse, there are different criteria for classifying city types. In this paper, we adopt the city classification standard announced by the State Council in 2014, which divides 277 prefecture-level cities into 3 classes, i.e., based on the resident population greater than or equal to 5 million, between 1-5 million and less than 1 million, the city classes are divided into mega-cities, large cities and small and medium cities in order. This classification standard has a high market acceptance, which is in line with the current urban development situation and meets the research needs of this paper. The method of dividing provinces and cities in the east, middle and west regions is divided according to the standard of the National Bureau of Statistics website, and is divided into three categories of east, middle and west according to the regions to which the prefecture-level cities belong.

The data of high-speed railway comes from mainly from the website of China Railway Corporation and the website of China Railway Corporation. At present, there is no uniform standard for high-speed railroad nationwide. In the “Railway Main Technical Policy” implemented on February 1, 2013, the existing line speed-up lines are removed from high-speed railroads, and high-speed railroads simply refer to new trains with a design speed of 250 km/h and above. And some of the 200 km/h track lines are included in the scope of China's high-speed railway network,

so this paper screens the high-speed railroads that do not meet the above requirements.

The data of control variables are mainly obtained from the China City Statistical Yearbook, China Regional Economic Statistical Yearbook, and the statistical yearbooks and national economic and social development bulletins of each prefecture-level city during the sample study period. Considering the availability of data, prefecture-level cities such as Tibet Autonomous Region, Laiwu City and Tongchuan City were excluded from this paper.

4. Empirical Analysis

4.1 Baseline Regression Results

Column 3 of Table 1 shows that the coefficient of HSR opening is positive at 1% significance level when year effect and city effect are controlled and no control variables are added, indicating that HSR opening has a significant positive effect on industrial structure upgrading. After adding the control variables, the coefficient of HSR opening is still significantly positive, which indicates that after controlling for the effects of other factors, the opening of HSR has a significant contribution to the upgrading of industrial structure. For the control variables, the coefficient of science and technology level is positive at 1% significance level, which indicates that the improvement of science and technology capability can promote industrial transformation to a certain extent; the coefficient of human capital is significantly negative at 1% significance level, probably because the existence of human capital mismatch inhibits the upgrading of industrial structure and cannot become the driving force of industrial optimization; the coefficient of prefecture-level city size is significantly negative, which indicates that the city size is not The coefficient of prefecture-level city size is significantly negative, indicating that the larger the city size is not better, presumably because of the massive influx of population to the city, which leads to the inability of city-related supporting infrastructure and public services to meet the changing trends of population and industry, causing difficulties for industrial structure adjustment.

Table 1 Baseline Regression Results on Industrial Structure Upgrading by the Opening of High-Speed Rail

	(1)	(2)	(3)	(4)
	ins	ins	ins	ins
did	0.1276 ***	0.035966***	0.00747***	0.00842***
	(26.12)	(8.69)	(2.760)	(0.00272)
gov		0.195417***		-0.0018901
		(9.85)		(-0.12)
te		0.036488***		.0078596***
		(18.44)		(3.80)
pgdp		0.040847 ***		.0002459
		(13.414)		(0.00207)
edu		1.79716***		-.4708257***
		(21.08)		(-2.56)
pop		-.0281741***		-0.0483***
		(-7.53)		(0.11)
Individual control	No	No	YES	YES
Time Control	No	No	YES	YES
_cons	2.22744 ***	1.923817 ***	2.273***	3.111***
	(732.78)	(24.02)	(1798.18)	(13.18)
R^2	0.1976	0.5748	0.936	0.937

Note: ***, **, * denote significant at the 1%, 5%, and 10% levels, respectively.

5. Propensity Matching Score

The propensity matching scores are shown in Table 2. Before matching, the industrial upgrading indexes of cities with and without high-speed rail are both significantly different at the 1% level,

which indicates that the impact coefficient of industrial structure upgrading is higher for cities with high-speed rail than for cities without high-speed rail, and the difference between the two is 0.127; after matching by the proximity matching method, the difference between cities with and without high-speed rail is significant at the 1% level The kernel matching and radius matching yielded approximately the same results, verifying the accuracy of the results. After considering the selective bias of whether to open HSR, the effect of opening HSR on industrial structure upgrading becomes significantly larger, and ignoring the selective bias of whether to open HSR and the endogeneity problem will lead to the underestimation of the effect of opening HSR on industrial structure upgrading.

Table 2 Estimated Results After Propensity Score Matching

Before and after matching	Experimental group	Control group	ATT	T
Before Matching	2.355	2.228	0.127	26.01
Neighborhood Matching	2.345	2.296	0.049	6.81
Kernel Matching	2.348	2.299	0.049	7.41
Radius Matching	2.345	2.297	0.048	7.17

5.1 Regional Heterogeneity Analysis

China's economic development is growing at a high speed, but there are still large differences in the level of economic development and industrial structure among regions due to the unreasonable spatial layout of industries and the unbalanced regional economic development. Therefore, this paper is divided into three regional categories of east, middle and west according to the provinces to which the prefecture-level cities belong, and further explores the differences in the role of high-speed rail opening on industrial upgrading in different regions.

Table 3 Regression Results of Regional Heterogeneity in the Impact of High-Speed Rail Opening on Industrial Upgrading

	(5)	(6)	(7)
	East	Central	West
did	0.009***	-0.011**	0.022***
	(2.747)	(-2.010)	(3.515)
gov	-0.000	-0.000	-0.001***
	(-1.260)	(-0.970)	(-3.854)
te	0.003	0.008*	0.005
	(1.269)	(1.756)	(0.973)
pgdp	-0.003	-0.023*	-0.061***
	(-0.642)	(-1.752)	(-5.011)
edu	-0.378*	-0.272	-0.525
	(-1.827)	(-0.712)	(-1.154)
pop	-0.056***	0.153***	-0.167***
	(-3.561)	(4.066)	(-4.822)
City Control	YES	YES	YES
Year Control	YES	YES	YES
_cons	3.173***	0.163	5.365***
	(12.555)	(0.275)	(9.874)
R^2	0.953	0.918	0.947

Note: ***, **, * denote significant at the 1%, 5%, and 10% levels, respectively.

From Table 3, we can see that the impact of high-speed rail opening on the urban-rural income gap in the eastern, central and western regions shows some heterogeneity. The coefficients of the variable of high-speed railway opening in both eastern and western regions are positive at the 1% significance level, indicating that the opening of high-speed railway has a significant positive driving effect on the optimization and upgrading of industrial structure in eastern and western regions. In terms of the magnitude of the coefficients, the opening of high-speed rail has a greater effect on industrial optimization and upgrading in the western region than in the eastern region,

probably because the weak construction of transportation infrastructure in the western region has restricted the adjustment of its industrial structure to a certain extent, and the exchange network with the eastern and central regions formed after the opening of high-speed rail has injected fresh blood into the western region and accelerated the flow of various factors, thus greatly promoting industrial Optimization and upgrading. The opening coefficient of high-speed rail in the central region is negative, which may be due to the fact that the network of high-speed rail construction in the central region and other regions is not yet mature or the promotion effect of high-speed rail on industrial upgrading has a certain lag, which will take some time to appear.

5.2 City Heterogeneity Analysis

Due to the different natural and social conditions of each city, the industrial development structure varies from city to city. In this paper, each city is divided into three different classes, namely, megacities, large cities and small and medium cities, according to the number of resident population in each city. The results are shown in Table 4, which shows that the opening of high-speed railway has a promotion effect on the industrial structure upgrading of small and medium-sized cities, large cities and mega-cities, but the promotion effect on the industrial structure upgrading of mega-cities is not significant, probably because the population base of mega-cities is large, so the corresponding public service supply cannot keep up with the adjustment of their industrial structure, and thus the opening of high-speed railway cannot significantly promote industrial upgrading.

Table 4 Regression Results of City Heterogeneity of the Impact of High-Speed Rail Opening on Industrial Upgrading

	(8)	(9)	(10)
	Small and medium-sized cities	Large cities	Megacities
did	0.067***	0.007**	0.004
	(2.794)	(2.372)	(0.826)
gov	-0.001	-0.000**	-0.000
	(-1.633)	(-2.300)	(-0.775)
te	-0.018*	0.005**	0.021***
	(-1.830)	(2.079)	(4.420)
pgdp	-0.179***	-0.008*	-0.011
	(-6.168)	(-1.774)	(-0.674)
edu	0.039	-0.513**	0.158
	(0.050)	(-2.410)	(0.422)
pop	-0.181***	-0.072***	-0.039
	(-4.709)	(-3.528)	(-1.183)
Individual control	YES	YES	YES
Time Control	YES	YES	YES
_cons	6.837***	3.390***	2.852***
	(9.875)	(11.103)	(4.832)
R^2	0.914	0.950	0.927

6. Conclusion and Insights

6.1 Conclusion

Using relevant economic data of 277 prefecture-level cities from 2010-2019, this paper constructs an industrial upgrading index based on the different situations of the three industries in prefecture-level cities, and uses the cities that have opened high-speed rail in the study interval as the treatment group and those that have not as the control group, and uses a two-way stationary model to investigate the role of high-speed rail opening on industrial optimization and upgrading, and on this basis, explores the effect of high-speed rail opening on different regions and heterogeneity in terms of industrial upgrading in different city sizes. The results show that.

Overall, the opening of high-speed rail has a significant role in promoting regional industrial optimization and upgrading, indicating that the transportation network formed by the opening of

high-speed rail can accelerate the flow of technology, capital, information and other factors, thus promoting industrial upgrading, and this economic effect varies among different regions and cities.

The improvement of the level of science and technology will boost industrial upgrading, and the development of science and technology determines the development of productivity, which further determines the direction of industrial development; in the current process of industrial optimization and upgrading, there may be a mismatch between the provision of human capital and demand, and the industries most in need of manpower with a certain skill cannot be satisfied.

6.2 Revelation

To improve the high-speed rail connection network between regions, increase the construction of high-speed rail, make full use of the economic effect of high-speed rail, and provide the basis for the coordinated development of industrial structure upgrading between regions; each region should focus on improving the level of science and technology, give full play to the leading role of scientific and technological innovation, strive to seek breakthroughs in technology, and allow technology to empower industrial optimization and upgrading[7].

Large cities cannot develop in isolation, but should strengthen the construction of a comprehensive governance system, establish a high-level industrial structure, achieve multi-dimensional sustainable development, avoid the formation of a large gap with the surrounding small and medium-sized cities, strengthen the role of radiation with the surrounding areas, strengthen the leading role, and avoid the “siphon effect” on other small and medium-sized cities.

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