Research on the Influence of Urban Rail Transit on the Upgrading of Industrial Structure——Beijing as an Example Based on Regression Analysis

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Abstract—At the stage of steady economic growth, the upgrading of industrial structure plays an increasingly important role in promoting urban development. Urban rail transportation as an important part of urban transportation, although large investment costs, long investment period, but a large number of social benefits brought rail traffic to the city. This article first analyzes the impact mechanism of urban rail transit on the industrial structure, and builds a multiple regression model; then, taking Beijing as an example, the article uses generalized least squares and other econometric methods to empirically test its impact. The results are as follows: Urban rail transit has a positive effect on the city to promote industrial upgrading; Mechanism analysis shows that urban rail transit improves labor and capital investment in the tertiary industry. The research in this article reveals the transportation effect of rail transit on human capital, and is of significance for exploring the positive externalities of urban rail transit and industrial upgrading in the future.

Keywords—Urban rail transit; Upgrading of industrial structure; Labor and capital investment

1 INTRODUCTION

With the gradual acceleration of China’s urbanization reform, large numbers of people flooded into the city, and there has been a serious separation of work and residence in large cities and megacities, which has led to a rapid increase in residents' travel distances and increasingly intensified tidal traffic. With the advancement of urbanization reform, the rapid increase in urban population and the acceleration of the motorization process have exacerbated the contradiction between the rapid growth of urban consumer demand and the limited resources in the city. The contradiction between the two has brought various problems to the city. In city traffic, rail transit is one of the indispensable large-scale urban transportation methods. It is fast, punctual, and environmentally friendly. It can not only save passengers' travel time, but also reduce their travel time and economic costs. Therefore, rail transit has become the direction and trend of solving traffic congestion and other problems in big cities. Urban rail transit not only plays a direct role in solving traffic problems, it can also bring many social and other indirect benefits to the city, which will have a significant and extraordinary effect on future urban development.

In the stage of stable economic development, China has made changes in its concepts of economic growth rate and economic structure, and gradually realized that GDP is not the best

ICIDC 2022, June 17-19, Qingdao, People's Republic of China

DOI 10.4108/eai.17-6-2022.2322705

indicator to measure the comprehensive national strength, and the improvement of technical level helps to enhance China's hard power. However, in the process of China's continuous efforts for industrialization, problems such as low-end industrial manufacturing and lagging development of the service industry have become prominent. In recent years, China continues to promote innovative R&D and boost industrial upgrading, but at present, China still has a certain distance from developed countries in terms of industrial development. Continuous industrial transformation and progress is a fatal prerequisite for ensuring urban economic, so it is of great practical significance to pay attention to the development of industrial structure. In the context of rail transit becoming an essential part of urban infrastructure construction, it is necessary and meaningful to focus the impact of urban rail transit on the future development of the city and the upgrading of urban industrial structure.

2 LITERATURE REVIEWED

Urban rail transit has brought many introductory benefits to the city in addition to direct economy. The upgrading of industrial is one of the most important tasks of our country. Therefore, this paper studies whether urban rail transit will have some positive externalities on the upgrading of urban industrial structure.

2.1Impact of Urban Rail Transit

With the acceleration of urbanization, the construction of urban rail transit has become a key component of the progress of cities. At the same time, many scholars have studied the impact of urban rail transit. These documents can be roughly classified as the impact of urban rail transit on macro and micro aspects.

2.1.1Macro Impact of Urban Rail Transit

The existing literature focuses on the social and economic benefits in studying the impact of urban rail transit on macro economy. On the social and economic impact, many literatures draw the conclusion that urban rail transit will promote economic growth. Crampton, G. studied the development of urban rail transit in European countries and empirically analyzed the economic impact of urban rail transit on cities [1]. In domestic research, many literatures also draw the conclusion that urban rail transit can promote the economy. In quantitative research, Cai, Q. conducted an empirical study on the urban rail transit and economic growth of the three cities of "Beijing, Shanghai and Guangzhou", and found that urban rail transit has a certain contribution to the economic development of the three cities, it is proved that there is a two-way impact between rail transit and economic growth [2]. Similarly, Wu, X., Wang, C.S. and Tan, M. studied the spatial optimization of Xi'an and found that the urban fast track can significantly improve the positioning and development of the urban center and axis, and can significantly optimize the urban spatial structure [3].

2.1.2Micro Impact of Urban Rail Transit

On the micro impact of urban rail transit, more research on its impact on house prices along the line. In terms of quantitative analysis, most literatures often take a subway line as an example to study the impact on the housing prices along the line, and draw the conclusion that rail transit

increases the housing prices along the line. Wu, L.G. and Yi, H.Y. took Wuhan Metro 4 as an example to study [4]. By using the characteristic price model, it is found that among the many factors that affect housing prices along the line, the effect of the subway is huge. And there is a phenomenon that as the distance from the station increases, the value-added effect decreases. In the qualitative research, Yang, M.S. and Zheng, F. also got the conclusion that rail transit significantly increased the house prices along the line by studying the urban rail transit factors [5].

2.2Empirical Research on Industrial Structure

In the relevant literature on industrial organization, most domestic and foreign research focuses on which factors have an impact on industrial organization. In foreign studies, Gilles, D. and Diego, P. concluded that there is a relationship between the level of urbanization and industrial structure [6]; Chen, C.L., Yao, S.J. and Hu, P.W. found that investment structure can promote the optimization of industrial structure by promoting industrial agglomeration [7]. In domestic research, Han, J. and Kong, L.C. studied the relationship between innovation factor flow and industrial structure change, and found that innovation factor flow promotes the escalating of regional industrial structure [8].

2.3Literature Summary

Through understanding and learning of the literature, the research methods on the impact on rail transit are mostly studied by qualitative analysis; Secondly, the research content of the impact on urban rail transit mainly focuses on its impact on social economic growth, spatial structure and house prices along the line. In the research on industrial organization, most researches are carried out from the perspective of financial investment and innovation. Few documents focus on the impact of urban rail transit on changes in urban organization. Therefore, this article focuses on the impact of urban rail transit on the industrial structure to promote the rational optimization of the urban structure.

3 THEORETICAL ANALYSIS

In the 1990s, Krugman and other economists put forward the new economic geography theory (NEG), which introduced tools such as returns to scale and imperfect competition into the study of spatial allocation of resources, and emphasized the important role of transportation in the study. The theory holds that the interaction of transportation and scale affects the spatial allocation of resources together. The emergence of scale agglomeration helps to reduce the production cost of enterprises. At the same time, the continuous increase of production volume, the addition of labor demand, and the improvement of wage return and return on investment, so as to gradually attract basic production factors such as labor and capital from outside the region to the region. According to the new economic geography theory, the construction and operation of urban rail transit improves the accessibility among regions, and makes the information, capital and other resources flow freely. The regional ties between various industrial organizations are closer, which is conducive to produce the combined effect of the industry. The paper proposes hypothesis 1:

Hypothesis 1: urban rail transit will have an incentive effect on the industrial structure of the city.

Based on the perspective of labor demand, according to the theory of new economic geography, the opening of urban rail transit promotes the agglomeration of industries, which reduces the production and transportation costs of enterprises, which in turn increased the demand for labor and employment, thereby increasing wages and attracting more labor outside the region. Therefore, it will attract more labor force from outside the region to flow to the region, and the increase of labor force will produce new consumption demand. So as to creates a new demand for labor. Based on the perspective of labor supply, according to the growth pole theory and point axis theory. On the one hand, the subway is a green way of urban transportation, which provides convenience for residents' life and travel, improves the overall level of the city and forms a "pole". At the same time, urban rail transit saves the travel time of workers and reduces the economic cost of travel, which will also help to improve the employment willingness of workers. On the other hand, the construction of rail transit as the "axis" will have a diffusion effect on the surrounding areas, promote the development of commerce, education and public infrastructure in the surrounding areas along the line. And the further use of land resources will attract more labor. Based on the above theory, the article proposes hypothesis 2:

Hypothesis 2: the opening of urban rail transit will significantly promote labor and capital investment in the tertiary industry.

4 EMPIRICAL ANALYSIS

4.1Research Design

4.1.1Variable definition

4.1.1.1Explained variable and explained variable

The core explanatory variable of this paper is industrial structure upgrading (*I_str*), labor input of each industry (*Number_1, Number_2, Number_3*), capital investment in the tertiary industry (*Asset*). By allusion to the mainstream literature, this paper defines the upgrading of industrial structure as "the ratio of the output value of the tertiary industry to the GDP"; Through theoretical analysis, it is found that urban rail transit can affect the industrial structure by attracting more labor and capital elements. Therefore, this article further studies the mediating effect of labor and capital investment in the tertiary industry, and defines the labor investment in each industry as "the number of employees in the tertiary industry"; Capital investment in the tertiary industry is defined as "the proportion of capital investment in the tertiary industry in urban investment". The explanatory variable is the development degree of rail transit, which is expressed as the number of rail transit mileage opened.

4.1.1.2Control variable

Through the understanding of the literature, the article selects the following control variables: urbanization level (*U_level*) and total import and export (*Im_Ex*). Through literature review, it is found that the faster the urbanization process, the higher the progress of the industrial structure. And high-level urbanization can refine and optimize the industrial structure [6]. Therefore, this

paper uses the ratio of urban population to total population to represent the level of urbanization to control the impact of urbanization environment; Relevant literature found that import and export will affect the output value of the secondary industry and the tertiary industry, so this paper selects the total value of goods import and export as the control variable to control its impact.

4.1.2Data sources

This paper selects Beijing Rail Transit data and industrial structure data from 2000 to 2018 to study. The data of explained variables and controlled variables are from Beijing Statistical Yearbook. The development degree data of urban rail transit includes the number of subway mileage and stations in Beijing. The number of stations is calculated according to a single subway line, ignoring the impact of transfer stations. The above data comes from the official website of Beijing Metro and other network resources.

4.1.3Model building

According to the theoretical analysis and the corresponding theoretical assumptions, the article constructs a research model based on research hypotheses:

$$I_{str_t} = \alpha_0 + \alpha_1 Rail\_tra_{t-1} + \alpha_2 Control_{it} + \varepsilon_t \quad (1)$$

$$Number_{it} = \beta_0 + \beta_1 Rail\_tra_{t-1} + \beta_2 Control_{it} + \varepsilon_t \quad (2)$$

$$Asset_t = \gamma_0 + \gamma_1 Rail\_tra_{t-1} + \gamma_2 Control_{it} + \varepsilon_t \quad (3)$$

$$I\_str_t = \delta_0 + \delta_1 Number_{it} + \delta_2 Control_{it} + \varepsilon_t \quad (4)$$

The explained variable I_{str_t} is the proportion of tertiary industry output value in total output value, $Number_{it}$ is number of employees in each industry, and $Asset_t$ is the proportion of tertiary industry investment assets in urban investment; Core explanatory variable $Rail\_tra_{t-1}$ is the degree of rail transit construction in the city. Since most of the subways are opened and operated in December of the current year, the explanatory variables in the text lag behind one phase; Control variables include urbanization level and total import and export.

4.2Research results

In this paper, the measurement method of generalized least squares is used to test the two hypotheses, and the stability of industrial structure is tested by changing the key variables. The regression results obtained can be seen in Table1.

TABLE 1. REGRESSION RESULTS

	（1）	（2）	（3）	（4）	（5）
	I_str	*Number_1*	*Number_2*	*Number_3*	*Asset*
Rail_tra	0.012***	-0.034***	-0.064**	0.620***	9.978***
	（0.003）	（0.007）	（0.026）	（0.098）	（0.886）
U_level	83.660***	-84.661	-1.202	3652.08***	25312.85***
	（23.337）	（52.559）	（200.302）	（758.603）	（6993.152）

Im_Ex	-0.00005 （0.0001）	0.0004 （0.0002）	-0.0004 （0.001）	-0.003 （0.004）	-0.063* （0.032）
R-squared	0.941	0.869	0.533	0.970	0.978

Note: * *, * respectively, they are significant at the confidence level of 1%, 5% and 10%, and the standard deviation in parentheses is robust.

4.2.1Impact of urban rail transit on industrial structure upgrading

In order to test whether hypothesis 1 is true, this paper regresses the development degree of Beijing rail transit to its industrial structure level, and the regression results obtained can be seen in column (1). As shown by the results, under the 1% confidence level, the development of Beijing's rail transit significantly stimulates the escalating of the industrial structure. It is consistent with hypothesis.

In order to verify hypothesis 2, this paper regresses models (2) and (3), and the results obtained can be viewed in columns (2), (3), (4), and (5). The results show that the regression coefficients of urban rail transit on the employment of the primary industry and the secondary industry are significantly negative, and only the coefficient on the employment of the tertiary industry is significantly positive. The results show that rail transit will significantly reduce the labor input of the primary and secondary industries and significantly increase the labor input of the tertiary industry. As shown by the results in column (5), at the confidence level of 1%, when the development degree of urban rail transit in Beijing increases by 1 unit, the proportion of Beijing's tertiary industry asset investment in the city's total assets increases by 9.978 units. The results show that rail transit will significantly increase the capital investment in the tertiary industry.

4.2.2Intermediary effect analysis

This paper makes a regression analysis on the model (4) to analyze the intermediate communication effect, the results of the mediation effect can be viewed in Table 2.

The result can be seen, both the urban primary industry and the secondary industry's employment numbers have a negative effect on the upgrading of the industrial structure; Labor input and capital investment in the tertiary industry have a positive impact on the upgrading of urban industrial structure. Through the analysis of the above structure, Beijing's urban rail transit promotes spatial accessibility, shortens people's commuting time, and allows labor, capital and other factors in the surrounding areas to flow freely. The strengthening of the links with industries in the surrounding areas has promoted the development of the urban tertiary industry, promoted the increase in employment and investment in the tertiary industry, and thus optimized the industrial structure.

TABLE 2. INTERMEDIARY EFFECT ANALYSIS

	（1）	（2）	（3）	（4）
Number_1	-15.303*** （4.041）			
Number_2		-18.681*** （6.000）		

Number_3			10.524** （3.799）	
Asset				4.396*** （1.184）
U_level	68.467** （25.121）	89.943*** （26.290）	5.422 （42.611）	29.143 （32.065）
Im_Ex	0.001 （0.001）	0.0001 （0.0001）	0.001 （0.001）	-0.001 （0.0001）
R-squared	0.936	0.924	0.917	0.936

Note: * *, * respectively, they are significant at the confidence level of 1%, 5% and 10%, and the standard deviation in parentheses is robust.

4.2.3Stability test

To prove the stability of the above results, this paper adopts the method of reconstructing the core explanatory variables to test the stability. In this paper, the number of urban rail transit stations is used to represent the development degree of urban rail transit. After replacing the explanation, the results of the stability test can be viewed in Table 3, the regression coefficients of the models (1), (2), (3), (4), (5) are still significantly positive at the 1% confidence level, that is, the development degree of Beijing Urban Rail Transit significantly promotes the employment and capital investment level of the tertiary industry, and further optimizes the urban industrial structure. Other control variables are basically consistent with the results of basic regression, so the stability test of the results proved to be passed.

TABLE 3. STABILITY TEST

	（1）	（2）	（3）	（4）	（5）
	I_str	*Number_1*	*Number_2*	*Number_3*	*Asset*
Site	0.019*** （0.005）	-0.0515*** （0.011）	-0.107** （0.039）	0.963*** （0.155）	15.719*** （1.333）
U_level	83.907*** （23.049）	-86.584 （54.850）	0.786 （194.716）	3674.245*** （769.751）	25337.46*** （6717.80）
Im_Ex	-0.00005 （0.0001）	0.0003 （0.0003）	0.0004 （0.0009）	-0.002 （0.004）	-0.063* （0.031）
R-squared	0.942	0.857	0.558	0.969	0.980

Note: * *, * respectively, they are significant at the confidence level of 1%, 5% and 10%, and the standard deviation in parentheses is robust.

5 CONCLUSION

During the period of steady economic growth, China is no longer blind pursuit of economic growth, but turned to focus on quality development. At this time, industrial upgrading is particularly important. As an indispensable means of transportation, urban rail transit has become the direction and trend for large cities to solve the problems of space and traffic congestion. But the construction of urban rail transit also has the economic characteristics of huge investment and high operation cost. It is meaningful to explore the social and other indirect effects brought about by rail transit Therefore, Therefore, this article explores whether the

operation of Beijing's urban rail transit will stimulate industrial escalating and explores the influence mechanism.

This paper draws a steady conclusion: the development of urban rail transit significantly promotes the increase of employment and investment in the tertiary industry, and which will help the rapid transformation of the regional industrial structure. As a public transportation mode, urban rail transit not only has the function of helping cities get out of traffic dilemmas such as environmental pollution and congestion, but also greatly shortens the commuting time and improves the spatial accessibility. So that the information, capital and other resources in various regions can flow freely. As a central city, Beijing attracts the inflow of labor and capital elements through higher rate of return on wages and investment. By investing more employment and capital in the tertiary industry, it will help the regional industrial structure.

This article enriches the research on the driving forces that contribute to the industrial upgrading, explores its impact on the upgrading of urban industrial structure by taking urban rail transit as the channel of labor and capital inflow; And it has enriched the research on the social effects brought by rail transit to the city; The article also explored the positive externalities of urban rail transit to industrial upgrading.

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