How High-speed railway Promotes Specialized Division of Labor? --Evidence from the Yangtze River Delta

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Abstract: The paper analyzed the specialization characteristics of cities in the Yangtze River Delta region from 2003 to 2017, and verified the influence of high-speed railway on the level of specialization by using DID method. It is found that: (1) the opening of Shanghai -Nanjing-Hangzhou in 2007 and Shanghai -Nanjing-Hangzhou High-speed Railway in 2011 have obviously promoted the specialization level of knowledge-intensive industries in cities along the Yangtze River Delta; (2)due to the difference in the ability to absorb knowledge, the opening of Shanghai -Nanjing-Hangzhou railway promotes the improvement of the specialization degree of the financial industry, while the improvement of the specialization level of other industries is not obvious

1. Introduction

Some scholars have analyzed the relationship between high-speed railway and accessibility, regional economic development and the upgrading of industrial structure (Su Hua, 2012). Generally speaking, the opening of high-speed railway can improve the accessibility level of the areas along the line, promote the flow of elements in the region, reduce the cost of urban communication, and promote the agglomeration of related industries, especially knowledge-intensive industries, to the cities along the line (Wnag Li,2010). However, the existing research on the manifestations of knowledge-intensive industries in urban agglomeration along the line has not yet been involved (Hong Shi Jian, 2016). According to the interpretation of New Economic Geography, due to some historical contingency factors, a region gains the advantage of scale economy. Driven by scale economy, it will produce accumulation effect through the forward and backward linkages of production, leading to the division of industrial specialization among regions. Transportation infrastructure has a certain impact on the specialization of regional manufacturing industry by adjusting transport costs. However, the opening of high-speed railway mainly reduces the time cost between regions and promotes the free flow of knowledge among regions, rather than the transportation cost of goods. A large amount of empirical evidence also shows that due to the opening of high-speed railway, knowledge-intensive enterprises in non-lined cities gradually migrate to cities along the line.

We can not help but ask whether the high-speed railway promotes knowledge-intensive enterprises to form a specialized division of labor system among cities? Answering this question will help us to further understand the interaction and relation between cities under the background of high-speed railway construction, and also provide some decision-making basis for relevant departments to formulate industrial policies. This paper chooses 26 prefecture cities in Yangtze River Delta from 2003 to 2017 to discuss the relation between high-speed railway and urban specialty through empirical research on the basis of defining the empirical approaches and variables.

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2. Empirical method, model and variables

2.1 Empirical methods and model setting

In terms of empirical method, most scholars studied the impact of transportation infrastructure on specialized division of labor under the framework of new economic geography, emphasized the key role of transportation cost on specialization, and used mileage as an empirical indicator to conduct empirical analysis accordingly.

However, high-speed rail promotes the transfer of knowledge-intensive industries to cities along the line by speeding up knowledge exchange between regions. All such studies are of little significance for reference. Fortunately, DID provides an available method, which can be used to compare the changes of specialization of cities along the line before and after the opening of the high-speed railway vertically ,and also to compare the differences of specialization between cities along the line and those not along the line transversely. If the influence coefficient is significantly positive, it indicates that the high-speed railway can improve the level of specialization and promote the level of specialization of cities along the line.

In this paper, the period from 2003 to 2007 is taken as the unopened period ,while the period from 2008 to 2011 is taken as the opening period of EMU of shanghai-nanjing section of Beijing-shanghai railway and Shanghai-Hangzhou section of shanghai-Kunming railway, and the period from 2012 to 2016 is taken as the opening period of Shanghai-Nanjing intercity high -speed railway and Shanghai-Hangzhou intercity high-speed railway .In addition, for the multiple method, it is not only necessary to distinguish the opening period from the non-opening period, but also to set up the classification of cities along the high-speed railway and non-line cities, that is the experimental group and the control group. According to general practice, Shanghai, Hangzhou and Nanjing are excluded because of their high level of economic development.

However, Nantong, Yangzhou, Taizhou, Ningbo, Huzhou, Shaoxing, Zhoushan and Taizhou are not directly connected to the Shanghai-Nanjing and Shanghai-Hangzhou lines. Considering the close spatial distance between these eight cities and the cities along the railway, they may indirectly benefit from the speed-up of the Shanghai-Nanjing-Hangzhou lines, we also include these cities in the experimental group. For the choice of control group, in order to ensure the accuracy of the multiple difference method, this paper chooses the provinces through which the Shanghai-Nanjing-Hangzhou line passes, and the prefecture-level cities that have not passed as members of the control group. In addition, some prefecture-level cities in eastern Anhui, which are geographically adjacent to each other, are added as members of the control group.

Based on the above analysis, This can be expressed by the following equation

$$\ln RZI_{it} = \alpha_i + \beta du_{it} \times dt_{it} + \varphi \ln X_{it} + t_i + \varepsilon_{it} \tag{1}$$

$$\ln RDI_{it} = \alpha_i + \beta du_{it} \times dt_{it} + \varphi \ln X_{it} + t_i + \varepsilon_{it} \tag{2}$$

The explained variables in Formula (1) and (2) are relative specialization index and relative diversification index, respectively. The explanatory variables include ($du_{it} \times dt_{it}$) of high-speed railway and other variables ($\ln X_{it}$) which affect the upgrading of industrial structure.

2.2 Variable description

2.2.1 Explainatory variables

Urban specialization is measured by the share of a given sector in local employment (Duranton and Puga, 2001). However, specialization in different cities needs to be realized in different sectors. Therefore, to compare the degree of specialization among cities, it is necessary to compare the largest share of employment sectors in each city. We define (S_{ij})as the employment share of sector (j) in city (i),the specialization index for individual cities is

$$ZI_i = \max_j (s_{ij})$$

In order to compare the level of specialization of different cities horizontally, we need to make clear the relative level of specialization (rather than absolute specialization) of different cities. Therefore, the relative specialization index can be defined as:

$$RZI_i = s_{ij} / s_j$$

Where (s_j) is the share of industry (j)in the whole 26 cities.The definition of diversification index generally adopts the reciprocal of Hirschman-Herfindal Index and the diversification index is

$$DI_i = \sum 1 / s_{ij}^2$$

Similarly, in order to compare the levels of diversification in different cities, we define the relative diversification index as

$$RDI_i = 1 / \sum \left| s_{ij} - s_j \right|$$

2.2.2 Core explanatory variable

(1)High speed railway ($du_{it} \times dt_{it}$)The high-speed railway indexs have been elaborated above and are not mentioned here.

(2) Accessibility (Acc).the opening of high-speed railways closes the "spatial distance" between cities, reduces the cost of knowledge exchange, and propels the removal of knowledge-intensive enterprises to cities along high-speed railway. In other words, the relative distance directly determines the travel time between cities. Therefore, in addition to the effect of inter-city traffic conditions on knowledge-intensive enterprise transfer, which affects the level of specialization of cities along the high-speed railway, the spatial distance between cities along the high-speed railway and other cities also affects the level of specialization. This paper uses relative accessibility method to measure

2.2.3 Control variable

(1) Professional talent density (Uis). The comparative advantage is the basis of the formation of regional division of labor and industrial specialization. The difference in the density of professionals among regions constitutes the regional comparative advantage. The index shows the professional talent density by the proportion of information transmission computer services and software industry, financial industry, leasing and commercial services, and scientific research and technology services in the total service industry (Su Hua, 2012)

(2) International trade. International trade factors are negatively correlated with the level of specialization, and the proportion of total imports and exports to GDP represents international trade factors.

(3) Density. There is a positive correlation between urban scale and industrial structure diversification, and the expected sign of the relationship is positive. We use population density to represent city size.

(4) Demand factor (Con). The diversification of consumption preferences can not only foster spatial agglomeration, but also differentiate specialized cities and diversified cities according to the degree of product differences. This trend shows that the higher the income, the higher the degree of industrial diversification. This paper uses GDP per capita to express demand factors.

Table 1. General description of data

variable	observertion	avg	standard deviation	minimun	maximum
lnrzi	390	0.428	0.178	0.177	1.560
lnrdi	390	1.452	0.429	0.398	2.581
Lnrzi_sci	390	-0.548	0.453	-1.909	0.689
Lnrzi_lnlea	390	-0.612	0.700	-3.565	0.906
Lnrzi_lnfin	390	0.00483	0.252	-1.121	0.569
Lnrzi_infor	390	-0.214	0.271	-1.059	0.395
lnacc	390	-3.339	1.248	-6.296	-1.105
lntrade	390	-1.196	0.986	-3.770	1.326
lncon	390	1.058	0.685	-0.620	2.814
lnhc	390	3.360	0.286	2.528	4.203
lndensity	390	-2.797	0.398	-4.239	-1.998

2.3 General description of data

Since the international trade index is measured by US dollar, this paper first adjusts it to RMB price according to the average exchange rate of the year. In order to ensure the consistency of sample data, if not specified, other data in this paper are basically from"China Urban Statistical Yearbook", China Statistical Yearbook and Provincial Statistical Yearbook.

3. Empirical results and their explanations

The empirical equation is estimated by the multiple difference method. The concrete results are shown in Table 3. We can confirm the following points:

3.1 Effects of high-speed railways and relative accessibility on the degree of specialization

From the regression results (1), (2) and (3) in Table 2, we find that the estimation coefficient of railway speed up on the degree of specialization is significantly positive whether or not the control variables is added to. On the contrary, the empirical results (4), (5), (6) are negative and not significant. The empirical results mean that in the whole period from 2007 to 2011 after the opening of EMU ,the specialization degree of cities along the line was significantly higher than that of non-along cities by 2.19 percentage points, and in the whole period from 2012 to 2016 after the opening of high speed railway the specialization degree was even higher by 2.32 percentage points .This fully shows that for the cities along the line, the knowledge-intensive industries in other non-line areas are undertaken through the high-speed railway network, and the benign interaction between cities is formed, so that the level of specialization of the cities along the line can be improved to a certain extent. We focused on the effect of relative accessibility on specialization indexs. Empirical results (1) show that relative accessibility has a significant positive impact on urban specialization, with a coefficient of 0.0229. The empirical results show that with the improvement of accessibility, the small and medium-sized cities in the Yangtze River Delta make use of the advantages of knowledge spillover within the cluster, fully absorb the knowledge spillover generated by large cities such as Shanghai, and accept knowledge-intensive industries transferred by big cities, showing a specialization diversion of labor among cities. For each unit increase in the relative accessibility, the specialization level increases by 0.0229 units. However, after the introduction of control variables, the influence coefficient becomes insignificant, so we need to further investigate the effect of relative accessibility on the level of specialization by industry.

Table 2 Empirical Analysis of the Impact of High-speed Railway on Specialization

	(1)	(2)	(3)	(3)	(4)	(6)
	lnrzi			lnrdi		
	2003-2007	2008-2011	2012-2017	2003-2007	2008-2011	2012-2017
$du_{it} \times dt_{it}$	0.0259*	0.0219*	0.0232*	-0.0778	-0.0474	-0.0633
	(2.43)	(2.34)	(2.44)	(-0.83)	(-0.64)	(-0.71)
lnacc	0.0229**	0.000345	0.000345	-0.0264	-0.0337	-0.0296
	(3.16)	(0.02)	(0.14)	(-0.87)	(-0.65)	(-0.93)
lntrade		-0.0964***	-0.0937***		0.0965**	0.0871**
		(-4.86)	(-5.03)		(3.29)	(3.22)
lnhc		0.154*	0.219*		-0.575***	-0.401**
		(2.23)	(2.7)		(-5.60)	(-3.57)
lndensity		-0.179***	-0.173***		0.167**	0.277***
		(-5.22)	(-5.09)		(3.27)	(5.27)
lncon		-0.112**	-0.191**		0.151**	0.553***
		(-3.06)	(-3.89)		(2.78)	(4.78)
t		-0.0598**	-0.0773**		-0.0886**	-0.0413**
		(-3.05)	(-3.53)		(-3.04)	(-4.11)
_cons	-0.293**	-0.880*	-0.707*	1.163***	0.233	0.815
	(-3.15)	(-2.50)	(-2.31)	(8.09)	(0.45)	(1.45)
R^2	0.15	0.43	0.51	0.33	0.58	0.44
N	234	234	234	234	234	234

The values in parentheses are t values; *,*** and *** are significant in the degree of 10%, 5% and 1% respectively.

From Table 3, we can see that the regression results (high-speed railway and relative accessibility) with 1nrzi_sci,1nrzi_lea,1nrzi_infor as explanatory variables have not passed the significance test, but only the regression results with 1nrzi_ fin as explanatory variable have passed the significance test and the coefficient is positive. It can be seen from this that the opening of high-speed railway only promotes the professionalization of the financial industry.The reason is that there is a big gap in technology between the cities along the high speed railway and big cities such as Shanghai, Hangzhou and Nanjing.

Although various elements can flow freely between the cities along the line, due to the lack of absorptive capacity of knowledge and information, it is impossible to form the location advantage of knowledge-intensive industry development. The opening of high-speed railway and the improvement of relative accessibility can not promote the formation of a specialized division labour system among cities.

Table 3 results of empirical analysis on the influence of high-speed railway on specialization level in different industries

	(1)	(2)	(3)	(4)
	Lnrzi_infor	Lnrzi_lea	Lnrzi_sci	Lnrzi_fin
$du_{it} \times dt_{it}$	0.0136	0.0381	0.173	0.0446**
	(0.23)	(0.26)	(1.79)	(2.78)
lnacc	0.0338	0.0341	0.0680	0.111**
	(-0.81)	(0.34)	(-1.02)	(2.81)
lntrade	0.0466	-0.307***	-0.0192	0.0829***
	(1.97)	(-5.31)	(-0.50)	(3.68)
lnhc	0.223**	0.491*	1.059***	0.0832
	(2.69)	(2.43)	(7.94)	(1.06)
lndensity	-0.225***	-0.437***	-0.128	-0.222***
	(-5.47)	(-4.35)	(1.93)	(-5.66)
lncon	-0.00894	-0.391***	-0.215**	-0.0216
	(-0.20)	(-3.65)	(-3.05)	(-0.52)
t	-0.0248	-0.0989	-0.0643	-0.0725**
	(-1.06)	(-1.73)	(-1.70)	(-3.24)
_cons	-1.576***	0.221	-3.600***	0.386
	(-3.76)	(0.22)	(-5.32)	(0.97)
R^2	0.32	0.39	0.37	0.29
N	234	234	234	234

The values in parentheses are t values; *,*** and *** are significant in the degree of 10%, 5% and 1% respectively.

3.2 The influence of other factors on the degree of specialization

This paper also examines the impact of other factors on specialization. The influence coefficient of international trade is negative, which is correspond with the proposition that international trade is negatively correlated with specialization. It shows that the economic growth mode characterized by "international subcontracting" is relatively large in market size, but most of the local enterprises are concentrated in the low-end links of the global value chain, the technology level is generally low, and the added value of products is relatively small. Because of the lack of high-end design and R&D capabilities, cities can not form a complete industrial chain, and can not subdivide the corresponding knowledge-intensive service industry. This competition mode directly leads to the isomorphism of regional industries. The level of specialization in the city is relatively low.

The estimated coefficient of professional talent density index is positive, which is correspond with the research results of Suhua (2012). The increase in the proportion of professionals shows that the developed labor market and abundant supply of intermediate products are closely related and cooperated with manufacturers or employees, which means that the region has more comparative advantages in developing knowledge-intensive services and is conducive to the centralized distribution and specialized production of manufacturers in the same region, and the city reflects the characteristics of specialized industrial structure.

4. Conclusion

Using panel data of 26 cities in the Yangtze River Delta from 2003 to 2017, this paper makes an empirical analysis to explore the effect of high-speed railway and other control variables on specialization.

The empirical results show that the opening of Shanghai-Nanjing-Hangzhou EMU in 2007 and Shanghai-Nanjing-Hangzhou High-speed Railway in 2017 have obvious promotion effect on the level of specialization of cities along the line, which shows that the opening of high-speed railway has obvious promotion effect on the level of specialization of cities along the line. We will promote the comparative advantages of knowledge-intensive industries in cities along the route and promote the formation of a specialized division of labor system among cities. In addition, this paper also examines the impact of high-speed railway on the level of specialization by industry demonstration. Empirical results show that the opening of Shanghai-Nanjing-Hangzhou Railway EMU only promotes the improvement of the specialization level of financial industry, while the improvement of the specialization level of other industries is not obvious. The main reason is that there are some differences in the spillover knowledge absorption capacity of different industries in Shanghai and other big cities, so the impact of knowledge spillover on the surrounding cities in Shanghai and other big cities is different. Same.

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