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Analysis of the influence on regional economic development of high-speed railway

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ABSTRACT

High-speed railway has made a deep impact on the regional economy for developed countries. In recent years, high-speed rail has brought great effect on stimulating China's economic and social development. The current research on high-speed rail mostly exists in theory, and lack of quantitative research using the precise algorithm to study the effect of high-speed railway on regional economy. This paper firstly analyzes the influence mechanism of high-speed rail. In addition, quantitative analysis in this paper, it uses the panel data model to calculate the economic influence of high-speed rail by taking the Wuhan-Guangzhou high-speed railway as an example, and adopting comparative analysis to analysis the influence on regional economic development before and after the operation of Wuhan-Guangzhou high-speed railway. The result shows that high-speed railway effects regional economy though economic growth, industrial structure and cities' spatial structure optimization and improvement of regional cooperation. Besides, economic effects of high-speed railway are different in regions with different scales and develop stages, which may increase the gaps between big cities and small cities.

Key words: High-speed railway; regional economy; influence mechanism

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INTRODUCTION

As a new mode of transport in some developed countries, the development of high-speed railway has brought about profound influence on social and economic development of the regions along the high-speed rail. Especially after the completion of high-speed rail network, the efficiency of communication among the areas will be further improved, and the diffusion of regional social and economic benefits will be more exertion by this traffic network[1].In addition, high-speed railway is one kind of "green" traffic tool, which has the advantages of low cost, low energy consumption and less environmental pollution. The carbon dioxide emissions per kilometer of railwayare just 1/3 and 1/6-1/20 to those of aircraft and automobile respectively. Moreover, costs of railway, aviation and highway caused by traffic accidents and environment pollution is respectively 1.9%, 6.1% and 91.5%[2], while the running of high-speed rail produces almost no pollution. In order to achieve the goal of energy saving and emission reduction, the development of high-speed railway is undoubtedly the best choice.

The successful experience of some developed countries has verified the effect of high speed railway on promoting the regional economic development, this dynamic mechanism of high-speed rail is also confirmed in the regions along the railway in the current China which is in the middle stage of industrialization. The transportation is critical infrastructure which deeply influences the level and quality of the national economy and society. The high-speed rail industry plays a very important role that constructing the modern traffic artery, accelerating the industrialization and urbanization, realizing the efficient of capital flow, information flow and technology flow among regions, as well as promoting the transformation of China's economic development mode[3].

The relationship between transportation and regional economic development is one of the key concerned problems of geography of transportation. In general, the scholars' researches on high-speed railway began in the aspect of engineering scheme and the technical problems of high-speed railway project. With the advent of high-speed rail's economic effect and the development of metropolitan areas, the regional economics researches of high-speed rail started occurrence [4]. At present, the focus of economic geographic researchers' attention on the relations between high-speed railway and region are mainly the following aspects:①The effect in multidimensional spatial scales such as the layout of the railway station, land use around high-speed rail station ,effect of high-speed rail on urban area, national spatial equity and efficiency in high-speed rail era, Influence of transnational high-speed rail on border and geo economic area[5-7], etc.;②Economic sectors under the influence of high-speed rail. For example, Knox studied the effect of high-speed rail on information sector [8]. Bellet thinks that the development of high-speed rail will promote the tertiary industry and the "new economy" characterized by knowledge economy[9].Masson andPetiot points out that the relationship between the high-speed rail and the development of tourism in the city[10];③The relationship between high-speed rail and other traffic modes. For instance,Garmendia takes the comparison of effects between high-speed railway and highway[11]. Wang uses the GIS spatial analysis technology to researchthe service markets of airport and high-speed rail station to prove that with the market spatial overlay scope of high-speed rail and civil aviation is bigger and bigger, the city group area, metropolitan area and "economic corridor" will become the main focuses of market competition[12]. Overall, certain achievements have been made in research of the effect from high-speed railway on the regional economy. However, most of them are qualitative researches, especially in China, most studies focuses on the industrial structure, regional accessibility, factor mobility and regional spatial structure, and lack of the analysis on the regional economic benefit and influence mechanism of high-speed railway.

China is in a period of deepening adjustment, and the development of high-speed rail has become a national strategy of China, which deeply relates the state investment, consumption and export by influencing the spatial distribution of production and consumption, so it has important significance by using quantitative and qualitative methods of science to study the regional economic effects of the high-speed rail. In this paper, we analyze high-speed railway's influence on the regional economy, and try to make clear the impact mechanism, in order to reveal the influence path and effect of high-speed railway on the regional economy.

DEVELOPMENT OF HIGH-SPEED RAILWAY IN THE WORLD AND CHINA

The development of transport modes can be understood as the continuous changing of the various modes of transportation's speed to some extent. From the waterways, and the carriage to the industrial revolution when the railway, aviationand highway began to appear, various modes of transportation are looking for their breakthrough to better meet the demand of transportation market.

The railway transportation was produced in 19th century, and widely used in the early part of the twentieth century due to the characteristics of long distance, large volume and low price. However, in the mid-20th century, with the emergence of new traffic tools, the traditional railway gradually lost its advantage in the transport market under the competition of aviation and highway, and became a sunset industry in some developed countries, such as American. Until 1964, Japan's Shinkansen was constructed as the first successful commercialization high-speed rail in the world, which made the development of railway transport achieve a historic breakthrough, and subvert the traditional concept of railway[13]. The obvious technical and economic advantages of high-speed railway well filled the gaps between the original modes of transportation. It adapts to the need of economic development in modern society, and wins market recognition quickly. The great success of Japanese Shinkansen led to the development of high-speed railway in the whole world. Developed countries such as Germany, France, Italy, Spain, Sweden, South Koreaetc.have established their own system of high-speed railwaywhich is providing new impetus to the development of the countries' economy and society.

In China, high-speed railway means transformation of the existing railway to reach the speed of 200 km/h, or establishment of new railway which can achieve 250km/h. The construction of high-speed railway in Chinacalled Qinhuangdao-Shenyang railway began in 1999 and completed in 2003. After 15 years of new high-speed railway construction and the reconstruction of existing railway, China's construction of high-speed railway has made significant achievements. At present, China has the world's largest scale of the high-speed railway network. The operating mileage of high-speed railway in China accounted for almost half of the world's, and ranked the world top steadily.

Tab.1: China's high-speed railways and brief introductions

Name of line	Length (Km）	Speed design （km/h）	Opening date （month/day year/）	Belongs to which part of China's high-speed rail system planned
Qinhuangdao-Shenyang railway	405	250	10/12/2003	Beijing-Harbinpassenger line
Hefei-Nanjing railway	156	250	04/18/2008	Shanghai-Wuhan-Chongqing passenger line
Jiaozhou-Jinan railway	364	250	12/20/2008	Qingdao-Taiyuan passenger line
Shijiazhuang-Taiyuan railway	225	250	04/01/2009	Qingdao-Taiyuan passenger line
Hefei-Wuhan railway	351	250	04/01/2009	Shanghai-Wuhan-Chongqing passenger line
Dazhou-Chengdu railway	386	200	07/07/2009	Shanghai-Wuhan-Chongqing passenger line
Wenzhou-Fuzhou railway	294	250	09/28/2009	Hangzhou-Fuzhou-Shenzhen passenger line
Ningbo-Taizhou-Wenzhou railway	268	250	09/28/2009	Hangzhou-Fuzhou-Shenzhen passenger line
Wuhan-Guangzhou railway	968	350	12/26/2009	Beijing-Hongkong passenger line
Zhengzhou-Xian railway	455	350	02/06/2010	Xuzhou-Lanzhou passenger line
Fuzhou-Xiamen railway	276	250	04/26/2010	Hangzhou-Fuzhou-Shenzhen passenger line
Shanghai-Hangzhou railway	158	350	10/26/2010	Shanghai-Kunming passenger line
Yichang-Wanzhou railway	377	175	12/22/2010	Shanghai-Wuhan-Chongqing passenger line
Beijing-Shanghai railway	1318	350	6/30/2011	Beijing-Shanghai passenger line
Guangzhou-Shenzhen railway	116	350	12/26/2011	Beijing-Hongkong passenger line
Wuhan-Yichang railway	293	200	7/01/2012	Shanghai-Wuhan-Chongqing passenger line
Hefei-Bengbu railway	131	300	10/16/2012	Beijing-Fuzhou passenger line
Harbin-Dalian railway	904	350	12/01/2012	Beijing-Harbin passenger line
Shijiazhuang-Wuhan railway	838	350	12/26/2012	Beijing-Hongkong passenger line
Beijing-Shijiazhuang railway	281	350	12/26/2012	Beijing-Hongkong passenger line
Suining-Chongqing railway	132	200	12/30/2012	Shanghai-Wuhan-Chongqing passenger line
Hangzhou-Ningbo railway	150	350	7/1/2013	Hangzhou-Fuzhou-Shenzhen passenger line
Panjin-Haicheng railway	90	350	9/12/2013	Beijing-Harbin passenger line
Tianjin-Qinhuangdao railway	261	350	12/1/2013/	Beijing-Harbin passenger line
Chongqing-Lichuanrailway	264	200	12/28/2013	Shanghai-Wuhan-Chongqing passenger line
Xian-Baoji railway	148	350	12/28/2013	Xuzhou-Lanzhou passenger line
Xiamen-Shenzhen railway	502	250	12/28/2013	Hangzhou-Fuzhou-Shenzhen passenger line

Below is an abbreviated drawing of the overall existing railway in China (include high-speed rail). Besides, China has a long-term plan formulated in 2008 that the development of its high-speed railway will take a "four vertical and four horizontal part" of the high-speed railway network pattern as the focus of the main skeleton, and by 2020, China's total railway mileage will reach 120000 km,inwhich the new-built high-speed railway will reach 16,000 kilometers[14]. Along with the other new high-speed railway and the existing railway line, China's high-speed rail network will reach more than 50,000 kilometers, connecting all provincial capital cities and other cities with more than 500,000 populations, and covering more than 90% of the national population.

Fig.1: The Existing system of railway in China

THE INFLUENCES MECHANISM OF HIGH-SPEED RAIL ON REGIONAL ECONOMY

High-speed rail enhances the accessibility of regions

High-speed rail closely connects central cities in the country. Besides, it is much faster than the traditional train, and the departure interval is smaller (10 to 20 minutes average in China).As a result, high-speed rail has greatly enhanced the accessibility of the regions. The basic pattern of regional accessibility still depends on the geographical position, but high-speed rail will generally improve the accessibility of each area and its outer zone. In addition, high-speed railway has changed the economic geography location of regions, and improved the regional advantage. Especially high-speed rail network has made each dispersed transit sites into a whole one, which are further strengthening the advantage of regional location, and producing greater economic benefits[15].

High-speed rail promotes optimization of regional industrial structure

With the development of high-speed railway, the influence on the regional industry is gradually increasing. As a new efficient transportation, high-speed rail plays an irreplaceable role in manufacturing industry, high-tech industry and tertiary industry. It is an important cause for the optimization of regional industrial structure. The mechanism of high-speed rail on the industrial structure is shown as Figure 2.

The effects of transportation on the manufacturing layout is far more than other industries, especially for chemical, building materials, paper, food, iron and steel industry which needs to consume a large amount of raw material and fuel in the production process. The rapid development of high-speed rail transport technology in terms of speed and efficiency, relatively short the space distance, and broke through the limitation of transport. As a result, the flexibility of manufacturing layout has greatly improved.

In the era of knowledge economy, science and technology talents, information, as well as infrastructure are prerequisite for the layout of technology intensive industry. These factors are closely related with transport capacity. However, the barriers due to the factors of geography, history and concept still exist which limit the market mechanism, and hinder the development of regional high technology industry. The development of high-speed rail greatly inhibits these constraints, and promotes the flexibility of high technology industrial layout.

The development of tertiary industry and transportation are closely related. High-speed rail enhances efficiency and diversification of regional land use. With the land development of high-speed rail hub area tends to be steady and service facilities increasingly mature, the new commercial forms and service center gradually will come into being, which will undertake a large number of population and demand for service sector.

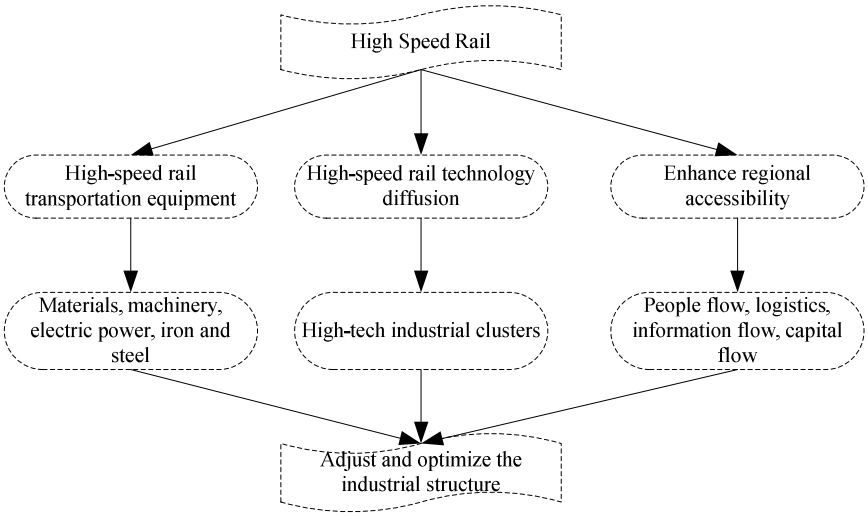

Fig.2:Influence mechanism of high-speed rail on the industrial structure

High-speed rail changes regional spatial structure

High-speed railway speeds up the circulation of space elements of modern tertiary industry, expands the spatial differentiation of concentration and dispersion of production elements, and thus promotes different forms of the spatial organization.

The influence of high-speed railon regional spatial structure is mainly manifested in two aspects: one is the construction of the high-speed rail improves the location condition of the city group or economic area, which can provides those areas with the siphon effect on its surrounding area. The economic growth rate in those areas will be higher than other areas, and eventually the economic belt formed; The other one is division of labor and cooperation appears obviously in the regions along the high-speed rail, which makes agriculture, industry and tertiary industry in the regions appear similar to some degree in the aspects of industry type configuration, product features and product growth cycle and other aspects of the comprehensive traffic economic belt. That is to say the consistency will be established in the comprehensive traffic-economic belt.

The procedure of high-speed rail's influence on regional spatial structure can be divided into three stages: first, modern tertiary industry gathers fast, and produces space polarization effect among regions; Second, with the guidance of tertiary industry, the agglomeration and dispersion of the core production elements of industry and agriculture begin to intensify, which leads to the change of the whole industry structure; Third, the different forms of spatial organization are formed, which has two characteristics: one is the polarization of economic resources, the other one is the consistency of economic activities.

High-speed rail closes regional economic relations

The interdependence among different regions is boosting the formation of mutual promotion and restriction of economic relations among regions. Whether the Regional economy can achieve sustainable development depends largely on regional economic relationship.

Regional economic relations, including the regional accessibility, regional factors flow and regional trade etc., are in the performance of regional trades to a great extent. Regional trade is restricted by traffic freight volume, transport costs and time. When the economy develops to a certain extent, demand for commodities is increasing, but because of the restriction of traffic conditions, regional trade always can't be achieved smoothly. High-speed railway can provide powerful transport capacity which can meet the increasing needs of transportation scale. High-speed railway is alleviating the tense situation of transportation. Those perishable and large-size products can be quickly and easily delivered through the high-speed railway network now. At the same time, compared to the air transport, high-speed railway cost smaller, which can attract more businesses and individuals to take use of cargo transport service of high-speed railway, expanding regional trade scale. As a result, the frequency and scale of regional trade are extended greatly. The influence mechanism of high-speed rail on the regional trade is as shown in Figure 3.

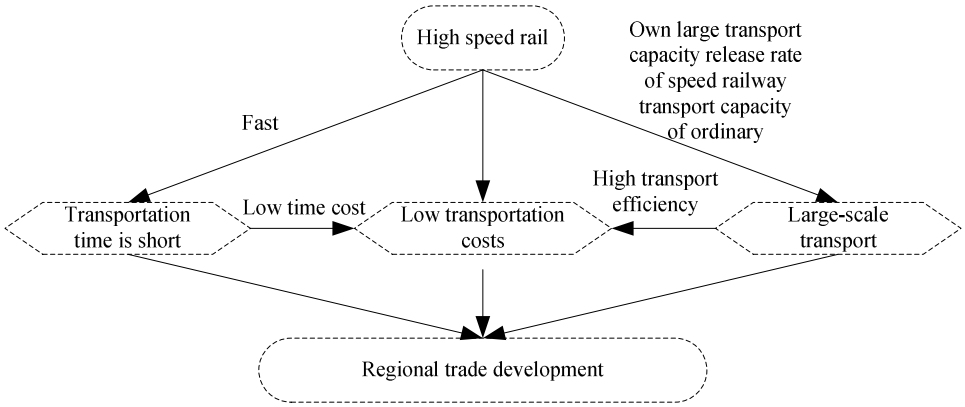

Fig.3:Influence mechanism of high-speed rail on the regional trade

IMPACT OF WUHAN-GUANGZHOU HIGH-SPEED RAILWAY ON REGIONAL ECONOMY

Research object and data sources

The Wuhan-Guangzhou high-speed railwayopened in 2009passes through three provinces of Hubei, Hunan and Guangdong in China. The total length is about 1068.8 km, and the investment of this project is 116.6 billion RMB. Wuhan-Guangzhou high-speed railway originates at Wuhan station, then via Xianning, Chibi, Yueyang, Changsha, Zhuzhou, Hengyang, Leiyang, Chenzhou, Lechang, Shaoguan,Yingde, Qingyuan and Huadu,and arrives at Guangzhou South Railway Station in the end, whichcrosses10 prefecture level cities includes three provincial capital cities(Wuhan, Changsha and Guangzhou).The Design speed of this railway is 300 km/ h. This paper takes the above 10 regions as the main research areasto research the economic changes before and after the Wuhan-Guangzhou high-speed rail. The main source of data roots in in *"China City Statistical Yearbook"* and statistical yearbook of each city in recent 11 years (2002-2012. Authoritative data of 2013 has not been released for now).

Research method

Panel Data is a means to intercept a plurality of sections from the time sequence, and bring the cross-sectional data and time series data together. The panel both has the advantages of cross-sectional data model and time series model. General model of panel data:

Denote the thei-th data of the cross section:

$$\mathrm{y}_i = \begin{Bmatrix} y_{i1} \\ y_{i2} \\ \vdots \\ y_{iT} \end{Bmatrix}, \quad X_i = \begin{Bmatrix} x^1_{i1} & x^2_{i1} \cdots x^K_{i1} \\ x^2_{i2} & x^2_{i2} \cdots x^K_{i2} \\ \vdots & \vdots \quad \vdots \\ x^1_{iT} & x^2_{iT} \cdots x^K_{iT} \end{Bmatrix}, \quad \mu_i = \begin{Bmatrix} \mu_{i1} \\ \mu_{i2} \\ \vdots \\ \mu_{iT} \end{Bmatrix} \tag{1}$$

$\mu$is a random error term corresponding to cross-section i and the time t.Next,

$$\mathrm{y} = \begin{Bmatrix} y_1 \\ y_2 \\ \vdots \\ y_T \end{Bmatrix}, \quad X = \begin{Bmatrix} x_1 \\ x_2 \\ \vdots \\ x_N \end{Bmatrix}, \quad \mu = \begin{Bmatrix} \mu_1 \\ \mu_2 \\ \vdots \\ \mu_T \end{Bmatrix}, \quad \beta = \begin{Bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_T \end{Bmatrix} \tag{2}$$

Therefore, the model expressed in the form of a matrix panel data is:

$$y = X\beta + \mu \tag{3}$$

This is a basic panel data model, and a variety of different panel data models can be derived from different assumptions on β and μ. As the panel data contains cross-sectional data, in order to analyze the special effect of each individual may exist, we make the following assumptions:

$$\mu_{it} = a_i + \varepsilon_{it} \tag{4}$$

Among them, $\alpha_i$is the representatives of the special effects of the individual, which reflects the difference between different individuals. The two most common panel data model is built based on different assumptions aboutα_i: One

hypothesis makes$\alpha_i$to be a fixed constant, this model is called fixed effects model; The other one supposeα_i is random, and this model is called a random effects model.

Calculation process and results analyzing

Model establishment and test

Using the panel data and introducing virtual variable D to establish the panel data model. Among them, the explanatory variables are passenger volume (PV) and freight volume (FV), and the explained variables are regional gross domestic product (GDP) and the proportion of the third industry (PTI). The regression equations are as follows:

$$GDP_{it} = \beta_0 + \beta_1 PV_{it} + \beta_2 FV_{it} + \beta_3 D_{it} + \varepsilon_{it} \quad (5)$$

$$PTI_{it} = \beta_0 + \beta_1 PV_{it} + \beta_2 FV_{it} + \beta_3 D_{it} + \varepsilon_{it} \quad (6)$$

Fig.4: Test results of formula (1)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	15842.75	3241.574	3.124785	0.0005
PV	26.5874	1.583101	9.273287	0.0000
FV	-3.41783	1.642175	-3.715745	0.0001
D	21578.54	2971.156	3.692418	0.0000
Random Effects(Cross)				
Wuhan	6215.457			
Xianning	-2657.154			
Yueyang	-2548.784			
Changsha	4345.681			
Zhuzhou	-2257.824			
Hengyang	-3571.854			
Chenzhou	-3026.512			
Shaoguan	-2568.478			
Qingyuan	-1935.715			
Guangzhou	2257.632			
		Effects Specification		
			S.D.	Rho
Cross-section random			6320.573	0.3142
Idiosyncratic random			8752.368	0.7982
D				
		Weighted Statistics		
R-squared	0.905721	*Mean dependent var*		162157.02
Adjusted R-squared	0.887981	*S.D. dependent var*		20472.57
S.E. of regression	8326.158	*Sum squared resid*		3566871251
F-statistic	96.27826	*Durbin-Watson stat*		0.498213
Prob(F-statistic)	0.000000			
		Unweighted Statistics		

The regression equations are:

$$GDP(Wuhan)_{it} = 15842.75 + 6215.457 + 26.5874\ PV_{it} - 3.41783\ FV_{it} + 21578.54\ D_{it} \quad (7)$$

$$GDP(Xianning)_{it} = 15842.75 - 2657.154 + 26.5874\ PV_{it} - 3.41783\ FV_{it} + 21578.54\ D_{it} \quad (8)$$

$$GDP(Yueyang)_{it} = 15842.75 - 2548.784 + 26.5874\ PV_{it} - 3.41783\ FV_{it} + 21578.54\ D_{it} \quad (9)$$

$$GDP(Changsha)_{it} = 15842.75 + 4345.681 + 26.5874\ PV_{it} - 3.41783\ FV_{it} + 21578.54\ D_{it} \quad (10)$$

$$GDP(Zhuzhou)_{it} = 15842.75 - 2257.824 + 26.5874\ PV_{it} - 3.41783\ FV_{it} + 21578.54\ D_{it} \quad (11)$$

$$GDP(Hengyang)_{it} = 15842.75 - 3571.854 + 26.5874\ PV_{it} - 3.41783\ FV_{it} + 21578.54\ D_{it} \quad (12)$$

$GDP(Chenzhou)_{it}=15842.75-3026.512+26.5874\ PV_{it}-3.41783\ FV_{it}+21578.54\ D_{it}$ (13)

$GDP(Shaoguan)_{it}=15842.75-2568.478+26.5874\ PV_{it}-3.41783\ FV_{it}+21578.54\ D_{it}$ (14)

$GDP(Qingyuan)_{it}=15842.75-1935.715+26.5874\ PV_{it}-3.41783\ FV_{it}+21578.54\ D_{it}$ (15)

$GDP(Guangzhou)_{it}=15842.752257.632+26.5874\ PV_{it}-3.41783\ FV_{it}+21578.54\ D_{it}$ (16)

Fig.5: Test Results of Formula (2)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	0.0.385417	0.011322	29.57824	0.0001
PV	0.0000698	0.000000803	9.527683	0.0000
FV	-0.0000429	0.000000632	-0.300578	0.4628
D	-0.080538	0.027635	-2.974251	0.0025
R-squared	0.924723	Mean dependent var		0.573684
Adjusted R-squared	0.925843	S.D. dependent var		0.301745
S.E. of regression	0.058912	Durbin-Watson stat		0.257721
Sum squared resid	0.389751			
Log likelihood	60.71893			
F-statistic	105.3125			
Prob(F-statistic)	0.000000			

The regression equation is as follow:

$PTI_{it}=0.385417+0.0000698PV_{it}-0.0000429FV_{it}-0.080538D_{it}$ (17)

From the regression results in Figure4 and Figure 5, the overall goodness of fit of the model are both reach to 90%,indicating that it is reasonable to build the model. The dummy variable P is significant below the 1% level, suggesting the role for dummy variables in the model is obvious. The operation of Wuhan-Guangzhou high-speed rail influences the economic growth and industrial structure of the regions along the railway.

As seen from Figure4, the impact strengths are different in regions with different scales and develop stages. From the intercept term of the regression equations, effects of the high-speed rail on three provincial capital cities (Wuhan, Changsha and Guangzhou) are the largest,inwhich the most obvious one is Wuhan, and followed by Changsha and Guangzhou. This is because Wuhan is one of the largest transportation hubs in China, and its geographical location is as Chicago in US. However, the development of this city is relatively slow in recent years due to the drop of city status in the national strategy and the competition among Chinese metropolis. The operation of Wuhan-Guangzhou high-speed rail greatly improves the geographical advantagesof Wuhan, promotes its economic exchanges and cooperation with other areas along the railway, attracts the layout of enterprises in this city, and enhances the regional comprehensive competitiveness. So is the Changsha city, whose scale is relatively smaller than Wuhan, but also is an important transportation and shipping center in south area. In contrast, Guangzhou is one of the most developed center city in China which has relatively perfect transport facilities, and the economic and social development there is mature. As a result, the pulling effect of Wuhan-Guangzhou high-speed rail on Guangzhou is not as obvious as those on Wuhan and Changsha. The other 7 cities are small and medium-sized cities in China, and the effects on their economic growths from Wuhan-Guangzhou high-speed rail has the features of both polarization and discrete. High-speed railway connects the small and medium-sized cities with big cities, and the former's traffic condition is obviously improved, which makes the producers are more accessible to the consumer markets in the small and medium-sized cities. However, the big city has more advantages of products. The result of the competition is the markets of small and medium-sized cities expand much more slowly, while a large number of economic resources there have been absorbed into the big cities, which makes the influences on the small and medium-sized cities are far less than those on the big cities. After Japan's Shinkansen operated, economic growth and population growth in lots of small cities obviously lag behind the Metropolis such as Tokyo, indicating that the high-speed railway may cause "hijacking" to the development of small and medium-sized cities[16].

Regional economic effects of the Wuhan-Guangzhou high-speed railway

The economic growth of regions along the railway

In order to obtain a better display effect due to the huge differences of economic volume among regions, we makes two figures respectively to display related data of big cities and small cities. As can be seen from Figure 6 and Figure 7, the GDPs of the areas along the Wuhan-Guangzhou high-speed railway maintain a high growth in recent 11 years, and after the operation of this railway, the development of regional economy is faster. In addition, there are imbalances among regions with different scales and develop stages. It can be seen clearly through the statistical data that economic growth amounts in almost all the cities are growing significantly after the year of 2009, which has proved our above analysis. Economic growths in big cities (Wuhan, Changsha and Guangzhou) are higher than those in small and medium-sized cities, and thus widening development gap between different scale regions. Besides, economic growths in small and medium-sized cities are not balanced due to thegeographical position, natural resources and historical context.

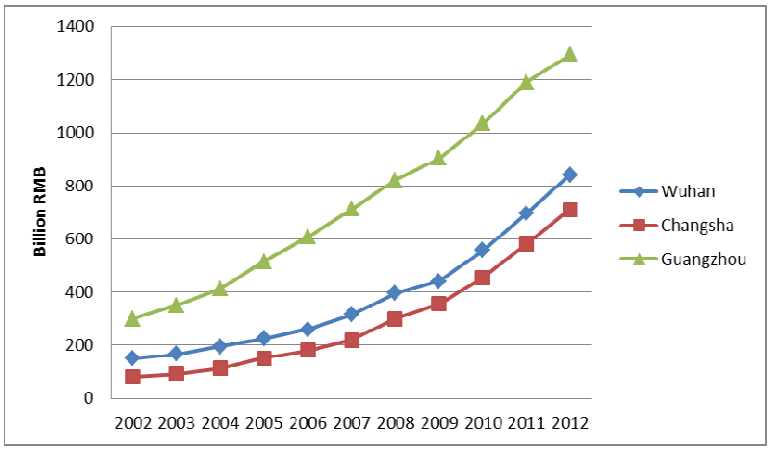

Fig.6: GDP growths of big cities in 2002-2012

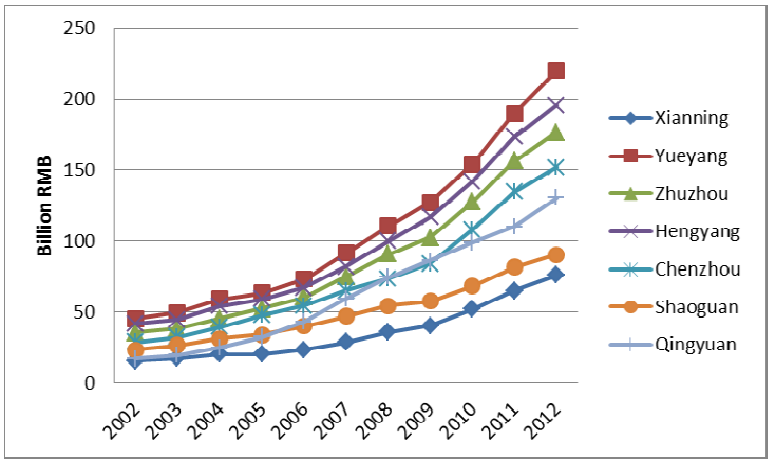

Fig.7: GDP growths of small and medium-sized citiesin 2002-2012

The industrial structure of regions along the railway

The impact of high-speed railway on the manufacturing sector is the most obvious in the industrial structure through the rapid transport of the means of production[17]. At the same time, the aggregation of industry and population will bring about the development of serviceindustry. Here we mainly analyze the development situation in various regions of the industrialization and the tertiary industry, so as to make clear the impacts of high-speed rail on regional industrial structure.

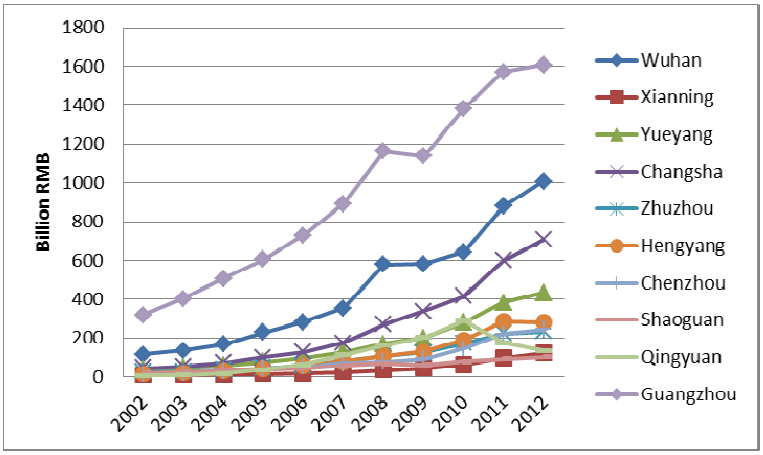

Fig.8: Industrial value of gross output of eachcity in 2002-2012

As seen from Figure 8, Wuhan-Guangzhou high-speed rail has increased the level of regional industrialization significantly in big cities, which shows the important role of traffic condition to the development of industry. Although this kind of phenomenon can be seen from other cities, its influence strength is much weaker. The value in Qingyuan even appeared negative growth in 2010-2012.It shows clearly that high-speed rail will not only improve regional accessibility, butalso increases the possibility of the loss of production factors, especially in the small cities.

As to the tertiary industry, the effect of high-speed rail is not significant, and only the Guangzhou city is keeping the growing state after the year of 2009.All of other cities including Wuhan and Changsha present the volatility of tertiary industry. We consider the reason are as follows: on the one hand, effect of high-speed rail on regional service sector lags behind that of the industry, and the role of Wuhan-Guangzhou high-speed rail, opened in 12/26/2009, has not yet been fully play; On the other hand, the optimization of industrial structure is a long-term process, which is under the deep influence of urban development phase. Atpresent, most of regions along Wuhan-Guangzhou high-speed rail are in the early and middle stage of industrialization, and fluctuation in the growth of tertiary industry is in accordance with the development of cities in this stage.

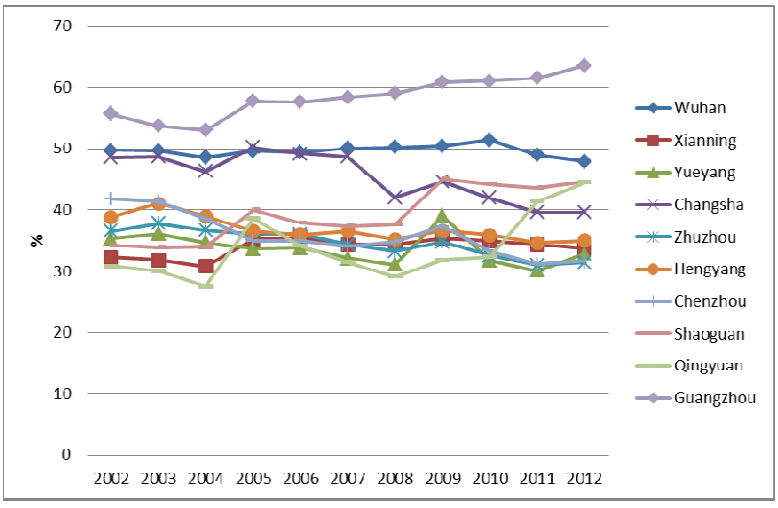

Fig.9: Proportion of tertiary industry ofeach city in 2002-2012

The regional trade of regions along the railway

High-speed rail improves the regional accessibility, promotes the flow of resources and factors, and expands the cities' production and service radius resulting in the significant increase of regional trade[18]. As shown in Figure 10 and Figure 11,although the growth rates are different in cities with different scales, the levels of foreign trades in all the cities have improved greatly by the influence of Wuhan-Guangzhou high-speed rail in 2009-2012,which presents the important role of traffic condition to exchanges and cooperation among regions.

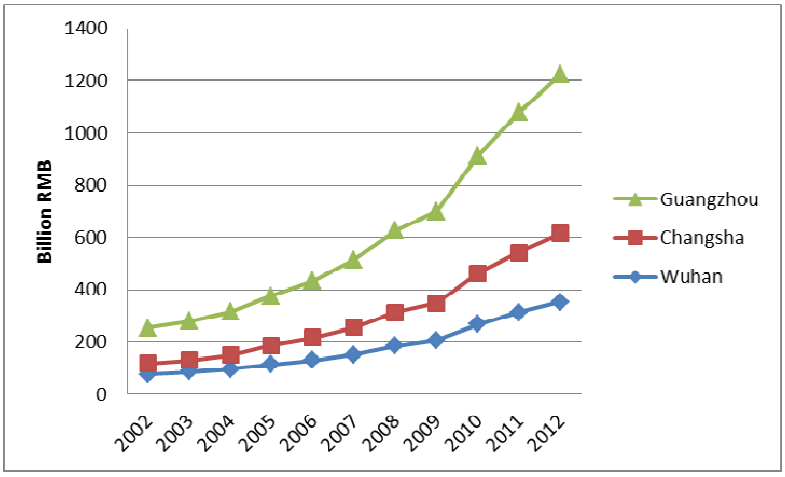

Fig.10: Value of foreign trades of big cities in 2002-2012

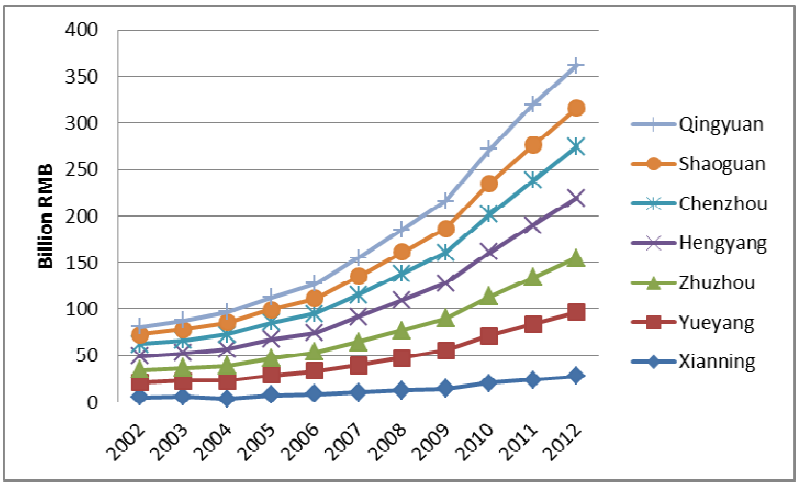

Fig.11: Value of foreign trades of small and medium-sized citiesin 2002-2012

CONCLUSION

High-speed railway improves the regional traffic conditions, changes the geographical locations, and accelerates the flow rate of elements, thus affects the regional economic development and economic relations. It is very meaningful for these aspects of the researches, especially in developing countries and areaswhich urgently need to stimulate the economy with the improvement of traffic conditions.

Regional economic development includes economic growth, industrial structure and cities'spatial structure optimization and improvement of regional cooperation, and the influence mechanism of high-speed rail on the regional economy is taking action through these aspects. The case study indicates that Wuhan-Guangzhou high-speed railway has significantly improved the rate of economic growth and level of foreign trade in each city.

Economic effects of high-speed railway are different in regions with different scales and develop stages. In the aspect of industrial structure, the effect has shown its dual character: high-speed rail promotes the regional industrialization process,meanwhile,it makes strong siphon effect on the small and medium-sized cities such as Qingyuan,which may increase the gaps between big cities and small cities.

Although we have made great progress in improving the traffic conditions, the time between appearance of high-speed rail and present is just 50 years, which is much shorter in developing countries, for instance China, so we still need the theory and practice experience to further optimize our traffic network,inwhich the theory research is urgently needed. The fully play of the role of high-speed rail need quite a long term, and this is the reason why the railway's effect on regional tertiary industry is not obvious in the cities for now. However, this paper only uses data in recent 11 years to analyze the issue of high-speed rail in China, which weaks the persuasiveness of the article. As a result, for the subsequent dynamic development process, we need to further our attentions and researches.

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