Analysis of the Contribution of China's Transportation Infrastructure Investment to Output under the Background of Global Value Chain

Leimei Ding

School of Economics, Shanghai University, No. 20, Chengzhong Road, Jiading District, Shanghai City, P.R.China 201800

Email: dingleimei@163.com

Keywords: Transportation infrastructure investment; Output; Spatial durbin model; Spillover effects

Abstract. Based on the data of investment and the gross output of transportation infrastructure of 31 provinces and cities in China in 1998-2017, the empirical analysis of the spatial durbin model shows that the transportation infrastructure investment of our provinces has multiplier effect and spatial spillover effect on output. Transportation infrastructure investment as a kind of government expenditure will have a positive multiplier effect on economic growth. At the same time, the increase of transportation infrastructure investment will make transportation developed, resulting in the flow of production factors to transportation developed areas. It will have a negative effect on the economy of other areas.

1. Background

In recent years, more and more researches on the global value chain. Because of reform and opening up, china has made remarkable achievements in economic growth in the past 40 years. It has made China the primary object of studying economic issues. To study China's position in the global value chain, we should also pay attention to the internal reasons for economic growth. The market-oriented reform has brought new problems to our economic growth. One of the prominent problems is the widening gap in regional development. By the end of 1990s, China had formed three distinct economic zones: the east, the middle and the west. The East was rich, the middle was second, and the West was poor. This enlarged the gap of regional economic growth which has brought challenges to the coordinated development of regional economy. The economic growth rate of the eastern coastal areas is higher than that of the inland areas is one of the important factors of unbalanced economic development. In 2017, the province with the largest investment in fixed assets was Shandong, which was 5 trillion and 520 billion 270 million yuan, about 30 times that of Xizang, 15 times that of Ningxia, and 1 times of that of Jiangsu. It can be seen that there have a great gap in the level of economic development among the province in China, and the geographical location of the provinces has a certain impact on the economic growth. Geographical location will restrict the resource endowment of different regions, and the inconvenience of transportation infrastructure will also hinder economic development[1-3].

Transportation infrastructure investment will directly or indirectly affect economic growth and the level of productivity. Economists have conducted more researches on the evaluation of the transportation infrastructure investment and policy choice. Previous researches have studied the effect of transportation infrastructure on economy only from a plane perspective, without considering that transportation network is interacting with each other. Road has the attribute of network. It links the economic activities of each region together. Through the diffusion effects, the region with faster economic growth can drive the region with slower economic growth, thus showing a positive spatial spillover effects. At the same time, the transportation infrastructure investment will have a negative spatial spillover effects. Through the aggregation effects, the production factors will flow to the economically developed region more conveniently. In this case, the economic growth of one region may come at the expense of economic recession in the other regions[4-6].

In recent years, the development of new economic geography makes the empirical analysis of spatial spillover effects of transport infrastructure investment more convincing. Therefore, this paper uses the spatial econometric model to analyze the impact of transport infrastructure investment on output.

DOI: 10.25236/sser.2019.059

2. Literature Review

There are two main theoretical mechanisms to study infrastructure and economy. On the one hand, as government expenditure, infrastructure has the effect of capital accumulation. Infrastructure investment, as an important part of government expenditure, has entered the field of theoretical research which stems from the rise of the Keynes doctrine of the 1930s. On the other hand, the construction of infrastructure has externalities, and the traffic network in one area will have an impact on other areas (Arrow and Kurz, 1970; Louhong,2004). The contribution of the investment in transportation infrastructure on the economic development is mainly qualitative research, and there are four aspects of correlation test from the perspective of infrastructure and economic relationship: the contribution of infrastructure investment on private output and the total factor productivity(Démurger,2001; Fan Jiuli and Bai Bao,2004)、the output elasticity of infrastructure(Ma Shucai、Li Hua、Yuan Guomin and Han Yunhong,2001; Zhang Xueliang,2007)、Causality between infrastructure investment and total output (Kamps,2005), and the spillover effects of infrastructure investment on the economic growth (Liu Binglian、Wu Peng and Liu Yuhai, 2010；Zhang Xueliang,2012). Among the researches about the spillover effects of the contribution of transport infrastructure investment on the regional economic growth, some scholars added infrastructure investment in adjacent areas to the traditional production function, and find that there may be positive spillover effects (Yilmaz, 2002) or negative spillover effects (Boarnet, 1998) about the infrastructure investment[7-9].

From the point of view of existing research methods, existing research is mainly carried out from two perspectives. One of the perspectives is based on time series of the cointegration relationship test、error correction model analysis and the granger test. These methods can test whether there is a long-term stable relationship between the development of transportation and the development of economy. The other is based on cross-section and panel data. New Economic Geography shifts the research of infrastructure construction to the space field. Because the flow of labor force and the location of enterprises are affected by the level of infrastructure, the construction of regional inclined infrastructure is an important policy tool to reduce the imbalance of regional development. The existence of spatial correlation makes the conclusions drawn from panel data lack of accuracy, and the development of spatial metrology provides us with a set of relatively perfect econometric models to effectively solve the above problems. Based on inheriting and developing the traditional panel model, the spatial panel model incorporates the geographical location into the model, which can effectively overcome the problem of the spatial autocorrelation, so as to make the conclusions drawn. It is more reliable.

Zhang Xueliang(2012) using 1993-2009 years of panel data and Spatial metrology research methods, the article draws the conclusion that the spatial spillover effects of China's transport infrastructure investment on the development of regional economy is very significant. If we do not consider the spatial spillover effect, we will estimate the contribution of transportation infrastructure on regional economic growth by mistake. Therefore, based on the author's research ideas and methods, this paper will empirically test the contribution of transportation infrastructure investment on regional economic growth in China in the past twenty years. The arrangement of this paper is as follows: the third part is the theoretical foundation and model construction, the fourth part is the empirical analysis, and the fifth part is the conclusion.

3. Theoretical Basis and Model Construction

3.1. Basic Theories and Models. A model can be used to analyze the contribution of transportation infrastructure on output. We assumed that only the transport infrastructure in the region will have a direct spillover effect on output. The production function is assumed to be $Y=Af(K,L)$. The factors in the production function satisfy the following conditions: $A>0, f_K>0, f_L>0, f_{LL}<0, f_{KK}<0$. The prerequisite is there have a market with complete competition and free flow of factors. the price of each factor of production is equal to the marginal income product. Given a certain amount of transportation capital, there are $\partial Y/\partial L= Af_L(K,L), \partial Y/\partial K= Af_K(K,L)$. When the supply and demand of input factors reach equilibrium, the factor price is equal to their marginal income, that is, $P_L=P_Y Af_L(K,L), P_K=P_Y Af_K(K,L)$.

According to the idea of Boarnet (1998), assuming that regional I increases the capital stock of transportation infrastructure, the price of labor and capital in regional I will rise. If the factors are completely mobile, then the difference of factor price will attract labor and capital from other regions. Factor transfer means that regional I will reach a new level of output. This also means that with the increase of public capital such as transportation, production factors such as labor force and capital will flow into regional I, and then the output of regional I will increase, while the output of other regions will decrease with the outflow of production factors.

Through the above analysis, we can see that under certain assumptions, improving the level of transport infrastructure in the region may cause factors of production in other regions to flow into the region, thus increasing the output of the region, while reducing the output of other regions, that is, traffic infrastructure will produce negative spillover benefits. However, because of the network attribute, transportation infrastructure will strengthen the economic links between regions, improve inter-regional trade and factor flow, and affect the industrial layout. Spatial network can promote the agglomeration and diffusion of economic activities, which may also have a positive spillover effect[10-12].

In this paper, we use C-D production function $Y=AK^{\alpha}L^{\beta}$. It shows the effect of capital and labor on output. Logarithm of the upper form, we get $LnY=LnA+\alpha Lnk+\beta LnL$. We divide the investment of Fixed Assets in the Whole Society into two parts: transportation infrastructure investment k_j and non-transportation infrastructure investment K_f. It mainly investigates the contribution of the investment of transportation infrastructure on the output. Therefore, the above formula can be written as $Y=Af(K_f,K_j,L,X)$. In order to facilitate regression, the logarithm of the formula can be obtained:

$$LnGDP=\alpha_0+\alpha_1 Lnk_j+\alpha_2 LnK_f+\alpha_3 LnL+\alpha_4 LnX+\xi_i \quad (1)$$

Among them, GDP is the output of provinces or cities, K_j is the transportation infrastructure investment, K_f is the investment of non-transportation infrastructure, L represents the labor force, X is the control variable, including regional openness, human capital, regional industrial structure, α_0、α_1、α_2、α_3、α_4 are the coefficients, and ξ_i is the random perturbation term.

3.2. Model Extension. In classical economic theory, it is assumed that the flow of production factors is completed instantaneously without transportation cost. Therefore, the spatial spillover effect of transportation infrastructure is not considered in the traditional econometric model. But in reality, this is impossible. Traffic facilities, including highways and railways, have network characteristics. They not only connect with the region, but also with other regions, which have an impact on other regions. Therefore, their spatial spillover effects should be studied.

Infrastructure investment not only as a kind of capital will have multiplier effects on the economy, but also will make the transportation between the region and the outside areas smooth, and there is a spatial dependence that is the mutual influence. Spatial Dependence means that the economic phenomenon in one region is always related to the corresponding economic phenomenon in its adjacent region. The economic phenomenon not only shows time correlation, but also has a certain degree of spatial dependence. With the development of new economic geography, many scholars re-examine the role of transport infrastructure in economic growth by spatial measurement. There are three kinds of spatial econometric models: Spatial Error Model (SEM), Spatial Lag Model (SLM or SAR) and the Spatial Durbin Model (SDM). Different spatial weighting matrices have different results. The commonly used methods to determine the weight matrix are the binary 0-1 spatial weight matrix reflecting the adjacent or not, the spatial weight matrix reflecting the geographical distance and the spatial weight matrix reflecting the economic distance.

Because the road, railway, pipeline and other transportation facilities in an area are connected with the adjacent areas first, the transportation infrastructure investment has a greater influence on the adjacent areas, and has a smaller impact on the non-adjacent provinces. Therefore, this paper chooses binary 0-1 to reflect the adjacent spatial weight matrix. Binary 0-1 belongs to the simplest calculation of the traditional spatial weight matrix. If two regions are adjacent, assign 1, and if they are not adjacent, assign 0. Finally, it is standardized so that the sum of each row is 1. Binary 0-1 reflects the calculation rules of the adjacent spatial weight matrix W as follows:

$$W_{ij}=\begin{cases}1 & \text{Region I is adjacent to region J}\\ 0 & \text{Region I is not adjacent to region J}\end{cases}$$

Therefore, formula (1) can be written into three spatial econometric models, as follows:

SLM model:

$$LnGDP_{it}=\alpha_0+\rho WLnGDP_{it}+\alpha_1 Lnk_{jit}+\alpha_2 LnK_{fit}+\alpha_3 LnL_{it}+\alpha_4 LnX_{it}+\xi_{it} \quad (2)$$

SEM model:

$$LnGDP_{it}=\alpha_0+\alpha_1 Lnk_{jit}+\alpha_2 LnK_{fit}+\alpha_3 LnL_{it}+\alpha_4 LnX_{it}+\mu_{it} \quad \mu_{it}=\rho W\mu_{it}+\xi_{it} \quad (3)$$

SDM model:

$$LnGDP_{it}=\alpha_0+\alpha_1 Lnk_{jit}+\alpha_2 LnK_{fit}+\alpha_3 LnL_{it}+\alpha_4 LnX_{it}+\rho WLnK_{jit}+\xi_{it} \quad (4)$$

GDP represents the output of each province; L represents the labor force and employment number of each province; K_j is transportation infrastructure investment, K_f is non-transportation infrastructure investment, X is control variable; i represents region (province and city), t represents time and W is binary spatial weight matrix.

3.3. Description of Variable Selection. This paper selects 31 provinces or cities in China (including Hainan and Xizang) from 1998 to 2017 for 20 years. According to the main industry classification of China Statistical Yearbook, the investment of fixed assets in the whole society is divided into two parts, namely the investment of transportation infrastructure (K_j) and the investment of non-transportation infrastructure (K_f). K_j is the fixed investment in transportation, warehousing and postal industry, and the rest of the industry's investment is regarded as non-infrastructure investment.

The statistical caliber of China Statistical Yearbook in 2002 (inclusive) is different from that after 2002. From 2003 to now, data can be obtained directly. Before 2002, the scope of fixed assets investment statistics includes capital construction、renovation and transformation、real estate development、other state-owned fixed assets、urban collective fixed assets、rural collective fixed assets、private housing construction in urban and industrial and mining areas and the rural individual fixed assets. K_j and K_f are included in the capital construction and the renovation and renovation. Therefore, by adding up the K_j in the capital construction and the renovation, we get the data.

There are many other reasons that affect output, this paper adds three control variables to reflect the characteristics of capital, population and economy, namely, industrial structure, openness and human capital. The industrial structure uses the added value of the third industry to account for the output proportion. The industrial structure shows the attributes of the economic conditions of various regions, and the economic structure is transformed from agriculture to service industry. Upgrading from low value-added agriculture to animal husbandry to the higher value-added service industry is obviously a means to improve economic efficiency, but the highly developed service industry may also bring about negative effects on economic development. In the highly developed economic environment of service industry, Baumol's cost disease may occur. The degree of openness uses the proportion of foreign investment in output, which shows the nature of capital flow in each province. The more open a region is, the more beneficial its economic development will be. Human capital is expressed in terms of years of education per capita, which is internationally popular. It shows the demographic attributes of each province. Generally speaking, the population in developed areas has a relatively high level of education. The formula for calculating the length of education per capita is $Q = 6q1 + 9q2 + 12q3 + 16q4$, q1、q2、q3、q4 respectively represent the proportion of the population of primary and secondary school education、junior high school education、high school education and the educational level of college above six years old and over. All variables come from the Chinese Statistical Yearbook over the years and the EPS database. The symbols and units of each variable are shown in the following table:

Table 1 Variable selection description

variable	explain	Unit
GDP	output	Billion yuan
K_j	Investment in Transportation Infrastructure	Billion yuan
K_f	Investment in non-transport infrastructure	Billion yuan
pop	Employment population	ten thousand people
stru	industrial structure	
edu	Per capita length of Education	/
open	Openness to the outside world	/

4. Empirical Analysis

4.1. Spatial Autocorrelation Test. Before choosing the spatial econometric model, we should first examine whether there is spatial dependence of variables. Testing the correlation of spatial sequences, commonly used global or local Moran's index I (Moran's I). This paper examines the global Moran's index I of GDP as follows:

Table 2 Global moran's I of GDP

year	Moran's I	year	Moran's I
1998	0.209**	2008	0.149*
1999	0.215**	2009	0.156**
2000	0.201**	2010	0.158**
2001	0.160**	2011	0.154*
2002	0.161**	2012	0.151*
2003	0.160**	2013	0.150*
2004	0.169**	2014	0.151*
2005	0.163**	2015	0.158**
2006	0.155**	2016	0.173**
2007	0.152*	2017	0.175**

*** p<0.01， ** p<0.05， * p<0.1

The minimum value of Moran index I is 0 and the maximum value is 1. If it is greater than 0, it means that the high value is adjacent to the high value, and the low value is adjacent to the low value. If it is less than 0, it means that the high value is adjacent to the low value. If it is close to 0, indicating that there is no spatial dependence, it is not suitable to use spatial econometric model. From the above table, we can see that the global Moran's I of GDP of 31 provinces or cities in China from 1998 to 2017 are all positive, and the P-value has passed the significant level of 10%. We strongly reject the original hypothesis of "no spatial autocorrelation", which indicates that there is a positive spatial correlation. There is indeed a spatial agglomeration phenomenon in China's provincial economy, and regional differences are significant. Introducing spatial geographic unit (cross-sectional) data based on time series data and using the integrated information of time and space expressed by spatial and temporal data to explain the role of transportation in the spatial and temporal evolution of regional economy is a good research idea and framework. Therefore, the spatial econometric model can be used to analyze the contribution of china's transportation infrastructure investment to output.

4.2. Basic Regression Analysis. There are three main models of spatial metrology, namely that SLM or SAR、SEM and SDM. According to the criterion proposed by Anselin, if the result of LM-LAG is significantly higher than that of LMERR in statistics, and the result of R-LMLAG is significant while that of R-LMERR is not, then SLM is chosen, and SEM is chosen instead. If the P-value of the Wald and Lration tests is less than 0.1, then SDM is selected. According to the calculation, the P-value of the Wald and Lration tests of data is less than 0.1, so the SDM is chosen.

Next, we use the Hausman test to choose the fixed effects or the random effects. Because P-value is 0 in Hausman test, stochastic effects is strongly rejected, the fixed effect is used to analyze. The regression results of each model are as follows:

Table 3 The results of regression

variable	OLS		SDM (time fixed)		SDM （spatial fixed）		SDM （double fixation）	
	coefficient	Z value	coefficient	Z value	coefficient	Z value	coefficient	Z value
LnK_j	0.097***	5.280	0.176***	7.710	0.074***	5.450	0.063***	4.940
LnK_f	0.484***	30.170	0.508***	22.590	0.221***	14.380	0.153***	10.020
Lnpop	0.436***	21.130	0.386***	21.670	0.260***	6.280	0.143***	3.330
Lnstru	0.244***	4.850	0.539***	10.100	-0.083**	-2.130	-0.221***	-5.330
Lnedu	1.124***	11.910	0.778***	13.210	0.453***	5.190	0.284***	2.890
Lnopen	0.029**	2.090	0.121***	9.430	-0.006	-0.500	-0.010	-0.810
Constant	-1.045***	-5.010						
$WLnK_j$			-0.320***	-8.170	-0.010	-0.490	0.012	0.490
Spatial rho			0.170***	6.220	0.529***	18.790	0.052	0.870
Log-likelihood			244.001		626.781		726.081	
R-sq	0.973		0.990		0.882		0.120	
N	620		620		620		620	

*** $p<0.01$，** $p<0.05$，* $p<0.1$

In order to compare the regression effect, OLS regression was carried out on the data. The results show that investment in transport infrastructure K_j、investment in non-transport infrastructure K_f、employment population、industrial structure、human capital and the openness all have significant promoting effects on the output of each province or cities. From the regression coefficient, non-transport infrastructure investment and employment contributed more to GDP, while transport infrastructure contributed less. At the same time, industrial structure 、openness and human capital and are in line with the previous forecast.

Further hypothesis about time fixed-effects and spatial fixed-effects is made. The results show that the hypothesis of "no time fixed-effects" is strongly rejected, indicating that time fixed-effects should be chosen. From the regression coefficient and significance of SDM, the regression result of time fixed-effects of SDM is also the best, which is discussed from the following three aspects.

(1) In the model, ρ is spatial rho, which represents the spatial autoregressive coefficient of the model. Spatial rho in the time fixed-effects of the SDM is positive, and has passed the significance test of 10%. It means that the economic growth of adjacent regions can promote the economic growth of the region and has a positive effect on the economic growth of the region, which is also consistent with the Moran index of GDP. From the numerical point of view, the economic growth of adjacent areas is one unit, and the regional economy will grow by 0.17 units.

(2) From the perspective of spatial interaction, $WLnK_j$ represents the impact of the K_j in adjacent areas on the output of the region. In the time fixed- effects of SDM model, the coefficient of $WLnK_j$ is -0.32 and significant at the level of 0.01, which indicates that the investment of transportation infrastructure in adjacent areas will have a negative influence on the economic growth of the region. This may be because the more investment in transportation infrastructure in a region, the more developed the transportation network in a region will attract the influx of human and material resources in adjacent areas, which will lead to the loss of resources in other regions and slow economic growth.

$WLnK_j$ represents the spatial spillover effect of transportation infrastructure investment, and its regression coefficient at 1% level shows that the K_j has the negative spatial spillover effects, that is, transportation infrastructure has the characteristics of spatial agglomeration. Increased K_j in a region will make the flow of production factors gather in the region and promote the economic development of the region, but it is important to do so. The outflow area is disadvantageous, which also accords with the theoretical prediction of the model.

(3) From the regression coefficient of the model, the regression coefficient of time fixed-effects of SDM is significant. The contribution ofK_j 、K_f and employment population to GDP is 0.176、0.508 and 0.386 respectively. Increasing one unit of K_j and K_f will increase GDP by 0.176 and 0.508 units respectively. Compared with OLS model, we can find that the effect of K_j on economic growth has increased, while the effect of K_f on economic growth also has increased. Because of neglecting the negative spatial spillover of transportation infrastructure, the effect of transportation infrastructure on economic growth and the negative spatial spillover of transportation infrastructure are mixed together, and the two are not distinguished, resulting in the low K_j coefficient of OLS model. At the same time, the contribution factors of employment population、industrial structure、human capital and openness to GDP have changed slightly.

4.3. Further Analysis. The spatial econometric model can not only regress the regression coefficients of each variable to the interpreted variable, but also decompose the effects of each variable and its lag term to the interpreted variable, which are direct effect, indirect effect and total effect, respectively. The direct effect shows the influence of the variables in this region on the economic growth of this region, and the indirect effect shows the influence of the variables in this region on the economic growth in other regions. Table 4 shows the decomposition effect of the variables in this paper.

Table 4 Direct、indirect and total effect of variables

variable	Direct effect		Indirect effect		Total effect	
	coefficient	Z value	coefficient	Z value	coefficient	Z value
LnK_j	0.165***	7.080	-0.338***	-6.770	-0.173***	-3.030
LnK_f	0.511***	22.840	0.100***	5.630	0.611***	20.610
Lnpop	0.390***	22.500	0.077***	5.430	0.467***	19.020
Lnstru	0.543***	10.050	0.107***	4.920	0.650***	9.750
Lnedu	0.784***	14.090	0.154***	5.310	0.937***	13.470
Lnopen	0.122***	9.510	0.024***	5.120	0.146***	9.560

From Table 4, we can see the decomposition effect of the transportation infrastructure investment. The coefficient of direct effect of K_j is 0.165, which is significant at the level of 1%. It shows that the K_j can promote the growth of output in this region. This is because transportation infrastructure investment as a part of government expenditure has a multiplier effect of government expenditure and will have a positive impact on economic growth. The indirect effect coefficient of K_j is -0.338, which is significant at the level of 1%. It shows that the K_j in this region will have the negative spatial spillover effect on economic growth in other regions. This is because the increase of investment in a certain region will make the transportation developed in the region. The developed transportation will not only reduce transportation costs and facilitate living, but also attract more factors of production, such as foreign investment and talents, which will promote the economic development of the region. However, factors of production remain unchanged in a certain period of time. The increase of factors of production in one region will lead to the decrease of factors of production in another region, so it will have a negative spatial spillover effect on the economic development of other regions.

In order to verify whether the model degenerates into the SLM or SEM, the LR test of the model is carried out. The test results are as follows:

Table 5 LR test

	LR value	P-value
SLM model	45.46	0.00
SEM model	45.10	0.00

As can be seen from the above table, the P-value is 0, and the SDM is rejected to degenerate into the SLM or SEM, so the regression results in tables 3 and 4 are credible.

5. Conclusion

Based on the empirical test in this paper, it is concluded that investment of transport infrastructure will promote the economic development of the region, but it will have a negative spatial spillover effect on the economic development of other regions, which is consistent with the previous conclusions of most scholars. This can explain the imbalance of economic development and the density of traffic network in eastern and Western China. However, China's Yangtze River Delta economic belt has developed well-developed transportation network and developed economy. Under such circumstances, transportation infrastructure investment does not necessarily have negative spatial effects, which needs further study.

Through the above analysis, we know that in the multi-dimensional factor spatial synergy model, if the spatial dependence is not taken into account in the model, we will underestimate the effect of the investment of transportation infrastructure on the development of regional economic. This shows that spatial econometric models help us better understand the relationship between the two. Under the background of globalization, china must follow the trend of the wind, seize the lifeblood of economic development, improve the international status of our economy, and gradually move towards the high-end from the low end of the global value chain.

In order to improve our position in the global value chain system, we should start from our own point of view, build a good basic guarantee, and provide more possibilities for economic development. It is drawn the conclusions in this paper, we believe that China should speed up the construction of the transportation infrastructure in the eastern、middle and western regions, especially the regional urban agglomeration, while constructing trans regional and high level transport infrastructure. When expanding transportation stock, the eastern region should strive to promote the quality of transportation infrastructure construction and accelerate the process of regional transportation integration. Because the scale of transportation infrastructure is still very small, the central and western regions still need to focus on accelerating the construction of internal transportation infrastructure in quantity, and actively promote the flow of all kinds of production factors within the central and Western regions, especially the flow and employment of the labor force within the region, in order to fully tap the advantages of labor resources in china.

References

[1] Lou Hong. Public Investment Policy in Long-term Economic Growth - Dynamic Economic Growth Model Including General Congestive Public Infrastructure Capital Stock [J]. Economic Research, 2004 (03): 10-19. (In Chinese)

[2] Fan Jiuli and Bai Bao. Regional differences in infrastructure investment and China's economic growth [J]. Humanities Geography, 2004 (02): 35-38. (In Chinese)

[3] Ma Shucai, Li Hua, Yuan Guomin and Han Yunhong. Research on the estimation of economic growth driven by investment in infrastructure construction [J]. Statistical Research, 2001 (10): 30-33. (In Chinese)

[4]Zhang Xueliang. Regional comparative analysis of transport infrastructure and economic growth in China [J]. Financial Research, 2007 (08): 51-63. (In Chinese)

[5] Zhang Xueliang. Does China's transportation infrastructure promote regional economic growth? Also on the spatial spillover effect of transport infrastructure [J]. Chinese Social Sciences, 2012 (03): 60-77+206. (In Chinese)

[6] Liu Binglian, Wu Peng and Liu Yuhai. Transportation infrastructure and total factor productivity growth in China -- Spatial Panel econometric analysis based on provincial data [J]. China's Industrial Economy, 2010 (03): 54-64. (In Chinese)

[7]Ye Changyou and Wang Xianjian. Transportation infrastructure, transportation industry and regional economic growth: spatial panel model based on provincial data [J]. Industrial Economy Research, 2013 (02): 40-47. (In Chinese)

[8]Liu Yong. Transportation infrastructure investment, regional economic growth and spatial spillover effects: Based on road and waterway transport panel data analysis [J]. China's Industrial Economy, 2010 (12): 37-46. (In Chinese)

[9] Liu Shenglong and Hu Angang. The test of the externalities of infrastructure in China: 1988 - 2007[J]. Economic Research, 2010,45 (03): 4-15. (In Chinese)

[10]Zhang Jun, Gao Yuan, Fu Yong and Zhang Hong. Why did China have a good infrastructure? [J]. Economic Research, 2007 (03): 4-19. (In Chinese)

[11]Sylvie Démurger. Infrastructure Development and Economic Growth: An Explanation for Regional Disparities in China?[J]. Journal of Comparative Economics,2001,29(1).

[12]Khalifa H. Ghali. Public investment and private capital formation in a vector error-correction model of growth[J]. Applied Economics,1998,30(6).