The Relationship Between Transportation Infrastructure Investment and Economic Growth ——Based on Provincial Spatial Panel Data Model

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Abstract. Based on the synergistic effect of multi-dimensional factors on China's regional economic growth, this paper studies the relationship between China's transportation infrastructure investment and economic growth by using spatial panel econometric methods and provincial panel data from 2001 to 2017. Empirical research results show that there is a significant spatial correlation between GDP and investment in transportation infrastructure in China from 2001 to 2017. Transportation infrastructure in other region has a positive spatial spillover effect on local economic growth; in addition, the promotion role of transportation infrastructure investment continued to increase with time going by.

1. Introduction

Since the reform and opening up, China's economic growth and transportation infrastructure construction have made remarkable achievements. While GDP has maintained an average growth rate of 9.4%, many infrastructure indicators rank among the top in the world. For a long time, traffic infrastructure has been regarded as the basis of the operation and development of modern economy and society. However, does infrastructure play a role in promoting economic growth? How much does it contribute to total output? Can the government further increase its transport infrastructure and achieve better results? In this paper, we will focus on the inter-provincial panel data of transport infrastructure investment, considering the spatial correlation between regions, and study the relationship between transport infrastructure investment and economic growth.

The relationship between transportation infrastructure investment and economic development has always been the focus of domestic and foreign scholars. However, an empirical study on infrastructure and economic development is known after 80s. In foreign studies, Aschauer (1989) used time series data to conduct pioneering research on the relationship between infrastructure and economic growth. Based on the data from 1971 to 1985 in United States, it is found that infrastructure, including transportation, plays an important role in promoting economic growth[1], Munnell (1990) and Merriman (1990),reached the same conclusion[2-3]. In addition, Carlino and Voith (1992) used panel data from 48 states in the United States from 1969 to 1983 to study the impact of transport infrastructure and other core infrastructure on economic growth[4]. In domestic research, Liu Shenglong and Hu Angang (2011) improved the traditional gravity model and found that the improvement of transport infrastructure had a significant positive impact on China's regional trade[5]. Zhao Pinpin and Li Qingbin (2010) used the provincial panel data from 1986 to 2008 to prove the importance of transportation infrastructure in economic growth[6].

To sum up, the empirical methods of existing research can be divided into two categories: one is cross-section panel data measurement method based on macroeconomic model or behavioral model with certain theoretical basis; the other is time series measurement method based on data extrapolation mechanism such as VAR model. Due to the disadvantage of time series data, cross-sectional data versus panel data, and inter-regional correlation, we use spatial econometric methods, it has unique advantages in empirical analysis to identify and measure the rules of spatial data change by using statistical and measurement methods to establish the measurement relationship between geographical location and geospatial data[7].

2. Variables and datum

This article takes 31 mainland Chinese mainland. The data of 2001-2017 years in cities and autonomous regions are built on the impact of transport infrastructure on economic growth. In order to maintain data consistency, except for individual variables, the main variable data used in this paper are derived from China Statistical Yearbook, China Traffic Statistical Yearbook and provincial statistical year-round. The specific variables and their data sources are as follows.

1) variables of economic growth

In this paper, the real gross domestic product (*RGDP*, 100 million yuan) of each region is taken as the variable of the economic growth of the sales area. The real gross domestic product (GDP) is gross domestic product (GDP) based on the commodity price index in 2000. All the data required are derived from the statistical yearbook of China has taken logarithms of actual gross domestic product in actual operation.

2) Transport infrastructure variables (*T invest*)

This paper uses the “Transportation, warehousing and postal industry fixed assets investment (100 million yuan)” in the “China Statistical Yearbook” to express the transportation infrastructure investment in each region. In our regress, the proportion of transportation infrastructure investment in GDP of each region is used.

3). Other control variables

(a) The variable of fixed assets investment (RK) in the whole society, it is used as a measure of the level of capital input. In practice, the ratio of transportation infrastructure investment divided by GDP of each region is used. The data needed are all from Chinese Statistical Yearbook and provincial statistical yearbooks.

(b) Labor input(Labor), using the end-of-year number of employment in various regions to measure the input of labor factors, in practice, the number of employment is logarithmically processed. The data required are from the statistical yearbook of China and the statistical yearbooks of various provinces.

(c) Variable of industrial structure (Second, Third), in this article, using the proportion of secondary and tertiary industries to GDP to measure the industrial structure of each region, the data needed are from the China Statistical Yearbook.

(d) Human capital variable (Education), using the per capita years of education as a proxy variable for human capital stock, Edu = 6S1+9S2+12S3+16S4, of which S1, S2, S3 and S4 represent the proportion of primary and secondary school culture, junior high school education, senior high school education and college education respectively. All the data needed are from the China Statistical Yearbook and the provincial statistical yearbooks.

(e) The degree of trade openness (Export), we use the proportion of total exports and gross production of a region to measure the degree of trade openness of a region. The required data are derived from China Statistical Yearbook and provincial statistical yearbooks.

(f) The level of urbanization (Urban), in this paper, the proportion of non-agricultural population in the total population of each region is taken as the index of urbanization rate. The data needed are from China Statistical Yearbook and provincial statistical yearbooks.

3. Spatial econometric models and related tests

3.1 Spatial econometric models

Spatial econometric models are mainly divided into spatial lag model (SLM) and spatial error model (SEM). Model (1) is spatial error model (SEM), model (2) is spatial lag model (SLM)

$$.y_{it}=x_{it}\beta+\eta_{it}.$$
$$\eta_{it}=\lambda\sum_{j=1}^{N}\omega_{ij}\eta_{jt}+\varepsilon_{it}. \quad (1)$$
$$y_{it}=\rho\sum_{j=1}^{N}\omega_{ij}y_{jt}+x_{it}\beta+\varepsilon_{it}. \quad (2)$$

The economic growth model constructed in this paper is as follows: (3) is spatial lag panel model (SLM), (4) is spatial error panel model (SEM):

$$Ln(RGDP)_{it}=\rho\sum_{j=1}^{N}\omega_{ij}Ln(RGDP)_{jt}+\beta_1 T\_invest_{it}+\sum_{k=2}^{8}\beta_k Control_{it}+\varepsilon_{it}. \quad (3)$$

$$Ln(RGDP)_{it}=\beta_1 T\_invest_{it}+\sum_{k=2}^{8}\beta_k Control_{it}+\eta_{it},$$
$$\eta_{it}=\lambda\sum_{j=1}^{N}\omega_{ij}\eta_{jt}+\varepsilon_{it}. \quad (4)$$

$Control_{it}$represents five control variables mentioned above . Fixed and random effects should be taken into account in the estimation of panel data model. Firstly, according to the results of Hausman test, it is determined whether the model has fixed or random effects. In addition, there are spatial effects and temporal effects in the spatial panel data model, so there are three models in practical analysis: temporal effects, spatial effects and temporal-spatial effects, which need to be selected according to the estimated results of the model.

3.2 Spatial correlation test

Moran's I is the main method to test spatial correlation. The Ln(*RGDP*) of Moran's I are as follows:

Table 1 . Results of spatial autocorrelation test of Ln (*RGDP*) in 2000-2017 years

year	2001	2002	2003	2004	2005	2006	2007	2008	2009
Moran	0.278***	0.282***	0.284***	0.283***	0.272***	0.271***	0.268***	0.272***	0.275***
year	2010	2011	2012	2013	2014	2015	2016	2017	
Moran	0.273***	0.266***	0.266***	0.274***	0.282***	0.281***	0.278***	0.274***	

From the above table, we can see that the Ln(*RGDP*) of all provinces and regions passed the significance test at 1% level from 2001 to 2017, and the Moran I values were positive, indicating that there was a significant positive spatial correlation between Ln(*RGDP*) in China.

4. Empirical Analysis

Before estimating the model, Hausman test is needed to determine whether individual effects are fixed or random effects. The Hausman test value is -71.0982 and the corresponding p value is 0. Therefore, the fixed effect is considered in the estimation of the model.

The SEM and SLM models with time effect, space effect and time-space effect are estimated by using MATLAB. The estimated results are as follows:

Table 2 . Spatial results of transportation infrastructure investment and economic growth

Variables	SEM Model			SLM Model		
	spatial fixed	time fixed	both fixed	spatial fixed	time fixed	both fixed
T_ivest	0.0964***	0.7748***	0.2024**	0.0935***	0.7710***	0.2459***
	(3.4661)	(3.3197)	(2.9735)	(3.4314)	(3.3177)	(3.1629)
RK	0.2263***	0.0512***	0.1819***	0.1267**	0.0467***	0.1400**
	(5.0520)	(3.4305)	(3.9935)	(2.7699)	(3.3923)	(3.0019)
LnLabor	0.1715*	0.9440***	0.0771***	0.3255***	0.9446***	0.07745***
	(2.4980)	(55.7620)	(3.2843)	(5.6397)	(55.2250)	(3.3219)

Second	2.6308*** (13.2443)	0.7088** (2.9689)	1.8669*** (8.6334)	2.5254*** (10.6154)	0.6872** (2.7643)	1.5626*** (6.7916)
Third	1.6817*** (6.9051)	-0.1610*** (-3.5676)	0.9672* (2.1304)	1.8816*** (6.8066)	-0.2284*** (-3.781597)	0.7007* (2.6384)
Education	0.0381 *** (3.0528)	0.0983*** (4.3477)	0.0268* (2.1304)	0.0294** (2.9537)	0.0949*** (4.1830)	0.0201 (1.5686)
Export	-0.2761 *** (-3.1048)	0.6567*** (6.1031)	0.2186** (2.8157)	0.1918* (2.5430)	0.6420*** (6.0329)	0.2018** (2.7245)
Urban	1.0049*** (5.2451)	2.3652*** (11.9269)	1.0256*** (5.5451)	1.6550*** (8.8251)	2.4599*** (11.9277)	1.0371*** (5.6311)
λ	0.9600*** (124.6283)	0.0450*** (3.6277)	0.2440*** (3.7319)			
ρ				0.6780*** (29.1270)	0.01372*** (3.9045)	0.0870 (1.3343)
Adjusted-R^2	0.8923	0.9731	0.9977	0.9973	0.9732	0.9977
Log-Likelyhood	471.24	571.54	107.54	509.61	567.14	107.79

By analyzing the results of empirical analysis, we can conclude that:

(a) The estimation results of SLM model with double fixed time points are obviously superior to those of other spatial panel models in likelihood value. Therefore, based on the double fixed panel SLM model, this paper analyses the relationship between transportation infrastructure investment and economic growth.

(b) In all models, the estimates of spatial autoregressive coefficients lambda and Rho are significant, which verifies the spatial correlation of economic growth in China's provinces, that is, venture capital between adjacent provinces will produce spatial spillover effect.

(c) According to the table2, the investment in transportation infrastructure has a positive and significant impact on economic growth. Generally speaking, investment in transport infrastructure can reduce transport costs, attract capital, labor, technology and other factors of production, thus promoting regional economic growth; however, investment in transport infrastructure makes the flow of factors between different regions more convenient, so that factors are transferred from areas with poor economic development level to areas with better economic development level, which damages the welfare of backward areas. But on the whole of our country, transportation infrastructure investment has a positive and significant impact on economic growth.

In order to further analyze the time-varying trend of the impact of transportation infrastructure investment on economic growth, we divided the period 2001-2017 into three sections and fitted them with double fixed panel SEM model. The estimated results are as follows (For reasons of space, Table 3 only lists the coefficients of the core explanatory variables.):

Table 3 . Results of staged SEM regression

Variables	Both fixed SEM Model		
	2001-2006	2007-2012	2013-2017
T_invest	0.1233	0.6159***	0.4017***
	(0.5425)	(3.0297)	(3.0335)
λ	0.0100	0.0989***	0.2500**
	(0.0794)	(3.8134)	(2.2157)
Log-Likelyhood	295.21	302.44	315.68

By analyzing the results of empirical analysis, we can conclude that:

(1) In the period of 2001-2006, the impact of transportation infrastructure investment on economic growth is not significant.

(2) With the passage of time, transportation infrastructure investment is playing an increasingly important role in economic growth. During the period of 2007-2012, the central government issued a 4 trillion yuan investment plan, and transportation infrastructure construction is an important part of the investment plan. In the period from 2013 to 2017, although the impact has weakened, it still plays a significant role in economic growth.

5. Main conclusions and policy recommendations

Considering the spatial correlation between regions, this paper finds that the GDP and investment in transportation infrastructure in China have obvious spatial correlation between 2001 and 2017. Then, the relationship between China's inter-provincial transport infrastructure and economic growth is studied. It is found that, China's transport infrastructure level has a significant positive impact on economic growth, in addition, with the passage of time, the role of transport infrastructure investment in promoting economic growth has gradually increased. Therefore, this article puts forward three policy recommendations:

(a) Deepening the reform of investment and financing system, innovating investment and financing modes, further studying and refining the support policies and safeguards to encourage social capital to enter the field of transportation infrastructure, the impact of transportation infrastructure investment on economic growth is still on the rise. When the demographic dividend is gradually disappearing and the export and consumption of the troika are obviously difficult to improve in the short term, ensuring that the transport infrastructure can drive economic growth.

(b) To maintain moderate construction scale. Good infrastructure construction can reduce production costs, change the accessibility and attractiveness of the region, and attract the continuous inflow of capital, labor and technological factors of production, but it must maintain a fast enough development speed to meet the needs of economic growth. Transportation infrastructure should maintain a certain scale of development, to avoid the lack of investment in transport infrastructure and slow economic development.

(c) avoid duplication of investment in the field of transport infrastructure. Under the current economic situation, it is of great significance to speed up the construction of basic magnetic facilities and achieve stable growth. However, duplicate construction of transportation infrastructure in some areas has greatly reduced the utilization efficiency of transportation infrastructure investment and reduced the marginal effect of transportation infrastructure investment, which can not meet the needs of economic growth. Please.

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