Research on Transportation Infrastructure Investment based on Economic Sustainable Development

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Abstract. The article explored the influence of transportation infrastructure investment on economic sustainable development with time series data of 1981-2017. Additionally, the co-integration theory and Grainger causality test were applied to analyse the relationship between transportation infrastructure investment and economic sustainable growth based on the C-D production function model. The results show that the investment in transportation infrastructure still has a stable effect on promoting long-term and short-term economic development.

1. Introduction

For a long time, transportation infrastructure investment, as an important part of the government's fiscal policy, plays an important role in stimulating demand and promoting economic development. In the past two decades, China's transportation infrastructure investment has maintained a high level, both in absolute and relative terms. Since the 13th Five-Year Plan, the proportion of transportation fixed assets investment in the total fixed assets investment of the whole society has remained at about 5%, which has become an important cornerstone of stabilizing the economy.

The role of transport infrastructure investment in promoting economic development has been repeatedly verified. However in the context of the “new normal” and “supply-side reform” of Chinese economy, whether the huge infrastructure investment can continue to play a good role in stimulating the economy, whether it can still maintain a high efficiency has attracted much attention. By analysing the short-term pulling effect of transportation infrastructure investment on demand side and the long-term driving effect of supply side, an econometric model is built to test the short-term and long-term effects of transportation infrastructure investment on economic development with time series data.

2. Literature review

The relationship between transportation infrastructure investment and economic development is always the focus of scholars. The role of transportation infrastructure investment in economic development can be analysed in the short and long term respectively.

Liu Shenglong and Hu Angang used panel data of 28 provinces from 1978 to 2007 for verification, and concluded that investment in transportation infrastructure had a significant positive effect on promoting economic development in China [1]. Zhang Xueliang used the space metrology model to verify that China's transportation infrastructure has an economic development of about 0.05-0.07[2]. Liu Xuehua used the granger causality test to conclude that the transportation infrastructure and economic development are mutually reinforcing each other [3].

Current studies focus on the short-term effect of transportation infrastructure investment on economic development, few scholars pay attention to long-term effect. This paper intends to explore the long-term effect and the mechanism of transportation infrastructure investment on economic development.

3. Model setting and data description

3.1. Action Mechanism

The role of transportation infrastructure investment in economic development is briefly analysed above. Next, the mechanism of transportation infrastructure investment promoting economic development is discussed theoretically.

Short-term effect refers to the initial stage of transportation infrastructure investment, which will promote the development of upstream and downstream industries, employment and income level by stimulating the demand of related industries. Income level can stimulate household consumption and promote economic development through multiplier effect. It is through this series of transmission mechanisms that transportation infrastructure investment achieves its contribution to economic development and improves employment level. Of course, large-scale infrastructure investment will also bring crowding-out effect of public investment on private investment. In the real economy, the crowding-out effect of transportation infrastructure investment will not have a large-scale offset effect on its positive impact. Therefore, it can be concluded that in the short term, investment in transportation infrastructure can produce a relatively rapid pull on economic development through relevant transmission paths [4].

The long-term effect of transportation infrastructure investment refers to that in the long run, the accumulation of stock will lead to a substantial increase in the level of transportation infrastructure, thus promoting the stable development of economy through a series of mechanisms. Firstly, it can reduce the transportation cost of enterprises, promote the flow of production factors in different regions, optimize the distribution of resources, and promote the balanced development of regional economy. At the same time, resource agglomeration and the flow of the elements can promote the adjustment and upgrading of industrial structure, thus achieving a new round of economic development. At the same time, the allocation of transportation infrastructure will change the regional accessibility, which will affect the choice of labor force greatly affected by the regional accessibility [5]. The improvement of the regional accessibility will promote the industrial agglomeration in the region. The industrial agglomeration will result in the labor agglomeration, and the labor-intensive areas tend to have a higher level of economic development. Therefore, in the long run, investment in transportation infrastructure can promote economic development through mechanisms such as influencing labor force aggregation and creating employment.

In summary, the short-term effect of transportation infrastructure investment is mainly manifested in the pulling effect of the rising employment level caused by the rising demand level on the economy. The long-term effect is mainly manifested in reducing trade costs, promoting factor flow, optimizing resource allocation and ultimately promoting the upgrading of industrial structure. Therefore, this paper argues that transportation infrastructure investment has a driving effect in the short term, a driving effect in the long term and a significant contribution to economic development.

3.2. Model setting

When analyzing the effect between transportation infrastructure and economic development, the previous scholars generally adopted the Cobb-Douglas production function as the model, and this paper also used this function for analysis. The Cobb-Douglas production function:

$$Y = AL^{\alpha}K^{\beta} \tag{1}$$

Where, Y represents output, which can be represented by GDP. A stands for technology, L stands for labor capital, K stands for capital, α stands for the production of labor, and β is the output elasticity

of capital input. Since transportation infrastructure investment is an important part of social capital investment, we can study the relationship between transportation infrastructure investment and economic development by means of the Cobb-Douglas production function. At the same time, in order to meet the research needs, the capital stock index is divided into transportation infrastructure capital stock *T* and general capital stock.

$$Y = AL^{\alpha}(K-T)^{\beta}T^{\gamma} \tag{2}$$

γ represents the elasticity of investment in transportation infrastructure. As capital, labor and other input elements constitute all the driving factors of economic development, they have the nature of constant return on scale in promoting economic development. So a lot of previous studies assumed that H_0: $\alpha+\beta+\gamma=1$. At the same time, in order to facilitate calculation, the upper formula is logarized.

$$Lny = lnA + \alpha ln(K-T) + \beta lnL + \gamma lnT + \varepsilon \tag{3}$$

ε is the random perturbation term. At the same time, human capital elements are mostly measured by the number of people, which is difficult to be quantified by currency. Therefore, dimensional difference between human capital elements and other variables measured by currency will occur, which is easy to cause regression result deviation. Therefore, this paper uses the method of dividing labor variables on both sides of the equation to eliminate dimensional difference. Where $\frac{Y}{L}$ represents per capita GDP, $\frac{Y}{T}$ represents per capita transportation capital stock and $\frac{(K-T)}{L}$ represents per capita non-transportation capital stock. Taking the logarithm of both sides of the equation, then we get the following formula.

$$(lnY - lnT) = lnA + \beta[ln(K-T) - lnL] + \gamma(lnT - lnL) + \varepsilon \tag{4}$$

In data selection, the output *Y* adopts the GDP from 1981 to 2017 published by the National Bureau of Statistics, and in order to eliminate the deviation caused by price level changes, the real GDP sequence is obtained through the index adjustment of GDP, which is based on 1978. Human capital factor input *L* chooses the actual employment number published in the National Statistical Yearbook from 1981 to 2017 as an alternative indicator. In the estimation of transportation capital stock, this paper adopts the perpetual inventory method to estimate the capital stock of transportation infrastructure investment.

4. The empirical research

4.1. The long-term promotion effect of transportation infrastructure investment on economic development

4.1.1. Model hypothesis and premise testing

The test shows that all the time series are single integral series of first order. Based on the above, the assumption of constant returns to scale is firstly verified that H_0: $\alpha+\beta+\gamma=100\%$.

The test results are shown in the following Table 1.

Table 1. Model constraint test

Test type	test statistic value	variance	P
T	-0.312	31	0.7565
F	0.097	(1, 31)	0.7565
Chi-square	0.097	1	0.7544

According to the results, t statistic, F statistic and chi-square statistic are not significant at the significance level of 5%, and the null hypothesis is not rejected. The equation is not different under the constraint condition without the constraint, so the return to scale hypothesis is established under the data selected in this paper.

4.1.2. Test of the long-term promoting effect of transportation infrastructure investment on economic development

EG two-step method was used to verify the long-term relationship between transportation infrastructure investment and economic development. The test results are shown in the following Table 2.

Table 2. Cointegration test

Cointegration equation	（LnY-lnL）=lnA+β[ln（K-T）-lnL]+γ（lnT-lnL）+ε	
Test sequence	ADF	P
ε	-3.951	0.0003

The test results show that there is a co-integration relationship between variables, so the variables designed by the model in this paper have a long-term equilibrium relationship, indicating that the investment in transportation infrastructure has a stable and balanced relationship with China's economic development in the long run.

The co-integration relationship between variables has been proved above, so the co-integration equation can be used to carry out the parameter estimation with the ordinary least square method. Meanwhile, in order to ensure the stationarity of data, first-order difference is adopted to carry out the regression of variables. However, the standard value dL(35,2)=1.28 is under the significance level of 5% with the D.W. statistic of the model, indicating that the sequence has a strong positive sequence correlation, which needs to be tested and corrected.

$$dYL = \beta dKTL + \gamma dTL + \varepsilon \tag{5}$$

$$dYL = lnYt - lnLt - 0.58(lnYt - 1 - lnLt - 1) \tag{6}$$

The least squares estimation method is used for regression and the results are shown in the Table 3.

Table 3. Regression results

A）Parameter estimation	t	P	coefficient
β	2.86	0.013	0.20
γ	10.71	0.000	0.61
B）Model diagnosis			
R^2		0.876	
Adjusted R^2		0.876	
D.W.		1.668	

According to the test results, the R^2 value was 0.876 that means that the model fitted well, and all parameters passed the test. Meanwhile, the D.W. statistic of the model was located in the standard value interval [1.58 2.42], indicating that there was no autocorrelation in the residual. β Indicates that the elasticity of transportation infrastructure investment to economic development is about 20%, and indicates that the elasticity of other capital input to economic development is 61%. At the same time, the contribution rate of labor factors to economic development is 100%-20%-61%=19%.

4.2. Test of short-term demand-pulling effect of transportation infrastructure investment

In terms of data selection, considering that the variables tested are the changes of transportation infrastructure investment and economic development respectively, this part of transportation infrastructure investment is analysed in an incremental manner, while the economic development index is analysed in terms of the real GDP growth rate.

The stationarity test shows that both of them are first-order single integral sequences. The test adopts the third-order lag regression model for prediction, establishes the third-order lag VAR model, and conducts the granger causality test. The results are shown in the following Table 4.

Table 4. Granger causality test results

Null hypothesis	coefficient	
	X^2-stat	P
Investment in transportation infrastructure is not an exogenous variable of economic development	28.90	0.00
Economic development is not an exogenous variable of transportation infrastructure investment	88.66	0.00

According to the test results, there is a causal relationship between transportation infrastructure investment and economic development, and the two are exogenous variables to each other. And the results indicate that there is a short-term correlation effect between the two, that is, transportation infrastructure investment has a pull effect on economic development in the short term.

5. Summary

Studies above show the effect of transportation infrastructure investment as a factor of production on sustainable economic development, and the following conclusions can be drawn.

First of all, investment in transportation infrastructure plays a good role in driving economic development by actively stimulating demand in a short term. Secondly, transportation infrastructure investment has a significant driving effect in the long run. The empirical results of this paper show that the contribution rate of transportation infrastructure investment on economic development is 20%. The investment in transportation infrastructure takes up a larger investment contribution rate with a lower investment proportion, indicating that the investment efficiency of transportation infrastructure is obviously higher than that of other capital factors.

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