Frontiers of Engineering Management
DOI 10.15302/J-FEM-2016041

ENGINEERING MANAGEMENT REPORTS

Ying-hui Xiang, Ting-ting Zhang, Qiu-yang Ren

The Spatial Spillover Effects of Infrastructure on Economic Growth in Shenyang Economic Zone

Abstract This article analyses the spatial spillover effects of infrastructure on regional economic growth by using the panel data of eight cities of Shenyang Economic Zone from 2001 to 2013. The empirical results of this paper indicate: (1) The infrastructure of adjacent regions have positive effects on local economic growth, demonstrating that the spillover effects of infrastructure in Shenyang Economic Zone are positive; (2) if one ignores the spillover effects of infrastructure, one will overestimate the effects of local infrastructure on local economic growth; (3) the effects of local infrastructure on local economic growth are far greater than those of adjacent regions; (4) there is great difference in spillover effects of infrastructure of different cities in the economic zone, which is related to the level of economic development.

Keywords: Shenyang Economic Zone, infrastructure, spatial spillover, economic growth, coordinated development

1 Introduction

The relationship between infrastructure and economic growth is a hot issue which scholars have been researching on. Infrastructure has impacts on economic growth through two ways. First, infrastructure can promote economic growth as a product directly. Infrastructure can stimulate economic growth in a short time through increasing the demand for production factors. Secondly, infrastructure can promote economic growth as intermediate inputs indirectly. The spatial spillover effects of infrastructure promote economic growth.

The related research about the relationship between infrastructure and economy staid on the level of qualitative analysis while quantitative analysis did not appear until the late 20th century, however, the empirical researches did not achieve the consistent conclusion on the issue of the spatial spillover effects of infrastructure on economic growth in two aspects. The first aspect is about whether the spatial spillover effects of infrastructure for economic growth exist. Joseph and Ozbay pointed that transport infrastructure had a significant spatial spillover effect on regional economic growth between counties and administrative counties and cities through probing the effect of transport infrastructure on economic growth considering the spatial effects between the regions. Zhang, Bi, and Ji (2011) studied on the impacts of infrastructure investment on regional economy and got the results that local public infrastructure investment not only had an impact on local economic growth but also had a significant impact on other regional economic growth.

However, the research of Liu and Hu (2010) showed that one can ignore the spatial spillover effects of energy infrastructure on regional economic. The second aspect is about whether infrastructure has a positive or negative spillover effect on economic growth. Some scholars thought that infrastructure might produce a positive spillover effect. The infrastructure construction could realize the advantageous of complement between the regions to narrow the regional difference and form larger market size to promote regional economic growth because infrastructure has network properties and economies of scale. Liu (2010) used the provincial-level panel data to study the spillover effects of the highway and waterway infrastructure on the economic growth and found that the spillover effects were positive while the results differed in different regions and different periods. Other scholars believed that infrastructure might produce negative spatial spillover effects. Local infrastructure construction might reduce production factors of the adjacent region and slow the speed of economic growth of the adjacent region because labor, capital and other factors of production will be concentrated in the region on the base of its good infrastructure (Bian, 2014). Yilmaz used the panel data of 48 American states to study the spillover effects and his

Manuscript received April 11, 2016; accepted August 17, 2016

Ying-hui Xiang (✉), Ting-ting Zhang, Qiu-yang Ren
School of Management, Shenyang Jianzhu University, Shenyang 110168, China
Email: xyhlrb@sohu.com

research indicated that the communication infrastructure produced a negative effect on regional economic growth between the states.

The continuous development of infrastructure has narrowed the world to some extent and strengthened the links between regions. Therefore, regional economic activities cannot run in isolated ways and are always connected with other regions. If one ignores this effect, the findings will be skewed, so it is very necessary to take the spatial correlation into consideration. In addition, considering the vast area of China, the same amount and quality of infrastructure investment in various regions may exert different effects because each region has different conditions, it indicates that the results of each region are not representative. Therefore, Shenyang Economic Zone is selected as the research object which has more practical benefits.

2 Estimation of spatial spillover effect of infrastructure

2.1 Model specification

In this paper, the spillover effects of infrastructure on the economic growth in eight cities of Shenyang Economic Zone were studied. Suppose a regional infrastructure affects not only the local economic growth, but also the economic growth in adjacent region because of the spillover effects and the effects may promote or hinder economic growth of adjacent region. Given that, considering the impact of both the local infrastructure and other regional infrastructure on local economic growth, the authors construct the model on the basis of production function model.

$$Y = f(L,K,G,OG), \tag{1}$$

in which Y stands for total output, L for labor input, K for capital input, G for local infrastructure stock, OG for other regional infrastructure stock.

To reflect the spatial relationships between regions, this article brings in spatial weight matrices in spatial statistics and spatial econometrics to construct the variable of other regional infrastructure stock on the basis of Eq. (1), then takes log of both sides, one can get the model, as follows:

$$\ln Y_{it} = \alpha_0 + \alpha_1 \ln L_{it} + \alpha_2 \ln K_{it} + \beta \ln G_{it} + \gamma \sum_{j=1}^{N} W_{ij} \ln OG_{jt} + \varepsilon_{it}, \tag{2}$$

in which i and j stand for region, t for time, ε_{it} for random error, α_0, α_1, α_2 for intercept term, output elasticity of labor and output elasticity of capital, γ for the coefficient used in estimating the external spillover of infrastructure, if $\gamma > 0$, it indicates that infrastructure have spillover effects between regions, if $\gamma<0$, it indicates that infrastructure have no spillover effects between regions, W_{ij} for the element in the spatial weight matrices, This paper sets the matrix on the basis of geographic location.

2.2 Variable selection and data interpretation

Eviews 6.0 is used to analyze the spillover effects of infrastructure of Shenyang Economic Zone by using panel data of eight cities of Shenyang Economic Zone from 2001 to 2013. Data in this paper are collected from *Liaoning Province Statistical Yearbook*, and the indicators below are selected considering data availability.

1) Infrastructure stock: The authors use fixed asset investment of infrastructure related industries to measure it. The infrastructure related industries include transportation and warehousing, post and electricity industry, gas and water production and supply industry, which are associated with the production directly. In the first year, the authors use fixed investment in infrastructure related industries instead of infrastructure stock, in other years the authors use perpetual inventory method of Eq. (3) to construct of infrastructure stock.

$$K_t = K_{t-1}(1-\delta_t) + I_t, \tag{3}$$

in which δ_t stands for depreciation rate, general take 5%, $K_{t\text{-}1}$ for infrastructure stock in the previous year, and I_t for infrastructure capital input in this year.

2) Regional output: GDP.

3) Labor input: Total employment of three industries.

4) Regional capital input: Investment in fixed assets of key industries.

2.3 Estimation results and interpretation

To choose the most suitable model, it is necessary to carry on the data stability examination. If the data are not stable, the authenticity of the regression results will be affected. The test results of 1% significant level are shown in Table 1.

Unit root test results in Table 1 show that the unit root test rejected the original hypothesis at the 5% significance level after the first order difference of the variables, namely each variable is first-order single whole sequence.

Regression results of spatial spillover effects of infrastructure in Shenyang Economic Zone are shown in Table 2. Table 2 shows that the fitting degree R-squared of regression equation is 0.9987 and the adjusted R-squared is 0.9985, so it is not difficult to see that the regression has good fitting degree that there is a high degree of agreement between predict results and actual situation, which can reflect the relevant issues to be studied in this paper.

Table 1

Unit Root Test of Panel Data

Test	Ln*Y*	ln*L*	ln*OG*	ln*K*	ln*G*
LLC test (common root test)	–6.88935	–4.37802	–10.1333	–8.22292	–8.59439
Fisher-ADF test (individual root test)	–2.73562	–2.65765	–5.08733	–4.52706	–3.91361

Note. The above results are analyzed after the first order difference of each variable 2. Null hypothesis: Variables have unit root.

Table 2

Test Results of the Spillover Effects of Infrastructure in Shenyang Economic Zone

Spillover effects	α_0	α_1	α_2	β	γ	R-square	Adjusted R-squared
Considering spillover effects	2.5373	0.6404	0.0576	0.3252	0.0036	0.9987	0.9985
Omitting spillover effects	2.5720	0.6270	0.0600	0.3680	—	0.9986	0.9984

Note. The above test results are all at significant at the 5% significance level.

To further study related problems about the infrastructure of each city in Shenyang Economic Zone, this paper uses Eq. (2) to present regression analysis on spatial spillover effects of each city. Regression results are shown in Table 3.

The regression results in Table 3 indicates that adjacent cities' infrastructure have the biggest spatial spillover effect on the economic growth of Tieling with the value of 0.156; the next is Fushun with the value of 0.113; adjacent cities' infrastructure have the lowest spatial spillover effect on the economic growth of Shenyang with the value of 0.044. This conclusion is closely related to the economic development level of the adjacent cities, the higher a region's economy developed, the greater spatial spillover effects of infrastructure it will produce, and vice versa.

3 Conclusions

(1) This paper mainly studies the spillover effects of infrastructure in regional economic growth, so the authors should focus on the coefficient γ in Eq. (2). Test results show that the coefficient γ that reflects the infrastructure spatial spillover effects are greater than zero, and indicates spatial spillover effects of infrastructure in Shenyang Economic Zone. The authors suppose other conditions are invariant in Table 3, when infrastructure spillover effects rise 1%, GDP rose 0.0036%.

(2) The output elasticity of transport infrastructure for Shenyang Economic Zone is 0.368 when infrastructure spillover effects are not considered and reduced to 0.325 when considered. This indicates that if one ignores the infrastructure spillover effects of the adjacent regions, the estimated local economic growth will be affected.

(3) One can see that the output elasticity of local infrastructure is greater than that of the infrastructure for adjacent regions from the test results of infrastructure spillover effects of eight cities in Shenyang Economic Zone. This shows that the local effects, compared to infrastructure spillover effects, have a bigger impact on regional economic growth. The conclusion is consistent with Liu and Hu's research on the cross-regional spillover effect of Chinese traffic infrastructure (Liu, & Hu, 2010).

4 Future research

(1) Realize the infrastructure sharing between cities. This

Table 3

Test Results of Spillover Effects of Infrastructure in Eight Cities of Shenyang Economic Zone

Cities	α_0	α_1	α_2	β	γ
Shenyang	4.847	0.312***	0.018***	0.130**	0.044***
Anshan	4.726	0.246***	0.030**	0.860**	0.067***
Fushun	1.820	1.222***	0.020**	0.200**	0.113***
Benxi	3.424	0.258**	0.031***	0.143***	0.092***
Yingkou	2.394	0.594***	0.250***	0.145***	0.101***
Fuxin	1.250	1.230***	0.130*	0.170***	0.082***
Liaoyang	1.707	0.919***	0.076***	0.491***	0.063**
Tieling	1.843	0.440***	0.070***	0.195***	0.156***

Note. ***, ** and * represent levels of significance at 1%, 5% and 10%, respectively.

is the necessary condition to realize Shenyang Economic Zone integration. The governments should incorporate spatial relationships between cities while they analyze the relationship between infrastructure and economic growth, and further improve future infrastructure allocation.

(2) Determine reasonable investment direction of infrastructure. The studies indicate that infrastructure investment in developed cities is beneficial to the economy development of the developed cities and the Shenyang Economic Zone. However, this type of investment is more influential on the economic developed regions, which will enlarge the gap between economic developed and other regions. Therefore, it is necessary to increase infrastructure investment of relatively poor regions, which cannot only promote local economic development, but also benefit Shenyang Economic Zone.

(3) Make the economic development coordination strategies of local and adjacent region. Meanwhile it is important to further accelerate the systematic communication and transportation infrastructure construction of the various cities within economic zone to facilitate the accumulation of information, human and other factors, accelerate the process of Shenyang Economic Zone integration and enhance the competitiveness of the overall zone.

Acknowledgements This paper is an outcome of Liaoning Social Science Fund project "Study on Investment and Operation Mechanism Innovation of Liaoning Sewage Treatment Infrastructure" (Grant No. L13DJY082).

References

Bian, Z. (2014). A study on spillover effects and mechanism of action of network infrastructures. *Journal of Shanxi Finance and Economics University*, (9), 72–80.

Liu, Y. (2010). Transport infrastructure investment, regional economic growth and the spatial spillover effects—based on highway and marine's panel data analysis. *China Industrial Economics*, (12), 37–46.

Liu, S., & Hu, A. (2010). Test on the externality of infrastructure in China: 1988–2007. *Economic Research Journal*, (3), 4–5.

Zhang, J., Bi, L., & Ji, Z. (2011). Spillovers effects study of inter-regional public infrastructure. *Urban Studies*, (2), 76–81.