The Empirical Analysis on Relationship Between Infrastructure Investment and Regional Economic Growth in China

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Abstract: Investment in infrastructure is an essential prerequisite to achieve sustained economic growth. The level of economic development and the construction of infrastructure are in state of imbalance in the country's eastern, central and western regions .The empirical analysis interpret that the infrastructure construction's difference between regions in China gives rise to the difference in regional economic growth. From the panel data results, empirical analysis shows that labor force, infrastructure investment and non-infrastructure investment have played a positive role in regional economic growth, in which the labor's output elasticity is the largest and the output elasticity of infrastructure investment is smaller, with the infrastructure investment's is in the middle of them.
Key words: Infrastructure investment; Regional economic growth; Mutual relationships; Output elasticity

1 Introduction

In some literatures about economic growth, infrastructure investment has been regarded as a general capital investment to be examined for a long time. The role that infrastructure investment played in economic growth and development had not been studied independently and in-depth. Until 1943, Rosenstein-Rodin studied the influence of such capital investment on problems of industrialization in Eastern Europe and South-Eastern Europe under the name of Social overhead capital, so infrastructure investment was regarded as a separate concept that appeared in literature about growth and development[1]. The year of 1989 was an important watershed between infrastructure investment and the relationship of growth, whose mark was that Aschauer published the article entitled "Is public expenditure productive?"[2] and "Does public capital crowd out private capital?"[3]in the <<Journal of Monetary Economics>>. Especially in the first article, Aschauer thought that the decline in public expenditure was the reason for decline in productivity growth in the United States since the late 1970s.Since then, public capital investment has become one of the central topics in economic growth and development. Then, it emerged Nurkse, Hirschman and some others who went some in-depth studies on the relationship between infrastructure investment and growth. Nurkse proposed the concept of "Social overhead capital", and analyzed the influence that "social capital advance" had in capital formation and economic growth. Hirschman divided investment activities into two types of production activities named indirect and direct capital investment, and analyzed the effect that social overhead capital investment played on balancing economic growth. Bougheas and some others extended Romer endogenous growth model, and analyzed the mechanism that infrastructure promoted the specialization and economic growth[4]. In 1995, by the means of extending Ramsey-Cass Discrete-time growth model, Justman introduced two-sector model to study the role that infrastructure investment played on the changes in industrial structure[5]. Martin and Rogers examined the influence of public infrastructure on the industrial location under the case of increasing returns, so the theory of industrial layout of public infrastructure was proposed[6].

Investment in infrastructure is an essential prerequisite but not sufficient condition to achieve sustained economic growth. Theoretical analysis shows that there is a most appropriate infrastructure investment scale[7]: On one hand, when the actual infrastructure is lower than the optimal size of infrastructure, the supply of infrastructure is insufficient, forming the so-called "bottleneck", resulting in the development of infrastructure sector uncoordinated with other sectors and limiting the economic growth. On the other hand, when the actual infrastructure is higher than the optimal size, it not only forms the waste of resources, but also the government uses the approach of raising taxes or issuing bonds for the financing of infrastructure construction, forming the so-called "crowding-out effect", which may not boost but hinder the promotion of economic growth. The appropriate amount of infrastructure helps improve labor productivity and promote economic growth finally.

The disparity in economic development is accompanied by the imbalance of infrastructure construction in eastern, central and western regions. Therefore, their level of economic growth also

differentiates where the level of infrastructure is different. In other words, the infrastructure will not only affect the overall level of economic growth, but also affect regional economic growth. The construction of infrastructure can explain part of the uneven development status of China's regional economy at least. From the perspective of quantitative analysis we propose a research topic: Whether the difference of regional infrastructure construction is the reason for the difference between the regional economic growth?

2 The Econometric Model

2.1 The set of econometric model

In the literature of studying economic growth, the most commonly used model is the Cobb-Douglas production function. In 1927, Douglas asked a mathematics professor Charles Cobb to design a formula to measure the relative influence of two production factor each to GDP, and also to meet his re-log-linear relationship of inputs and outputs data. The nonrestraint form of Cobb - Douglas function can be written:

$$f(x) = A\prod_{i=1} x_i^{a_i} \tag{1}$$

Among them, *A* is an efficiency parameter, a_i is the elasticity of function $f(x)$ to x_i, x is limited to R_{++}^n. As a production function, x_i is the input of production of factor.

In addition, the Cobb-Douglas form requires that each production function is necessary. There is no factor can completely replace the other factors. In other words, various factors of production are complementary rather than substitutes in Cobb-Douglas production function. Through changes in the efficiency parameters of A in Hicks neutral, the increase of factors and changes in the scale of factor inputs in Hicks neutral, and the changes of production elasticity in Hicks non-neutral, the change of technology can be reflected in Cobb - Douglas production function.

The first term of our analysis is total production technology. The equation of the form:

$$Y_t = A_t \cdot f(L_t, K_t, G_t) \tag{2}$$

Among them, Y_t represents economic total output - input ratio, L_t represents total work force, K_t represents total capital stock of non-infrastructure sector, A_t represents productivity or Hicks-neutral technical change parameter. Variable G_t represents the total capital stock of the infrastructure sector. We let $C_t = K_t + G_t$. Additional, total economic output is a function of time of total impact Z_t which is independent of the above variables. The equation (2) obtains the logarithmic form of the Cobb - Douglas function when removes logarithm:

$$y_t = a_t + e_l \cdot l_t + e_k \cdot k_t + e_G \cdot g_t \tag{3}$$

Among them, e_i represents total output elasticity for all kinds of variables, $i = L, K, G$.

While studying the relationship between the discrepancy of regional economic growth and the infrastructure construction. We use panel data, dividing the country's 31 provinces, municipalities and autonomous regions into 3 parts: the Eastern, the Western, the Central. We study the relationship between economic growth and each production element including infrastructure investment in the 31 provinces during the years 1986-2004. So, we introduce dummy variables in the model, defining the Eastern, the Western, the Central.

$$y_{it} = a_{it} + e_l \cdot l_{it} + e_k \cdot k_{it} + e_G \cdot g_{it} + e_i \cdot D_i + e_j \cdot D_j \cdot x_{jt} \tag{4}$$

The equation (4) adds a dummy variable D_i, when $D_1 = 1$ in the eastern region, then $D_2 = D_3 = 0$ in the central and western region. When $D_2 = 1$ in the central region, then $D_1 = D_3 = 0$ in the eastern and western region.. $D_j \cdot x_j$ is a cross term, x_j is various factors of production, $x_j = k_t, l_t, g_t \cdot e_j$ reflects the difference of output elasticity of the factors of production in different regions. Our study focus the different roles that the investment in infrastructure in different

parts plays, and for the term $e_j \cdot D_j \cdot g_{it}$. When $D_1 = 1, D_2 = D_3 = 0$, $e_j = \overline{e_{g_1}} - \overline{e_{g_{2,3}}}$, it represents the difference between the output elasticity of infrastructure investment in the eastern region and the output elasticity of infrastructure investment in the central and western region.

2.2 The interpretation of data

We weigh total economic output by gross domestic product (GDP), and the national employment represents labor force, and regard total fixed assets investment as total economic investment. Among them, total fixed asset investment is divided into infrastructure investment and non-infrastructure investment. We selected the electricity, gas and water production and supply industry, geological prospecting, water conservancy management industry, transport, storage and telecommunications industries, health, sports and social welfare, education, culture, arts, radio, film and television industry, scientific research and comprehensive technical services in six major industries as infrastructure investment in fixed assets investment. According to Chinese statistical practice, fixed asset investment management channel was divided into capital investment, renovation and investment, real estate investment and other investment four before 2003. According to availability of data, we regard the sum of investment in basic construction and renovation to above-mentioned six great crafts' investment as infrastructure investment, and the infrastructure investment during 1980-1984 did not include the amount of electricity, gas and water production and supply data; After 2003, the statistical classification of fixed asset investment is no longer customary channels, and we are unable to obtain the data of basic investment and renovation investment. Fortunately, we can acquire the above-mentioned six great industries' whole social fixed investments directly. Therefore, the date of infrastructure investment in 2003 and 2004 is the six industries' investment in social fixed assets. After we calculate the infrastructure investment data, we use fixed assets to minus total infrastructure investment getting the non-infrastructure investment. Infrastructure investment and non-infrastructure investments correspond to theoretical models of public and private capital.

3 The Results of the Model

According to Chinese economic geography, we divide 29 provinces, municipalities and autonomous regions into three groups of China. The Eastern includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi and Hainan ,while the Central includes Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei with the Western including Sichuan, Guizhou, Yunnan, Tibet, Shanxi, Gansu, Qinghai, Ningxia and Xinjiang provinces.

The degree of regional economies development presents the character of gradual decrease from eastern, central to western area[8]. The following table shows, the average of the Eastern, the Central and the Western GDP was 43.1, 33.3, 11.7billion dollars ,and the average per capital GDP respectively was 1575, 840, 720 dollars. Through twenty years reform and opening up, our regional economic imbalance further expands, while the phenomenon of imbalance was existed but not very serious in the beginning of the Reform and Opening Period. In 2000, the Eastern, Central and Western area's GDP was respectively 481.1, 292.3, 102.1 billion dollars, per capital GDP was respectively 13685, 6060, 4745 dollars. The expansion of imbalance of regional economy may be explained by the expansion of factor's input. The expansion of regional economic imbalances, disparities can be explained by factor inputs. In 1986, the total investment among the Eastern, the Central and the Western was 2.7:1.9:1. In 2000, this proportion became 3.2:1.64:1. Obviously, the proportion of investment in the Eastern increased more and investment in the Central and the Western regions has narrowed the gap.

Table 1 The Comparison of Economic Growth and Factor Inputs in the Eastern, Western, Central

	Area	GDP	GDP per capita	Labor force	Infrastructure investment	Non-infrastructure investment
1986	The Eastern	431.0008	1575.417	1820.128	13.70333	124.0183
	The Central	333.4411	840.3667	1911.111	8.014444	87.55889
	The Western	117.7289	720.2222	1173.61	5.978889	43.50111
2000	The Eastern	4811.651	13685.42	2375.697	259.2425	1352.075
	The Central	2923.306	6060.889	2584.989	160.4389	668.1367
	The Western	1021.468	4745	1500.629	119.6189	383.8422

Now we proceed to a quantitative research about imbalance of regional economic growth. Because of using a panel data, there is a trade-off between fixed effect and random effects model. Thus, we conducted a Housman test to determine which one to adopt. We compare each two regions and additionally compare the eastern with the west-central region, so we obtain four models. After we use fixed effects and random effects models in each situation, Hausman test results are listed below. The original hypothesis for the Hausman test is: difference in coefficients is not systematic. The choice of fixed effects model is appropriate as the statistic test is greater than the threshold volume. Four fixed-effects model results are shown in the table.

Table 2 Hausman Test Results of Four Models

	The comparison of the Eastern and the Western	The comparison of the Eastern and the Central	The comparison of the Central and the Western	The comparison Of the Eastern and west-central regions
chi2(6)	41.18	32.49	84.8	49.83
Prob>chi2	0	0	0	0

Table 3 The Results of Regional Economic Growth Model

	The comparison of the Eastern and the Western	The comparison of the Eastern and the Central	The comparison of the Central and the Western	The comparison Of the Eastern and west-central regions
Constant	-6.068*	-5.450*	-6.593*	-6.121*
LOG(labor)	1.482*	1.218*	1.482*	1.362*
LOG(infrastructure)	0.091*	0.220*	0.091*	0.148*
LOG(noinfrastructure)	0.619*	0.510*	0.619*	0.576*
d2	-0.318	-0.054	-0.265	-0.197
d3	0.228*	0.099**	0.129*	0.170*
d4	-0.208*	-0.098	-0.109	-0.165*
R^2 (within)	0.972	0.973	0.971	0.971
(between)	0.317	0.752	0.459	0.532
(overall)	0.403	0.760	0.521	0.584
F	1665.730	1717.050	1383.930	2335.200

4 Conclusions

Empirical analysis shows that labor force, investment in infrastructure and non-infrastructure investment in regional economic growth have played a positive role, from the results of panel data. Among them, the output elasticity of labor force is the largest, the output elasticity of infrastructure investment is the smallest, and the output elasticity of non-infrastructure investment is in the middle of them. In addition, the result of model also has found an interesting phenomenon. In the four models, although d2 is negative, it is not statistically significant, which represents that the contribution of labor force in different region has no significant differences; d3 is positive, and it is significant statistically, which represents that the contribution of infrastructure investment in different areas has significant differences. Among them, the contribution of infrastructure investment in the Eastern is higher than in the Central and the Western, the contribution of which in the Central is higher than the Western. Compared the Eastern with the Western and the Eastern with west-central region, d4 is negative apparently. However, d4 is not significant compared in the east-central region with west-central region. The contribution of non-infrastructure investment in the Eastern and the Western or the Eastern and the west-central has significant differences, but the Eastern and Central or the Central and Western does not have significant difference. It says that, the imbalance of regional economic development is not the result of labor force and non-infrastructure investment but is the result of the discrepancy of the infrastructure investment's reward in different areas. Because the Eastern has more infrastructure contribution than the Central and the Western, and the Central has more than the Western, it leads to imbalance in regional economic development.

Seeing the modular values further, we can discover that the coefficient of d3 is maximum which is 0.228 when we make comparisons in the Eastern and Western,; Compared the Eastern with west-central region, the coefficient of d3 follows it which is 0.17; The coefficient of d3 is in the middle of them which is 0.129 making comparisons in the Western and the Central; The coefficient of d3 is the smallest

which is 0.099 compared the Eastern and the Central. This result suggests that, the gap of output elasticity of infrastructure investment between the Eastern and the Western is the biggest, while the gap between the Eastern and Central follows it, then the gap between the Eastern and the Central is the smallest. Obviously, the measurement results are in line with the reality. The Eastern of our country is southeast circumlittoral progress region whose infrastructure is sound and perfect. On the contrary, the Western is economically backward region whose level of infrastructure is low. The situation of the Central is in the middle of them. Therefore, we get a pattern of regional economic development which is from the Eastern to the Central then to the Western just like a descending terrace.

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