The Interregional Allocation of Public Capital and Its Economic Effects

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I. Introduction

There can be no question whatever that public capital is essential for regional economic growth as well as national economic growth. Also it is very closely related to the association between public and private capital. So many authors have argued that public capital(generally, social overhead capital)is most important ingredient of economic growth. On the other hand, some public capital is also required as a prerequisite of private capital investment. In other words, public capital is indispensably required for producing any given private capital in the begining of regional economic growth[1].

The purpose of this paper is to provide some empirical evidence on the economic effects of public capital on regional economy in the case of Japan. In this paper, we discussed mainly on the complementary and substitutive relationship between public

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and private capital in production. Public capital refers to the total capital formation by central and local governments, and public enterprises. And public capital and overhead capital is treated as synonymous. Also private capital and directly productive activities are treated as synonymous. For analizing objective, public capital is subdivided into economic overhead capita land social overhead capital. And it is assumed that public capital has a lot of influence on the regional economic growth. The analysis is concerned with the dimension of economic progress that are definded in terms of the growth rate of per capita regional income. Therefore, this study provides the differences in the potential contributions of public capital to regional economic growth in the two types of region, i. e., low-growth and high-growth regions.

In what follows, section 2 describes the theoritical framework on the association between public capital and regional economy, and the basic assumption and hypothesis on the role of public capital in this study. Section 3 provides the model that is specificated by a Cobb-Douglas production function and the methodology for estimating the parameters of the model, and describes the data used for the analysis. Finally, Section 4 discusses the empirical results of this study and summarizes the some findings.

Ⅱ. The Role of Public Capital

On the relationship between public capital and regional economic growth, the major study is by N. M. Hansen(1965), in which public capital is divided into the two categories, direct productive capital and overhead capital (economic and social overhead capi-

tal). N. M. Hansen made the following hypothesis : economic overhead capital should be most effective in stimulating economic expansion in intermediate developed regions, but social overhead capital is expected to have the greatest impact on lagging regions. Because the lagging regions are unable to compete with intermediate developed regions, they have deficient social overhead capital, and do not offer any significant advantages compared with other regions[2].

Some authors have tested N. M. Hansen's hypothesis, for instance, J. Da Silva Costa, R. W. Ellson, and R. C. Martin (1987), who estimated the elasticity of public capital using a translog production function for states in the United States. Here, their results tend to confirm N. M. Hansen's hypothesis that the ratio of public to private capital is negatively related to the regional output elasticity of public capital However, the fact that public capital will strongly support the economic development of lagging regions is not clear[3]. And an empirica levidence on this issue can be found in K. Hori (1989), who estimated the rate of returns to public and private capital using a Cobb-Douglas production function for the rural and urban areas of Japan. Here, the results indicate that the rate of returns to public capital are greater for the urban areas than for the rural areas[4]. However, another study by J. De Rooy (1978) which calculates the mutipliers of different type of public capital for the sunbelt and snowbelt regions of the United States, no evidence on N. M. Hansen's hypothesis has been found[5].

In this study, the regions are divided into the two types, low-growth and high-growth region according to the growth rate of per capita regional income. The low-growth region which is slow-

ly developed are characteristerized by the shortage of public capital. These regions has two aspects. One has the fact that economic overhead capital do not offer any significant advantages to the regional economic growth, and that social overhead capital is more necessary than economic overhead capital for improving the basic living conditions of the regional residents. In this sense, public capital has still no effect on private capital investment[6]. The other has the fact of the congestive effects of regional economy. Congested regions are characterized by very high concentrations of population, industral and commercial activities, and public capital[7]. The induced effect of public capital on private capital still remains. However, the expansion of private capital investment increases the need for social overhead capital such as water supply, housing, education, and health center etc. It is one of the paradoxes of regional economic growth and development that developed regions can not always afford to be economical. The high-growth regions which is rapidly developed are caused by improving the conditions of the relative efficiency between public and private capital. So to speak, social overhead capital is more or less sufficient, but economical overhead capital offer a significant advantage to the regional economic growth. Therefore, the expansion of public capital creates an induced effect on private capital investment.

In theoretical framework, our principal assumption throughout this study is that the growth rate of per capita regional income depends upon the accumulation of public capital and the relationship between public and priviate capital in production[8]. In our discussion of public capital versus private capital, we made two

hypothesis : that the differences of the elasticities between public and private capital in each region will show that of the low-growth regions smaller than that of the high-growth regions, and that the relationship between public and private capital in production may be complementary in the low-growth regions and substitutive in the high-growth regions.

Ⅲ. The Model and Data

We assume in the model that every region has the same general production function, and that the relationship between regional output and input for each region is expressed in terms of a Cobb-Douglas production function that explicitly includes public capital.

$$Y = A_0 Kp^{\alpha 1} Kg^{\alpha 2} L^{\alpha 3} \tag{1}$$

where regional output (Y) is determined by the factors of production, private capital (Kp), public capital (Kg), and labor (L), that are available, and A_0 is constant. If the technology is homogenous, then the sum of the coefficients on the squared terms and cross effects will be zero. Linear homogeneity required the above conditon plus :

$$\alpha_1 + \alpha_2 + \alpha_3 = 1 \tag{2}$$

The coefficients are estimated with logarithmically linear production function with all the variables divided by the labor.

$$\ln Y - \ln L = \ln A_0 + \alpha_1 (\ln Kp - \ln L) + \alpha_2 (\ln Kg - \ln L) \tag{3}$$

The output elasticity of each input variables is estimated by Equation (3). In addition, as definded earler, public capital is subdivided into the two categories, economic overhead capital(Keg)and social overhead capital (Ksg). Then, Equation (3) is able to be replaced as Equation (4).

$$\ln Y-\ln L=\ln A_0+\alpha_1\ (\ln Kp-\ln L)\ +\alpha_2\ (\ln Keg-\ln L)\\ +\alpha_3\ (\ln Ksg-\ln L) \qquad (4)$$

The estimation of output elasticity using the Equation (4) was shown to be statistically impossible in the preliminary test due to multicollinearity among input variables. Therefore, we attempted to estimate the parameters in the forms of Equation (5) and (6).

$$\ln Y-\ln L=\ln A_{10}+\alpha_{11}\ (\ln Kp-\ln L)\ +\alpha_{12}\ (\ln Keg-\ln L) \qquad (5)$$

$$\ln Y-\ln L=\ln A_{20}+\alpha_{21}\ (\ln Kp-\ln L)\ +\alpha_{22}\ (\ln Ksg-\ln L) \qquad (6)$$

In this study, the technological functional relationship in the production process among regions and over time is neglected. Even though technical progress over time is introduced by an of an exponential neutral tachnical progress, the question of interregional heterogeneity remains. One method of avoiding the problem is to estimate a production function for each region from the regional time series data. Twenty-three observations which we have compiled are, however, insufficient for estimating production functions with the three input variables, private capial, public capital and labor[9]. Therefore, for estimating the regional production functions, cross-section and time series data for each region are

pooled to make the number of observations sufficiently large, more than 92, for statistical purposes. The parameters of the model is estimated by the Ordinary Least Squares Method.

The basic data compiled in this paper come from The Annual Report On Prefectural Accounts of Japan published by Economic Planning Agency (EPA). The Economic Planning Agency publishes national estimates of public and private capital, and labor[10]. However, prefectural estimates of public and private capital is not available from the Economic Planning Agency or any other governmental angency. Therefore, the values of public and private capital for prefectures are calculated using a benchmark year method.

Firstly, The national estimate of public capital is provided by Economic Planning Agency. In this paper, the stock of public capita by region (prefecture) is calculated by the national estimate as distributing proportionally to Kg^i which is defined as :

$$Kg^i(t+1) = Kg(t) + [Kg(t+1) - Kg(t)] [Ig^i(t+1) / Ig(t+1)]$$

where Kg is national stock of public capital, i is individual regions, Ig is national value of public investment, and t is years (1965-1987). The value of public capital by prefectures is aggregated into the gross values of 11 variables, roads, agricultural and fishery industry, harbor facilities, industrial water supply, airport facilities, soil and water conservation, educational facilities, waterworks, sewerage system, seabord conservation, park facilities, etc.

Secondly, the stock of private capital by region (prefecture) is used the national estimate of private capital which is provided by

the Economic Planning Agency. Also the stock of private capital by region is distributed proportionally to Kg^i which is defined as :

$$Kp^i(t+1) = kp(t) + [Kp(t+1) - Kp(t)] [Ip^i(t+1) / Ip(t+1)]$$

where Kp is the national stock of private capital, i is the individual regions, Ip is the national value of private investment, and t is years (1965-1989). Private capital refers to the gross capital stock of private enterprises for each prefectures. It is constucted from annual capital outlays for the 1965-1987 period.

Thirdly, the estimates of labor by region (prefecture) are provided by The Economic Planning Agency. However, those of labor are not available in the period of 1966-1969. Thus, we estimated the labor of each region by using the method of geometric mean for the blank periods. In addition, the data of labor are from The Annual Report On Prefectural Accounts of Japan. We recognize that our procedures are imperfect, and alternatives are numerous. We believe that our estimates are, however, consistent and reasonable.

The regions employed that are provided in Table 1. The re-

Table 1 : The list of the low-growth and high-growth regions

	growth rate (%)	prefectures
low-growth regions	3.58～3.85	Osaka, Wakayama Hiroshima, Nara
high-growth region	5.38～5.60	Yamanashi, Ibaraki Tochiki, Okayama Kumamoto, Hukushima

gions are sellected by the level of anual average rate that is calculated by the per capita regional income from 1965 to 1987.

IV. Results and Conclusion

We can now discuss the empirical results how public capital is related to regional economic growth. The estimated parameters of Equation (3), (5), and (6) for the two types of region are provided in Table 2. The importance of public capital is apparent in the results of the two types of region, low-growth and high-growth regions. All the coefficients are positive and highly significant.

The output elasticities of private capital, α_1, evaluated 0.2941, and 0.4952, and that of public capital, α_2, evaluated 0.1636, and 0.1335 for the low-growth and high-growth regions, respectively. These differences of the output elasticities between public and private capital refer to complementary relationship for high-growth regions, and substitutive relationship for low-growth regions. It is interesting to note that the hypothesized inverse association between public and private capital. This hypothesis is also clear-cut in the cases of economic and social overhaed capital, respectively (see the estimated parameters of equation 5 and 6).

In this paper, we discussed the role of public capital in production at the regional level, and the estimation of regional production function by a neoclassical model with empirical results of Japan. The empirical evidence from this study indicates that the role of public capital with relation to private capital in production process was confirmed. In addition, N. M. Hansen's hypothesis on the relative efficiency of economic and social overhead capital

TABLE 2 : ESTIMATED PARAMETERS OF REGIONAL PRODUCTION FUNCTION

		Low-growth regions	High-growth regions
Equation (3)	A_0	0. 1463 (14. 3442)	0. 1925 (17. 3759)
	α_1	0. 2941 (3. 6059)	0. 4952 (7. 9417)
	α_2	0. 1636 (2. 7544)	0. 1335 (2. 4617)
	R^2	0. 8950	0. 9674
Equation (5)	A_{10}	0. 1837 (23. 3286)	0. 2429 (31. 1369)
	α_{11}	0. 4318 (4. 9078)	0. 5355 (9. 8247)
	α_{12}	0. 0577 (0. 9376)	0. 0889 (2. 0069)
	R^2	0. 8856	0. 9653
Equation (6)	A_{20}	0. 1364 (21. 6510)	0. 2143 (42. 3479)
	α_{21}	0. 2697 (4. 1542)	0. 5475 (10. 9105)
	α_{22}	0. 1923 (3. 9025)	0. 0956 (2. 0169)
	R^2	0. 9039	0. 9669

Note : T-statistics are in parenthesis.

for regions in Japan was also confirmed.

Notes

1) Albert O. Hirschman (1958), *The Strategy of Economic Development*, Yale University Press, p. 86.

2) Niles M. Hansen (1965), "Unbalanced Growth and Regional Development", *Western Economic Journal*, Vol. 4, Western Economic Association, pp. 3-14.

3) Jose Da Silva Costa, Richard W. Ellson, and Randolph C. Martin (1987), "Public Capital, Regional Output, and Development : Some Epirical Evidence", *Journal of Regional Science*, Vol. 27, Regional Science Association, pp. 419-437.

4) Kaname Hori (1989), "On the Economic Effect of Public Investments", *Journal of Kobe University of Commerce (The Shodai Ronshu)*, Vol. 41, Kobe University of Commerce, pp. 79-102.

5) Jacob De Rooy (1978), "Productivity of Social Overhead Capital : North South Comparisons", *Review of Business and Economic Research*, Vol. 14, University of New Orleans, pp. 45-59.

6) Ibid. p. 82. And See M. A. Rahman (1963), "Regional Allocation of Investment", *The Quarterly Journal of Economics*, Vol. 77, Harvard University Press, pp. 26-39 ; N. Sakashita (1965), "Regional Allocation of Investment and Economic Growth", *The Economic Review (Keizai Kenkyu)*, Vol. 16, The Institute of Economic Research, Hitotsubashi University, pp. 177-182 ; Y. Ohtsuki (1970), "Optimal Path of Capital Accumulation and Pontryagin's Maximum Principle", *The Economic studies Quarterly (Riron Keizaigaku)*, Vol. 21, The Journal of The Japan Association of Economics and Econometric, pp. 32-40.

7) Niles M. Hansen, op. cit. pp. 5-6.

8) See Tetsuya Nosse(1982), *Econometric Analysis of Public Finance*, Sobun Publisher, pp. 78-101. In this paper, Professor Tetsuya Nosse confirmed that the complementary and substitutive relationship between public and private capital depends upon the stock amount of public capital at national level in the case of Japan.

9) K. Mera (1973), "Regional Production Functions and Social Overhead Capital : an analysis of the Japanese case", *Regional and Urban Economics*, Vol. 3, Regional and Urban Economics Association, p. 162.

10) The data from *Social Overhead Capital : from flow to stock*,

Economic Planning Agency, Gyosei Publisher, 1986 ; *Government Investment* (Gyousei Toushi), The Ministry of Home Affairs, 1965-1989 ; *Annual Report On Prefectural Accounts from 1955 to 1989*, Economic Planning Agency, 1991 ; *Annual Report On Prefectural Accounts 1991*, Economic Planning Agency, 1991.

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