ESTIMATING THE EFFECTS OF MOVING CAPITAL FUNCTIONS ON THE TOKYO METROPOLITAN AREA[1]

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ABSTRACT In order to solve the Tokyo monopolar problem, the Japanese government has proposed a controversial policy that is to move the capital functions from Tokyo to the other places of the country. The paper presents an approach and a case study to estimate the effect of this policy on the Tokyo metropolitan area by comparing the spatial distributions of agglomeration economies and diseconomies within the area with and without the implementation of the policy. The effects are estimated by using the cubic-spline function approach and other regression methods, and the estimation results of two extreme cases are obtained. Firstly, in the most effective case that the removal of capital functions is supposed to give rise to the reduction of agglomeration economies and diseconomies not only at the area centre but also at all the other locations as well, such a relocation policy would reduce the total agglomeration economies resulting from the whole area to become smaller than the total diseconomies, which would lead to a decrease in the global city size of the area. Secondly, in the least effective case where it is assumed that such a removal would only cause the decreases in the agglomeration economies and diseconomies at the area centre, the relocation policy would not affect the existent balance of the total agglomeration economies and diseconomies very much (i.e., the former would still remain greater than the latter), which means that the Tokyo monopolar situation would not be changed by the capital-moving policy. Notwithstanding these different results, both of these two cases indicate that the peripheral cities and the outskirts of the Tokyo metropolitan area would be affected by the removal of capital functions from the area centre.

1. INTRODUCTION

In order to solve the Tokyo monopolar problem, which implies not only the spatial over-concentration of various economic activities but also the over-centralisation of the Japanese political powers in Tokyo, the Japanese government has proposed a long-term policy that is to move the capital functions including the three national powers of administration, legislature and judicature from Tokyo to some other places of the country in the early years of the 21st century.

This large-scale relocation policy would definitely bring about great impacts on

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[1] This is a revised version of a paper presented at the 22nd Australian and New Zealand Regional Science Association Conference, Tanunda, South Australia, 21-23 September 1998. The author is indebted to the conference participants for their useful comments. Special thanks are due to John Mangan, the editor, and referees of the journal for their valuable suggestions. However, all remaining errors are the possibility of the author.

Tokyo as well as on the rest of the country. The purpose of this paper is to estimate its effects on the Tokyo metropolitan area by investigating the spatial distributions of agglomeration economies and diseconomies within the area with and without the implementation of the policy. It will be shown that firstly, in the most effective case that the removal of capital functions is supposed to give rise to the reduction of agglomeration economies and diseconomies not only at the area centre but also at all the other locations as well, such a relocation policy would reduce the total agglomeration economies resulting from the whole area to become smaller than the total diseconomies, which would lead to a decrease in the global city size of the area. Secondly, in the least effective case where it is assumed that such a removal would only cause the decreases in the agglomeration economies and diseconomies at the area centre, the relocation policy would not affect the existent balance of the total agglomeration economies and diseconomies very much (i.e., the former would still remain greater than the latter), which means that the Tokyo monopolar situation would not be changed by the capital-moving policy. Regardless of this difference, both of these two cases indicate that the peripheral cities and the outskirts of the Tokyo metropolitan area would be affected by the removal of capital functions from the area centre.

The paper is organized as follows. In Section 2, the basic idea and model used here to measure the policy effects will be explained, and the existent spatial distributions of the agglomeration economies and diseconomies before (or without) the implementation of the relocation policy will be presented as a standard for comparison. Against this standard, the possible distributions of the agglomeration economies and diseconomies after (or with) the implementation will be estimated and discussed for the following two extreme cases, the most effective case in Section 3 and the least effective case in Section 4, respectively. Finally, Section 5 will conclude the paper and suggest some policy implications from this empirical work.

2. THE BASIC MODEL AND ESTIMATION

2.1. The Basic Model and Estimation Approach

The basic idea behind the estimation of the effects brought about by the capital-moving policy is that these effects could be measured by comparing the spatial distributions of the agglomeration economies and diseconomies within the Tokyo metropolitan area with (or after) and without (or before) the implementation of the policy. If, for example, the balance of such agglomeration economies and diseconomies resulting from some certain locations is altered by the policy, the agglomeration of population and/or the other economic functions there would undergo a change. If not, by contrast, the local economies could be considered to remain unchanged. This is because an urban (or metropolitan) area results from the agglomeration of population within a limited regional space due to the economies of agglomeration, and its growth and decay is depending upon the economies and diseconomies generated from such agglomeration, which has been pointed out by many urban economists (e.g. Henderson, 1977; Kanemoto, 1980; Fujita, 1989).

These agglomeration economies and diseconomies at a location, say x (i.e., it is x units of distance away from the urban centre), based on some acceptable assumptions, can be represented by the annual wage offered at the location to daytime workers and the annual income of a household residing at that location at night, respectively. The theoretical model is as follows (also refer to Zheng, 1998).

Suppose that the urban economy in question is composed of only two economic actors, firms and households. Concerning the behaviour of firms, it is assumed that the production function of a firm located at x is given as

$$Q(x) = G(x)N(x)^a L_f(x)^b, \qquad a + b = 1 \tag{1}$$

where $Q(x)$, $N(x)$ and $L_f(x)$ express the amounts of product, labour and land, respectively; $G(\bullet)$ is the positive effect of agglomeration received by the firm, which is dependent on the daytime population density denoted as $m(x)$. More specially, it is assumed $G(\bullet)$ has the following expression as

$$G(x) = Am(x)^c \tag{2}$$

In the above two equations, A, a, b and c are all positive parameters.

By supposing that the firm is to maximise its profit by choosing appropriate amounts of labour and land inputs, and that in the long-term equilibrium the firm's profit will ultimately fall to zero, the following important equation can be easily obtained

$$w(x) = Aapm(x)^{c-b} \tag{3}$$

where $w(x)$ is the wage offered at x to the workers and p is the price of the product given at the national or international market. That is, the wage is a function of the daytime population density.

Now, turning to the side of households, it is assumed that the utility function of a household living at x is given as

$$U(x) = C(x)^\alpha L_h(x)^\beta / Z(x), \qquad \alpha + \beta = 1 \tag{4}$$

where $U(x)$, $C(x)$ and $L_h(x)$ mean the utility level realized, amounts of composite goods and land consumed, respectively. $Z(x)$ represents the negative effect of agglomeration generated at x, which is assumed to be a function of the night-time population density denoted by $n(x)$, i.e.,

$$Z(x) = Bn(x)^\gamma \tag{5}$$

Here, B, α, β and γ are all positive parameters.

Suppose that the household is to maximise its utility level under the budget constraint that the household's income is used for the consumption of composite goods and land. The long-term equilibrium will give the household's income, denoted by *y(x)*, as follows

$$y(x)=\left(\frac{p}{\alpha}\right)\left(B\overline{U}\right)^{\frac{1}{\alpha}}n(x)^{\frac{\beta+\gamma}{\alpha}} \tag{6}$$

in which $\overline{U}$ is the equilibrium utility level given. The above equation means that the household's income is a function of the night-time population density.

Notice that the wage offered to the workers at x, or $w(x)$, is the payment for their marginal products, it can be considered as the benefit received by the workers at x. Suppose that the opportunity benefit (i.e., the benefit that people would gain if they did not work in the urban area) at x is w_0, which , theoretically, has the same value as the wage at the boundary of the urban area. Then, the difference of $w(x)$ and w_0, or $w(x)$ - w_0, is the monetary value of the economies (or benefit) resulted from the urban agglomeration at x.

On the other hand, since the household's income at x, or $y(x)$, has the nature of compensating for all the costs and negative externalities occurred at the location, it can be considered as the total cost for people to bear at x. Assume that the opportunity cost (i.e., the cost that people would bear if they did not live in the urban area) at x is y_0, which would theoretically equal the cost for people to bear at the urban area's boundary. By assuming the perfect intra-urban mobility, the difference of $y(x)$ and y_0, or $y(x)$ - y_0, just measures the compensation for the diseconomies (or costs) resulted from the urban agglomeration at x.

Based on the above arguments, if the opportunity benefit (w_0) and cost (y_0) are relatively small when compared to the benefit and cost generated within the urban area, as it is in the real world, the urban agglomeration economies and diseconomies at x could be represented only by $w(x)$ and $y(x)$, respectively.

Furthermore, even if it is not assumed that w_0 and y_0 are very small, by supposing a long-term equilibrium for the labour market in the rest of the urban economy, the opportunity benefit should be equal to the cost, i.e., $w_0 = y_0$. In that case, since

$$\left[w(x)-w_0\right]-\left[y(x)-y_0\right]=w(x)-y(x) \tag{7}$$

the difference of $w(x)$ and $y(x)$ could be used to measure the balance of agglomeration economies and diseconomies at the location x so as to evaluate the effects brought about by various public policies[2].

Concerning the estimation approach used in this paper, firstly, it should be noted that according to the above theoretical results, equations (3) and (6), the monetary values of agglomeration economies and diseconomies are dependent on the day- and night-time population densities. Since these population densities are

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[2] The theoretical explanation here is partly suggested by an anonymous referee of the journal, which should be gratefully acknowledged.

basically brought about by the agglomeration of industries and other socio-economic activities, such economies and diseconomies can be decomposed into several important factors for further estimation in the following sections.

Secondly, to see the spatial distributions of agglomeration economies and diseconomies, and to compare their magnitude for all locations, it is important to accurately estimate *w(x)* and *y(x)* as functions of the distance between the urban centre and the location in question. For this reason, the cubic-spline function approach could be applied, which uses piecewise, continuous cubic polynomials, having great flexibility to describe the relationships between the diseconomies and distance of various patterns. In more detail, if the distance interval in question, denoted as (x_0, x_b), could be divided into k segments of equal length, and the dividing knots be x_i $(x_i < x_{i+1},\ i = 1,2,.., k\text{-}1)$, the cubic-spline function can be given as

$$z(x) = a + b(x - x_0) + c(x - x_0)^2 + d_1(x - x_0)^3 + \sum_{i=1}^{k-1}(d_{i+1} - d_i)(x - x_i)^3 D_i + v \quad (8)$$

where *z(x)* is the dependent variable [here, *w(x)* or *y(x)*], x is the distance between the centre and the location in question; a, b, c and d_i are the parameters to be estimated; v is a normally distributed disturbance term with zero mean and constant variance; and D_i is a dummy variable such that

$$D_i = \begin{cases} 1, & \text{if } \quad x \geq x_i \\ 0, & \text{otherwise} \end{cases} \quad (9)$$

Since the cubic-spline estimation is just a multiple regression with about $k + 3$ parameters, a, b, c, d_i and $(d_{i+1} - d_i)$, it can be carried out by using any standard regression procedure. Concerning the optimal number of segments k in equation (8), a few cases of different segments can be estimated, from which the most appropriate case could be chosen as the final estimation result based on the significance of estimates and also the fit of the regression.

2.2. Estimation of the Present Agglomeration Economies and Diseconomies

Using the cubic-spline function approach, the spatial distributions of the present (i.e., before the implementation of the capital-moving policy) agglomeration economies and diseconomies within the Tokyo metropolitan area will be estimated in this subsection.

Here, the Tokyo metropolitan area is defined as an urban space within a range of 50km from the Tokyo railway station as the area centre (Figure 1). It contains 129 cities, towns and villages (or *shi*, *machi* and *mura* in Japanese), which administratively belong to Tokyo Metropolis, Kanagawa Prefecture, Chiba Prefecture, Saitama Prefecture and Ibaraki Prefecture, and 23 special districts (*ku*) of Tokyo Metropolis.

The data used in estimation are those of 1990 at the level of cities, towns, villages and districts, which are gathered and processed from different sources as follows. Firstly, the data on per capita wage (w) are processed on the basis of total wages from the *Census of Manufactures* (Ministry of International Trade and Industry, 1990). That is, the total annual wages are multiplied by the employee ratio of total industries to manufacturing, and then divided by population, taken from the *Population Census of Japan* (Japan Statistics Bureau, 1990).

Secondly, the data of per capita income (y) are based on the total of taxable annual income, as provided by the Ministry of Home Affairs (Toyo Keizai, 1994). That is, the income total is divided by the population total. Since, at the level of towns and villages, the income data of 1990 are missing, those of 1991 are used instead.

Finally, the distance of each city, town, village and district to the area centre is measured as a straight-line distance between the location of its local government and the Tokyo station.

In estimation, the data at the level of cities, towns, villages and districts are group data, that would result in a bias in coefficients because of the heteroscedasticity of data (see Judge *et al*, 1980). To correct this bias, the weighted least-squares method (WLS) is used instead of ordinary least-squares (OLS). The weight used could be defined as the function of some data variables that are supposedly related with the variance of error term.

Using the WLS procedure and letting the per capita wage be the weight, the cubic-spline estimation of the agglomeration economies yields

$$\begin{aligned} \log w(x) = {} & 9.45642 - 0.793387(x-1.7) + 0.042093(x-1.7)^2 \\ & (179.530)\,(\text{-}25.2640) \qquad\qquad (15.8156) \\ & - 0.000684214(x-1.7)^3 + 0.000918519(x-25.8)^3 D_1 \\ & (\text{-}12.1930) \qquad\qquad\qquad (7.54399) \\ & \tilde{R}^2 = 0.955431 \end{aligned} \tag{10}$$

where, D_1 is the dummy variable defined as follows

$$D_1 = \begin{cases} 1, & \text{if} \quad x \geq 25.8 \\ 0, & \text{otherwise} \end{cases} \tag{11}$$

where figures in parentheses are associated t values and $\tilde{R}^2$ is adjusted R-squared. Here, it should be noted that the use of the dependent variable, per capita wage, as the weight in WLS seems to be a little strange. In fact, by some trial and error, the variance of error term in the regression equation is found to have a stronger relation with the per capita wage than other variables, but, this would probably raise some econometric problems, which needs more consideration in the future.

Similarly, the cubic-spline estimation of the agglomeration diseconomies gives

Figure 1. Tokyo Metropolitan Area

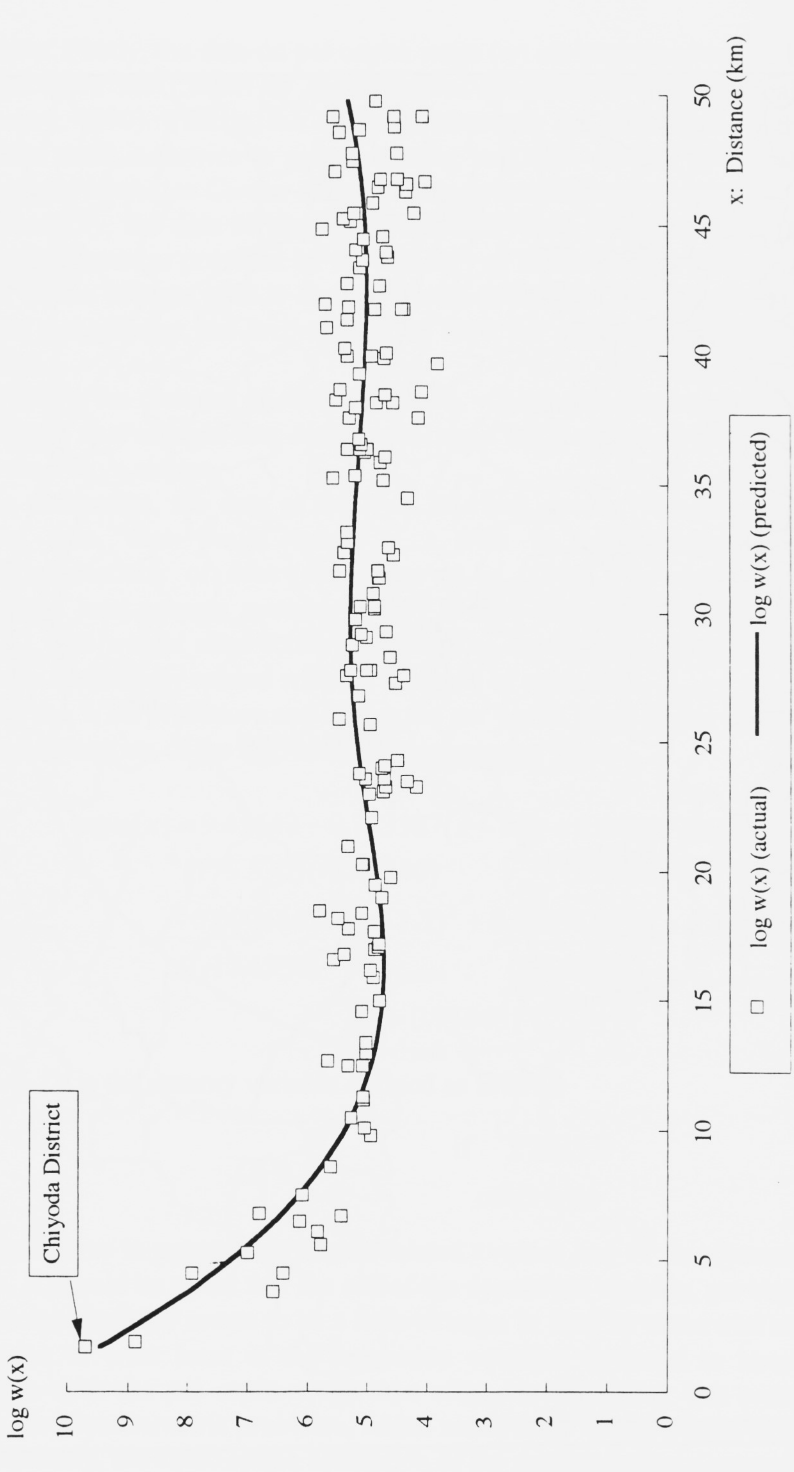

Figure 2a. The Present Agglomeration Economies Before the Policy

Figure 2b. The Present Agglomeration Diseconomies Before the Policy

$$\log y(x) = 6.19366 - 0.193257(x-1.7) + 0.010629(x-1.7)^2$$
$$(260.354)\,(-13.6257) \qquad (8.84220)$$
$$-0.000181774(x-1.7)^3 + 0.000274483(x-25.8)^3 D_1$$
$$(-7.17227) \qquad (4.99155)$$
$$\widetilde{R}^2 = 0.876189 \qquad (12)$$

in which D_1 has the same form as defined by (11).

By drawing these two estimated functions with the actual data in Figures 2a and 2b, respectively, and the two functions together in Figure 3, the spatial distributions of the present agglomeration economies and diseconomies can be analysed and compared. From Figure 3, firstly, it can be seen that within the central area having a radius of about 10km, and a ring between 25km and 40km of the Tokyo railway station (where many peripheral cities exist), the agglomeration economies seem to be greater than the diseconomies. This means that in the central and peripheral cities where business and commercial functions are very agglomerated, the resulting economies exceed the diseconomies such as traffic congestion and environmental pollution.

Next, in the zone of 10-25km from the centre, the agglomeration economies become smaller than the diseconomies. This is because that within this area, since there exist very few large central cities, the economies of agglomeration are rather low and cannot offset the high diseconomies resulting from the heavy traffic and high night-time population density there.

Finally, by looking at the total agglomeration economies and diseconomies generated from the whole Tokyo metropolitan area, it can be easily confirmed from Figure 3 that the area under the agglomeration economies curve log $w(x)$ is larger than that under the diseconomies curve log $y(x)$. As a result, the total agglomeration economies are greater than the total diseconomies. Here, if the optimality of city size is defined as such a case that the benefit resulted from the city is larger than the cost, which means that such a city size could make positive revenue or surplus for the whole urban economy including the firms and households, the global city size of the Tokyo metropolitan area as a whole could be considered to be optimal and would last till the balance of the economies and diseconomies is changed.

3. ESTIMATING THE EFFECTS

3.1 The Most Effective Case

The policy that the Japanese government has proposed to move the capital functions from Tokyo to other places includes the removal of the national administration, legislation and judicature, in which 54,000 government workers are now employed, from Tokyo, and the construction of a new capital with a final scale of 600,000 population at a location about 60-300km away from Tokyo, in the

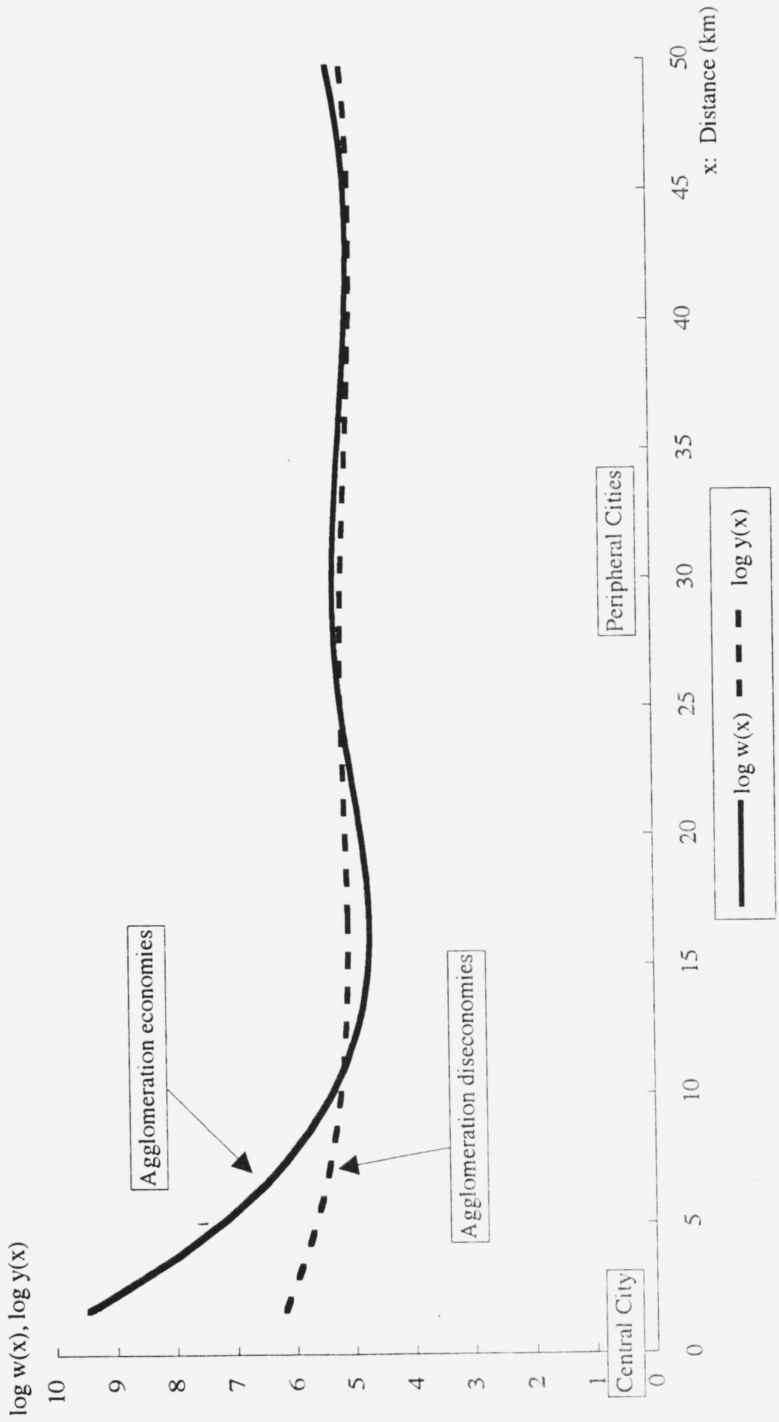

Figure 3. The Present Agglomeration Economies and Diseconomies Before the Policy

early years of the 21st century.

To estimate its effects on the Tokyo metropolitan area, it is important to measure the impacts that the removal of these 54,000 government employees will impose upon the economies and diseconomies of agglomeration generated within the area. According to the theoretical results, or equations (3) and (6), in the last section, such economies and diseconomies of agglomeration are dependent on the daytime and night-time population densities, respectively. Since the population densities basically result from the spatial concentration of such main industrial and economic functions as the corporate headquarters, financial industries and governmental organizations, the daytime and night-time densities can be thought to be the functions of the agglomeration of these functions, i.e.,

$$m(x) \equiv f\left[E_1(x), E_2(x), E_3(x), \cdots\right] \tag{13}$$

$$n(x) \equiv g\left[E_1(x), E_2(x), E_3(x), \cdots\right] \tag{14}$$

where $E_1(x)$, $E_2(x)$, $E_3(x)$ and so forth are the ratios of employment of the finance and insurance industrial workers, the governmental workers, the management workers, and other types of workers to the total industrial employment at the location x. Substitution of the above two equations into equations (3) and (6), respectively, and rearrangement yield the following expressions

$$w(x) \equiv F\left[E_1(x), E_2(x), E_3(x), \cdots\right] \tag{15}$$

$$y(x) \equiv G\left[E_1(x), E_2(x), E_3(x), \cdots\right] \tag{16}$$

Here, $f[...]$, $g[...]$, $F[...]$ and $G[...]$ are all symbols of mathematical functions. Notice that the employment ratios are based on different classifications of industries and occupations. The total of employment ratios, i.e., $E_1(x) + E_2(x) + E_3(x) + \ldots$, should not necessarily equal one. Moreover, for any two tracts which are equal-distant from the Tokyo station, the above equations mean that $E_1(x)$, $E_2(x)$ and $E_3(x)$ would have the same values. But in the real world, they are definitely different from each other, depending also on which railway lines or highways the tract's locations are nearby. In this sense, the study area should be divided into several radial sub-areas in accordance with the main railway lines starting from the Tokyo station. This subject is left for further study in the future.

Using the data of these industries and occupations taken from the *Population Census of Japan* (Japan Statistics Bureau, 1990), a regression estimation of equations (15) and (16) is carried out. The method used is such a basic econometric approach that can be briefly stated as follows. First of all, the functional forms of $F[...]$ and $G[...]$ in equations (15) and (16) are specified to be linear, or exponential, or the like. Secondly, by using some standard regression procedure such as ordinary least-squares (OLS), equations (15) and (16) are estimated with relation to a certain combination of explanatory variables described in the foregoing. And thirdly, the estimation result will be evaluated to see whether the signs of estimated coefficients are the same as expected from the theoretical model, to what extent these estimates are statistically significant, and how much the actual data have been explained by the regression obtained. If the estimation result is not satisfied, the estimation will be carried out from the first step once again, with the functional forms redefined and/or the explanatory variables recombined. To state only the result of such trial and error here, the final estimation result are as follows

$$\log w(x) = 2.98172 + 12.2479E_1(x) + 2.35600E_2(x) + 45.4684E_3(x)$$
$$(12.3484)\ (3.40773)\qquad (0.800816)\qquad (7.34365)$$
$$\tilde{R}^2 = 0.712762 \tag{17}$$

$$\log y(x) = 4.50185 + 3.62528E_1(x) + 1.69435E_2(x) + 11.9817E_3(x)$$
$$(57.8706)\ (3.130913)\qquad (1.787676)\qquad (6.00684)$$
$$\tilde{R}^2 = 0.638262 \tag{18}$$

It should be noted that $E_2\ (x)$, which represents the agglomeration of governmental workers at x, is not satisfactorily significant in equations (17) and (18). This is probably because that the data of governmental employment include not only people working in the central government but also those in the local (Tokyo Metropolis and others) governments, due to the limitation of data. It leaves one more subject for further study in the future. In this paper, since it is widely recognised within the Japanese public that the spatial concentration of governmental functions have greatly contributed to the agglomeration of other economic activities in Tokyo, the estimated results of equations (17) and (18) will be still used in the following policy analysis.

While using these estimation results to measure the effects of the capital-moving policy, one would note that all the 54,000 government employees to be removed are at present working in Chiyoda District of Tokyo Metropolis, which has a mean distance of 1.7 km (i.e., x=1.7) away from the area centre, Tokyo station. By putting this information into the previously estimated cubic-spline functions (10) and (12), the following can be derived

$$\log w(x = 1.7) = 9.45642 \tag{19}$$
$$\log y(x = 1.7) = 6.19366 \tag{20}$$

which mean that the first parameter to be estimated [or parameter a in the cubic-spline function (8)] is just the actual value of the data of Chiyoda District (or, of the first tract in question nearest to the area centre). Thus, the estimated equations (10) and (12) can be rewritten as

$$\log w(x) = \log w(x = 1.7) - 0.793387(x - 1.7) + 0.042093(x - 1.7)^2$$
$$- 0.000684214(x - 1.7)^3 + 0.000918519(x - 25.8)^3 D_1 \tag{21}$$

$$\log y(x) = \log y(x = 1.7) - 0.193257(x - 1.7) + 0.010629(x - 1.7)^2$$
$$- 0.000181774(x - 1.7)^3 + 0.000274483(x - 25.8)^3 D_1 \tag{22}$$

Suppose that the capital functions have been removed and there has been a decrease of 54,000 government employees in Chiyoda District. According to the estimated equations (17) and (18), such a decrease in the government employment, while keeping other variables unchanged, will cause reductions in the economies and diseconomies of agglomeration generated within this district, and their values after (or with) the implementation of the capital-moving policy can be easily calculated as follows

$$\log w(x = 1.7)' = 8.25138 \qquad (23)$$

$$\log y(x = 1.7)' = 5.97127 \qquad (24)$$

Substitution of the above two values into equations (21) and (22) again will yield the cubic-spline functions of the agglomeration economies and diseconomies after (or with) the implementation of the policy as follows

$$\log w(x)' = 8.25138 - 0.793387(x - 1.7) + 0.042093(x - 1.7)^2 - 0.000684214(x - 1.7)^3 + 0.000918519(x - 25.8)^3 D_1 \qquad (25)$$

$$\log y(x)' = 5.97127 - 0.193257(x - 1.7) + 0.010629(x - 1.7)^2 - 0.000181774(x - 1.7)^3 + 0.000274483(x - 25.8)^3 D_1 \qquad (26)$$

By illustrating these two functions along with equations (10) and (12) in Figure 4, the effects of the capital-moving policy on the spatial distributions of agglomeration economies and diseconomies become very clear. From the figure, it can be seen that both the curves of agglomeration economies and diseconomies are shifted vertically down by the removal of capital functions from the area centre, which means that the decrease in government employment would bring about the reduction of the agglomeration economies and diseconomies at all locations within the area. Furthermore, since the reduction of the agglomeration economies caused by the removal of government employees is greater than that of the diseconomies [see the coefficients in equations (17) and (18)], after the implementation of the relocation policy, the agglomeration economies would become smaller than the diseconomies for most locations except for the central area. Most importantly, from the figure it seems that the total agglomeration economies generated from the whole area would become smaller than the total diseconomies. So, it can be concluded that after the implementation of the capital-moving policy, the local city size of most locations within the area, and then the global city size of the whole Tokyo metropolitan area would decrease. In this case, the Tokyo monopolar situation would be changed.

Finally, it should be noted that the preceding estimation results are based on an assumption that the decrease in government employment at the area centre, Chiyoda District, would have the same impact on the agglomeration economies

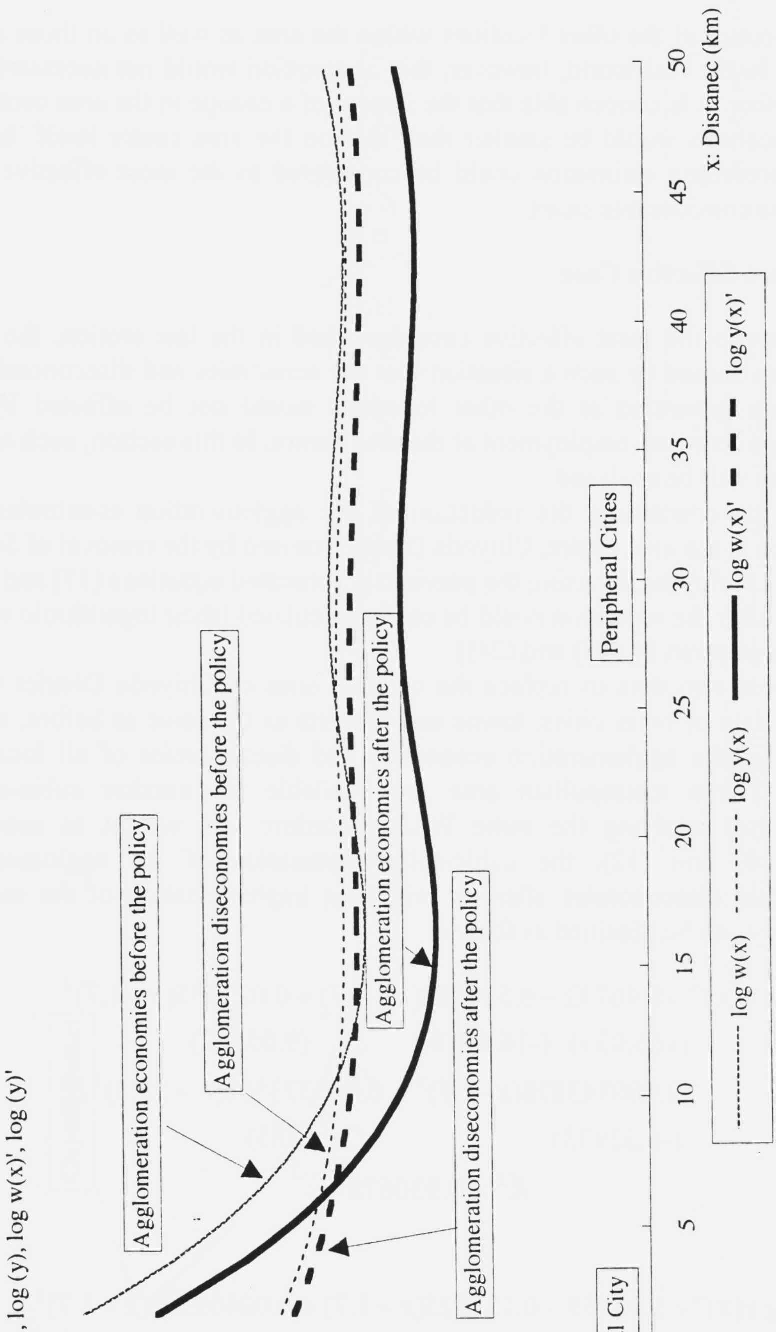

Figure 4. Agglomeration Economies and Diseconomies Before and After the Policy (the most effective case)

and diseconomies at the other locations within the area as well as on those at the area centre. In the real world, however, this assumption would not necessarily be realized. Rather, it is conceivable that the impact of a change in the area centre on the other locations would be smaller than that on the area centre itself. In this sense, the preceding estimation could be considered as the most effective case among all the considerable cases.

3.2 The Least Effective Case

In contrast to the most effective case described in the last section, the least effective case should be such a situation that the economies and diseconomies of agglomeration generated at the other locations would not be affected by the decrease in government employment at the area centre. In this section, such a least effective case will be analysed.

First of all, concerning the reduction of the agglomeration economies and diseconomies at the area centre, Chiyoda District, caused by the removal of 54,000 government employees, by using the previously estimated equations (17) and (18), their values after the reduction could be easily calculated [their logarithmic values are the same as given by (23) and (24)].

Using these two data to replace the original ones of Chiyoda District while keeping the data of other cities, towns and districts as the same as before, a new set of data on the agglomeration economies and diseconomies of all locations within the Tokyo metropolitan area are available for another cubic-spline estimation. Just applying the same WLS procedure and weight as used for equations (10) and (12), the cubic-spline estimation of the agglomeration economies and diseconomies after (or with) the implementation of the capital-moving policy can be obtained as follows

$$\begin{aligned} \log w(x)'' = {} & 8.46742 - 0.504962(x-1.7) + 0.023335(x-1.7)^2 \\ & (166.035) \quad (-16.6078) \qquad\qquad (9.05561) \\ & - 0.000343878(x-1.7)^3 + 0.000373553(x-25.8)^3 D_1 \\ & (-6.32933) \qquad\qquad\qquad (3.16885) \\ & \tilde{R}^2 = 0.930678 \end{aligned} \tag{27}$$

$$\begin{aligned} \log y(x)'' = {} & 5.95455 - 0.123525(x-1.7) + 0.00609358(x-1.7)^2 \\ & (327.071) \quad (-11.3803) \qquad\qquad (6.62410) \\ & - 0.0000994915(x-1.7)^3 + 0.000142727(x-25.8)^3 D_1 \\ & (-5.12963) \qquad\qquad\qquad (3.39157) \\ & \tilde{R}^2 = 0.881995 \end{aligned} \tag{28}$$

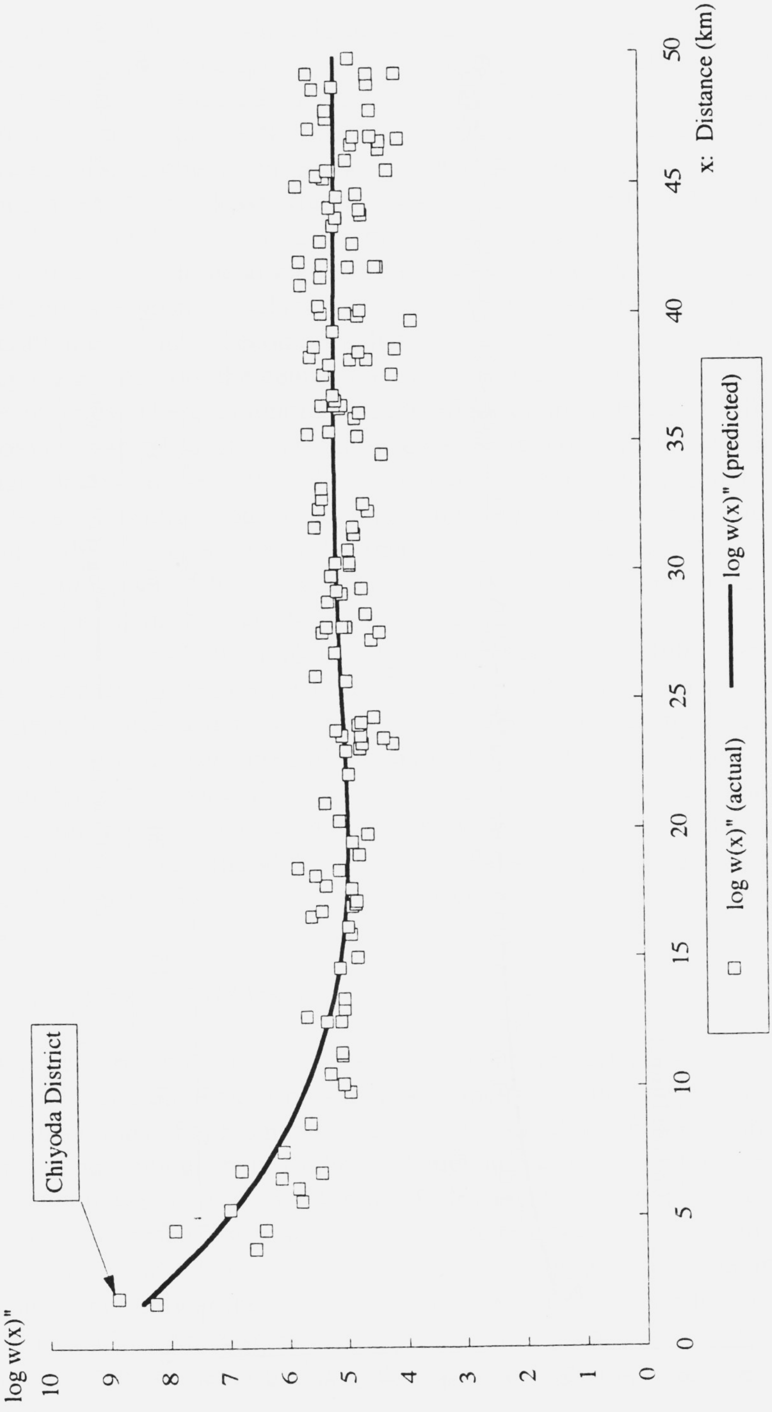

Figure 5a. Agglomeration Economies After the Policy
(the least effective case)

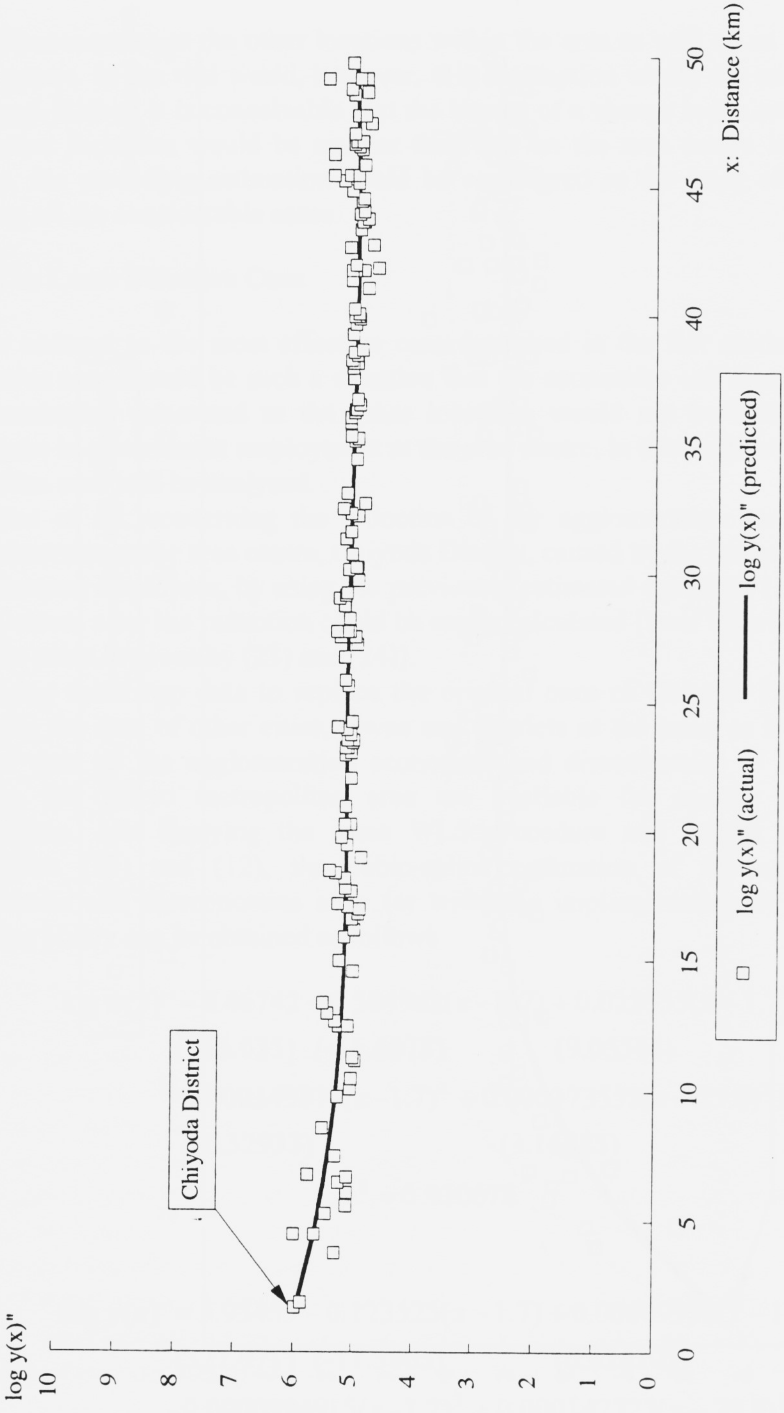

Figure 5b. Agglomeration Diseconomies After the Policy
(the least effective case)

in which D_1 is the dummy variable defined by (11). Figures 5a and 5b illustrate these two estimated cubic-spline curves with their actual data, respectively. By drawing these two estimated functions along with equations (10) and (12) in Figure 6, one can examine the effects of the relocation policy on the spatial distributions of agglomeration economies and diseconomies within the Tokyo metropolitan area for the least effective case. It can be seen from Figure 6 that the balance of the agglomeration economies and diseconomies for each location within the area seems to be altered to some extent. For example, while the central area still shows a positive balance, in the zone of 15-30km from the centre the agglomeration economies become smaller than the diseconomies. However, in the areas beyond 30km from the centre, the agglomeration economies are higher than the diseconomies. These estimation results might be interpreted as follows. Since the removal of capital functions from the area centre would give rise to a reduction of the agglomeration there, the other economic functions and population at those areas outside the central area would tend to move inward to compensate for such a reduction of the agglomeration at the area centre. Such a concentrating movement, at the same time, would lead to a fall of the agglomeration economies around the peripheral cities at about 30km from the centre.

On the other hand, by looking at the balance of the total agglomeration economies and diseconomies resulting from the whole area, it can be found from Figure 6 that the area under the curve of the agglomeration economies still remain greater than that under the curve of the diseconomies. This means that the existent balance of the total economies and diseconomies would not be changed by the capital-moving policy. In this case, the removal of the capital functions from Tokyo would not affect the global city size of the Tokyo metropolitan area very much, and no great changes would take place to the existent Tokyo monopolar situation.

5. CONCLUDING REMARKS

This paper presented a case study to estimate the effects of the removal of capital functions from Tokyo on the Tokyo metropolitan area by examining the spatial distributions of agglomeration economies and diseconomies within the area with (after) and without (before) the implementation of the capital-moving policy. The estimation was carried out for the following two extreme cases; the most effective case in which it was supposed that the removal of capital functions from the area centre would give rise to the reduction of agglomeration economies and diseconomies not only at the area centre but also at all the other locations as well, and the least effective case which supposed that such a removal would only directly cause the decreases in the agglomeration economies and diseconomies at the area centre.

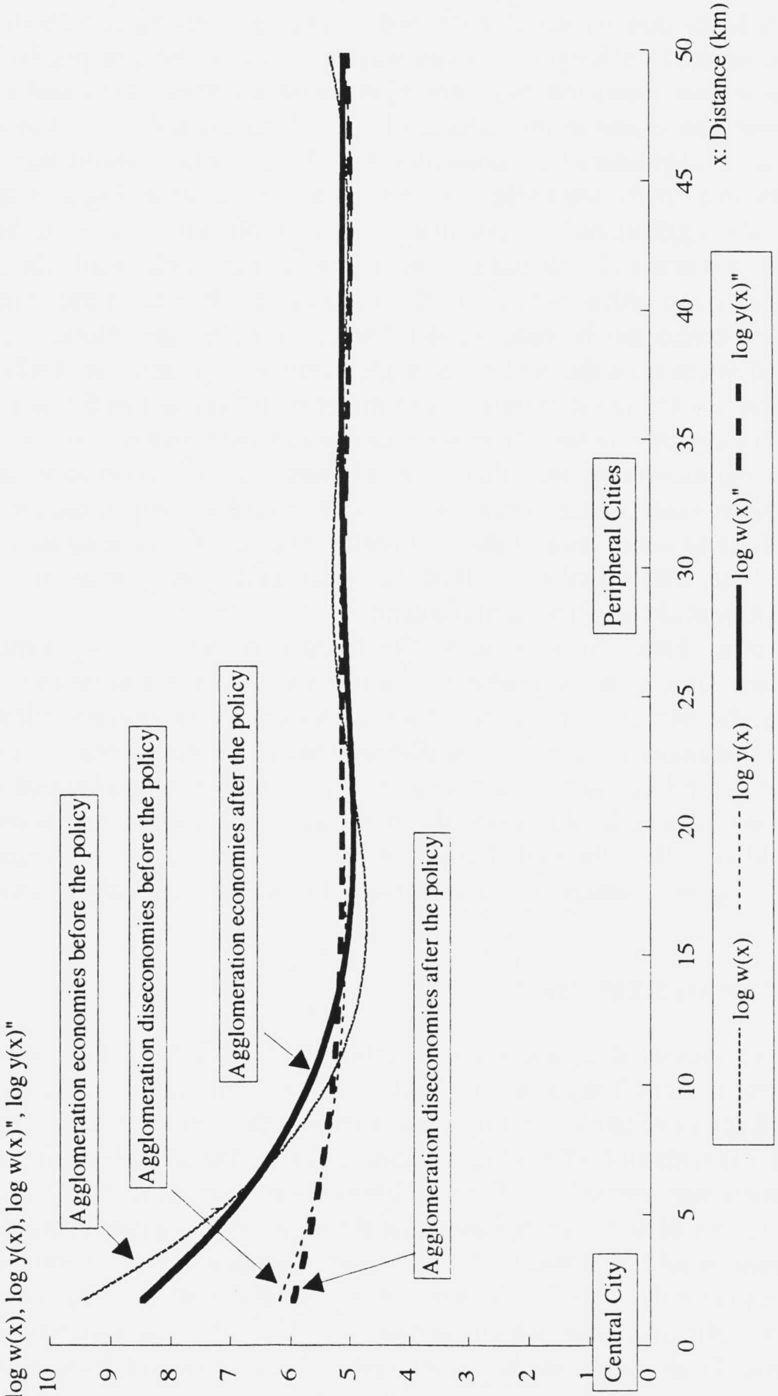

Figure 6. Agglomeration Economies and Diseconomies Before and After the Policy (the least effective case)

It was shown that in the most effective case, the capital-moving policy would reduce the total agglomeration economies resulting from the whole area to be smaller than the total diseconomies, leading to a decrease in the global city size of the area and an improvement of the existent Tokyo monopolar situation. On the other hand, however, the estimation result of the least effective case suggested that the policy would not affect the present balance of the total agglomeration economies and diseconomies very much, which implies that such a large-scale policy may not bring about great changes to the Tokyo over-concentration situation. Regardless of this difference, both of these two cases indicated that the peripheral cities and outskirts of the Tokyo metropolitan area would be affected by the policy in that the agglomeration economies there would fall below the diseconomies, and the local city sizes would decline.

The main policy implications from the preceding estimation results are as follows. Whether the capital-moving policy would bring about an improvement of the existent Tokyo monopolar situation seems to depend upon to what extent the removal of capital functions from the area centre could affect the spatial distributions of agglomeration economies and diseconomies over the whole area. To make the policy more effective in solving the Tokyo monopolar problem, some of the policies concerning the industries, housing, transportation and environment are needed to accompany it so as to adjust the balance of the agglomeration economies and diseconomies for the other locations. Concerning the estimation result that the peripheral cities and outskirts would be affected by the policy, a number of public policies seem to be needed to preserve the existent living environments from any negative effects caused by the decline of the local city sizes.

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