Discriminatory Local Tax under Decentralization

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Abstract

Since Tiebout's "voting with the feet" theory, numerous studies of local public goods have been done under the assumption of residents' free migration across regions. However, the existence of migration costs and risk might become serious restrictions when a resident decides to migrate. In addition, it can be inferred that cities in a region are not of equal status: they depend economically on a central city.

For this study, we assume a region that consists of a central city and its surrounding city. The purpose of this paper is to analyze the economic influence between the central city and the surrounding city under imperfect migration through tax policies of the central city.

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1 Introduction

Conversion from centralization to decentralization has come to be promoted positively in advanced countries since the 1980s. It was necessary to reexamine the roles of central government and local government along with the steady progress of internationalization, diversification, information orientation, and aging in modern societies. Although numerous studies have examined decentralization problem, most of them have paid attention only to the following two points: the problem of provision of public goods, and financial problems faced by local governments. The role of local governments has grown further in the provision of public goods because the range of benefit of public goods is limited to the region. When local governments supply public goods in the region, the residents' preferences toward goods in the region can be reflected more accurately. Moreover, it is said that efficient fiscal administrations can be achieved if competition exists among local governments.

Oates (1972), through his "Decentralization Theorem," asserted that the social welfare level would definitely be improved by the supply of public goods by local governments. However, it has since been pointed out that provision by local governments has not necessarily become efficient, largely owing to the existence of externalities such as free rider problems and spillovers. Especially, because of spillover effects, achieving an optimal supply level is difficult without intervention of the central government. Meanwhile, migration of residents among regions is not considered in the theory of Oates.

A theory that does consider migration of the residents was advanced by Tiebout's "voting with the feet". Since that study was published, it has been acknowledged that the supply of public goods by the local government can not achieve an optimal level when residents are able to migrate freely between regions, as related by Flatters, Henderson and Mieszkowski (1974), and Boadway and Flatters (1982). On the other hand, Myers (1990) and Wellisch (1993) have asserted that the supply level of local public goods, as determined by competition between regions, is Pareto efficient if the income transfer can be done through regulation of tax policies by the local government. They posited that local governments procure fiscal resources of the supply of local public goods from a fixed asset tax on rent revenue. In addition, a lump sum income tax is assessed on residents of the region. The fixed asset tax is a regulation instrument for income transfer between regions. Unlike earlier theories such as Oates, they pointed out that it is necessary to consider the influence on migration of residents when the local government supplies public goods. Local governments can internalize the externality by maximizing the welfare of the residents in a region even if no intervention exists in a central government, and when Pareto optimality can be achieved by doing so. The economies of respective regions are assumed to be symmetric or partially asymmetric in the all of the studies described above. Firms of respective regions perform all production in their respective regions: residents are employed at firms in regions where they reside and obtain their income. They also set a situation in which the income transfer between regions is considered under the assumption that land is equally owned by residents throughout the region; they analyzed the supply problem of public goods and the population migration problem under such a situation.

However, migration is not so simple in the real world. Migration costs and risks curb residents' decisions to migrate for a higher utility level. In addition, it is intuitive that favorable residential sites do not correspond to rewarding work places, if we consider a region that consists simply of a central city and its surrounding city. For that reason, residents might work in the central city while residing in the surrounding city for various reasons. In this sense, it can be said that population migration between the central city and the surrounding city is imperfect. Mansoorian and Meyers (1993) present an analysis that incorporates imperfect migration. They showed that Pareto optimal resource allocation can be achieved even if migration between regions is imperfect and if the imperfection of the migration is introduced in the form of mental or emotional attachment to the region.

Another important matter is the local finance problem, especially when we consider decentralization. Decentralization enables the provision of public goods that suit local features by transferring authority and fiscal resources to local governments. It is also typically promoted along with deregulation of finance to local governments, that is, the independent fiscal resources principle becomes necessary and indispensable.

We took up the income tax and the fixed asset tax as main items of local taxes, and analyzed the effect of the change of the tax rate on the regional economy when assuming that the local government has taxation authority and can set each tax rate freely. Haughwout and Imman (2001) examined studies of fiscal policy of the central cities in metropolitan areas. They discussed the effects of fiscal policy of a central city using data of Philadelphia for a general equilibrium model of a certain metropolitan area. However, they did not clarify the economical relation between the central city and the surrounding city. In general, it seems that the influence of central city's policies on the surrounding city is very large. Population migration is also imperfect. Various causes exist in the imperfect population migration. In this paper, land ownership is inferred as the cause. If a resident has land and some kind of dwelling, then some satisfactory environment is already established. For that reason, migration does not occur easily even if the work place and the residential site are different. Consequently, we assume imperfect migration, by which the landowners of each city do not migrate and that those residents who are not landowner migrate in search of a higher utility level.

In this paper, we assume a region that consists of a central city and its surrounding city, and analyze the economic influence between the central city and the surrounding city through the tax policy of the central city under the above-mentioned assumptions: imperfect migration and local government tax authority.

This paper is organized as follows. The respective behaviors of economic subjects in the region are examined. Chapter 3 describes the market equilibrium under the introduced basic model. Moreover, the influence that the central city fiscal policy imparts to the entire region is analyzed using a Cobb-Douglas function presented in Chapter 4. Finally, Chapter 5 presents some conclusions.

2 The Model

We consider a region that consists of a central city and a surrounding city. It is assumed that firms, residents and the government in each city compose the regional economy. The firms are located in the central city; all the residents in the region are considered to be labor suppliers. That is true not only in the central city; the surrounding city is considered to supply the labor market for firms. All residents in the region are employed by firms that are located in the central city and obtain their income from them. Moreover, the land in each city is assumed to be owned by some residents. Landowners and residents who rent land for housing lots reside in the same city. In addition, the landowners evenly own the land in the city in the same size. It is assumed that landowners in each city do not migrate between cities even if they face a lower utility level than the other city. Therefore, migration by residents who do not own land in the city occurs rarely. Each city government collects an income tax from each resident and a fixed asset tax from landowners. It provides public goods using those fiscal resources. Here, the effect of the spillover of public goods between cities is assumed not to exist.

2.1 The firm

A representative firm which is located in the central city produces consumer goods X with labor N_f and land L_f as inputs. The consumer goods are consumed not only in the region, but also outside of the region. Furthermore, we assume that it is also possible that homogeneous consumer goods are imported into the region according to circumstances. Therefore, the price of consumer goods is assumed to be unity. Public goods of central city G_1 also influence production of firms aside from N_f and L_f. At this time, it is assumed that the marginal production of public goods is positive. That is, the supply level of public goods positively affects the production of the firm. Therefore, it is possible for the production function of the firm to be expressed as[1]

$$X = f(N_f, L_f, G_1). \tag{1}$$

It is assumed that the production function (1) provides constant returns to scale for the N_f and L_f. The amount of land in the city is constant. The firm's behavior is therefore expressible as

$$\max_{N_f, L_f} f(N_f, L_f, G_1) - wN_f - R_1 L_f.$$

where, w and R_1 respectively represent the wage and the land rent. From the first order conditions of this problem, we see that

$$\frac{f_{N_f}}{f_{L_f}} = \frac{w}{R_1}, \tag{2}$$

where f_{N_f} and f_{L_f} represent the partial differential of the production function $f(\cdot)$. The market of consumer goods is competitive: the profit of the firm is assumed as zero. If full employment is assumed in a labor market in the region, the land demand function is obtainable from Eq. (2) because the production function gives constant returns to scale. When we denote N by the total residents in the region, which corresponds to the supply of labor, we obtain

[1]Subscript 1 refers to variables related to the central city; subscript 2 indicates those for the surrounding city.

$$L_f = L_f(w, R_1, G_1, N).$$

2.2 Residents of the central city

Two types of residents exist in the city: residents who own their land in the city and those who do not own their land and rent some land for a housing lot. It is also assumed that landowners rent land as housing lots just as other residents because locations of the residential sites and the owned sites are different. In addition, the land in each city is assumed to be owned evenly by landowners who reside in the region. Each resident obtains utility from consumption goods x_{1j}, land L_{1j}, $(j = 1,2)$ and public goods G_1. Income w is obtained by provision of labor of one unit to the firm inelastically[2]. The city government levies taxes from residents as an income tax. Let t_{w1} denote the income tax rate of the central city. A fixed asset tax is imposed on landowners, too. Rental income becomes taxable if the asset value of land is considered to be its rental income. Therefore, the problems of residents of each type in the central city can be shown as follows. The problem of the residents who are tenants is

$$\max_{x_{11}, L_{11}} \quad U^{11}(x_{11}, L_{11}, G_1)$$
$$s.t. \quad (1 - t_{w_1})w = x_{11} + R_1 L_{11}.$$

The problem facing landowners is

$$\max_{x_{12}, L_{12}} \quad U^{12}(x_{12}, L_{12}, G_1)$$
$$s.t. \quad (1 - t_{w_1})w + (1 - t_{L_1})\frac{R_1 L_1}{N_{12}} = x_{12} + R_1 L_{12},$$

where t_{L_1} represents the fixed asset tax rate of the central city and N_{12} represents the number of landowners who reside in the central city. The second term of *LHS* indicates the rental revenue of landowners. Migration of landowners is assumed not to exist. Therefore, N_{12} is constant; R_1 and G_1

[2]The second subscript 2 refers to variables that relate to the landowners and second subscript 1, to those residents who are tenants. Subscript *ij* indicates a variable showing residents of *j* type who reside in city *i*.

are as described for firms. The price of consumer goods is unity. From the first order conditions of the utility maximization problem, we see that

$$\frac{U^{1i}_{L_{1i}}}{U^{1i}_{x_{1i}}} = R_1, \quad i = 1, 2. \tag{3}$$

From this condition and each one's budget constraint, the following demand functions are obtained.

$$\begin{aligned} x_{11} &= x_{11}(w, R_1, G_1, t_{w_1}), \\ L_{11} &= L_{11}(w, R_1, G_1, t_{w_1}), \\ x_{12} &= x_{12}(w, R_1, G_1, t_{w_1}, t_{L_1}, N_{12}, L_1), \\ L_{12} &= L_{12}(w, R_1, G_1, t_{w_1}, t_{L_1}, N_{12}, L_1) \end{aligned}$$

Even though firms and residents behave as if rent R_1, income w, public goods G_1 and respective tax rates t_{w_1} and t_{L_1} are given, R_1, w and G_1 are determined endogenously in equilibrium under the constraint condition of land and the population, as we show later.

2.3 Residents of the surrounding city

Two types of residents exist also in the surrounding city. No job opportunities exist in the surrounding city. However, the residents work in the central city and obtain their income. Time and a monetary cost are necessary for residents of the surrounding city to commute between both cities. Their real income becomes τw[3]. The rent income in the surrounding city is added to this in the case of landowners. The government of the surrounding city also levies an income tax and a fixed asset tax on residents and supplies public goods, just as the central city government does[4]. Each

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[3] $\tau (0 < \tau < 1)$, which can be viewed as representing the convenience of access to the central city if we denote the cost as $(1-\tau)$. That is, a traffic infrastructure in the region is maintained well when τ approaches 1.

[4] There is an accompanying problem of place: for the residents of the surrounding city, the income is not necessarily obtained at the same place as the residence. However, if the residence principle is adopted when the income tax is paid, it does not contradict reality. Actually, the residence principle is taken for Japan.

resident's problem is therefore expressed as the following.

$$\max_{x_{21},L_{21}} \quad U^{21}(x_{21}, L_{21}, G_2)$$
$$s.t. \quad (\tau - t_{w_2})w = x_{21} + R_2 L_{21},$$

$$\max_{x_{22},L_{22}} \quad U^{22}(x_{22}, L_{22}, G_2)$$
$$s.t. \quad (\tau - t_{w_2})w + (1 - t_{L_2})\frac{R_2 L_2}{N_{22}} = x_{22} + R_2 L_{22}.$$

From the first order conditions of this problem, we see that

$$\frac{U^{2i}{}_{L_{2i}}}{U^{2i}{}_{x_{2i}}} = R_2, \quad i = 1, 2. \tag{4}$$

In the same way as Eq. (3), each resident's demand function is obtained as

$$\begin{aligned} x_{21} &= x_{21}(w, R_2, G_2, t_{w_2}), \\ L_{21} &= L_{21}(w, R_2, G_2, t_{w_2}), \\ x_{22} &= x_{22}(w, R_2, G_2, t_{w_2}, t_{L_2}, N_{22}, L_2), \\ L_{22} &= L_{22}(w, R_2, G_2, t_{w_2}, t_{L_2}, N_{22}, L_2). \end{aligned}$$

Each resident of the surrounding city also behaves as if the variables including rent are given, just as the residents in the central city do.

3 Market equilibrium

Each demand function that is obtained as a result of maximization problem of firms and residents in each city should satisfy the following equilibrium conditions. The equilibrium conditions in the entire region are given as follows.

$$L_1 = L_f + N_{11}L_{11} + N_{12}L_{12}, \tag{5}$$
$$L_2 = N_{21}L_{21} + N_{22}L_{22}, \tag{6}$$

$$N_f = N_{11} + N_{12} + N_{21} + N_{22} = N, \tag{7}$$

$$G_1 = t_{w_1} w(N_{11} + N_{12}) + t_{L_1} R_1 L_1, \quad (8)$$

$$G_2 = t_{w_2} w(N_{21} + N_{22}) + t_{L_2} R_2 L_2, \quad (9)$$

$$f(N_f, L_f, G_1) - wN_f - R_1 L_f = 0, \quad (10)$$

$$U^{11}(x_{11}, L_{11}, G_1) = U^{21}(x_{21}, L_{21}, G_2). \quad (11)$$

Eqs. (5) and (6) respectively show land constraints in both cities. Satisfying these conditions means that vacant land does not exist because all land in the city is used for production activities of firms or residents' housing lots. Both L_1 and L_2 are constants because the amount of land in each city is fixed. Eq. (7) shows the supply and demand of labor market. N is the total population in the region. It represents the size of the labor supply. Therefore, Eq. (7) shows the labor market that achieves full employment in equilibrium.

Eq. (8) and Eq. (9) respectively indicate the budget constraint for public goods in each city. They show that no direct income transfer exists between both cities. Finally, Eq. (10) is the zero profit condition of the firm. When the tax rates of the cities are given as t_{w_1}, t_{L_1}, t_{w_2} and t_{L_2}, the equilibrium solution is obtainable as follows. First, if the total population of the region does not change in N, even though a change is apparent in N_{11}, N_{12}, demand for labor N_f is determined according to Eq. (7) because it is possible for the residents who are not landowner to migrate between cities. Next, when we use profit and utility maximization conditions (2), (3), (4), equilibrium conditions (5), (6), (8), (9), (10) and (11), we obtain equilibrium solutions,

$$\{x_{11},\ x_{12},\ x_{21},\ x_{22},\ L_{11},\ L_{12},\ L_{21},\ L_{22},\ R_1,\ R_2,\ w,\ N_{11},\ N_{12},\ G_1,\ G_2\}.$$

4 Effect of central city's tax policies

This chapter examines how equilibrium solutions are changed when the central city government respectively changes the two tax rates: the income tax and fixed asset tax. Furthermore, to clarify results of analyses, we use the following Cobb-Douglas production and utility functions:

$$X = N_f^a L_f^{1-a} G_1^c, \qquad a, c > 0,$$

$$U^{ij} = x_{ij}^p L_{ij}^q G_i^r, \quad i = 1,2, \ j = 1,2, \ p,q,r > 0$$

We can consider public goods, G_1, for the firms and residents as an external economy, i.e. $c>0$, $r>0$.

4.1 Market equilibrium

First, we obtain the market equilibrium solution in the region considering the possibility of the migration between cities. The equilibrium solutions are obtainable as follows. The profit maximization condition (2) can be rewritten as

$$L_f = \frac{1-a}{a}\frac{w}{R_1}N_f. \tag{12}$$

In general, only a relative relation between L_f and N_f is obtainable because the homogeneous production function is assumed. However, we can get L_f because the demand for labor N_f corresponds to population of the region, N, if full employment is assumed. On the other hand, from the budget constraint and the utility maximization condition shown in Eqs. (3) and (4), the demand functions for consumption goods and land are obtained as

$$x_{11} = \frac{p}{p+q}(1-t_{w_1})w, \tag{13}$$

$$L_{11} = \frac{q}{p+q}\frac{1}{R_1}(1-t_{w_1})w. \tag{14}$$

In the same way, those of landowners are obtained as

$$x_{12} = \frac{p}{p+q}\left[(1-t_{w_1})w + (1-t_{L_1})\frac{R_1 L_1}{N_{12}}\right], \tag{15}$$

$$L_{12} = \frac{q}{p+q}\frac{1}{R_1}\left[(1-t_{w_1})w + (1-t_{L_1})\frac{R_1 L_1}{N_{12}}\right]. \tag{16}$$

When these solutions are substituted for land and population constraints (5) and (7), the relation between rent R_1 and wage w is obtained as

$$R_1 = A\frac{w}{L_1},$$
$$A \equiv \frac{p+q}{p+qt_{L_1}}\left[\frac{1-a}{a}N + \frac{q}{p+q}(1-t_{w_1})(N_{11}+N_{12})\right]. \tag{17}$$

When Eq. (17) is substituted for the profit maximization condition of firm Eq. (12) and zero profit condition Eq. (10), we can obtain the rent and wage as

$$w = a^a(1-a)^{1-a}G_1^c A^{a-1}L_1^{1-a}, \tag{18}$$
$$R_1 = a^a(1-a)^{1-a}G_1^c A^a L_1^{-a}, \tag{19}$$

provided that the Eqs. (18) and (19) are those in which the size of population in the city, $N_{11,}$ N_{21} are given. It is necessary to confirm the surrounding city residents' behaviors for obtaining equilibrium solutions in the region. The behavior of surrounding city residents resembles that of the central city residents. They face the same utility function and the same tax system as residents of the central city, even though their tax rates differ. Therefore, when we consider the behavior of surrounding city residents, the utility maximization conditions of Eq. (3) and Eq.(4) are available. Consequently, the following demand functions are obtainable as

$$x_{21} = \frac{p}{p+q}(\tau - t_{w_2})w, \tag{20}$$
$$L_{21} = \frac{q}{p+q}\frac{1}{R_2}(\tau - t_{w_2})w, \tag{21}$$
$$x_{22} = \frac{p}{p+q}\left[(\tau - t_{w_2})w + (1-t_{L_2})\frac{R_2L_2}{N_{22}}\right], \tag{22}$$
$$L_{22} = \frac{q}{p+q}\frac{1}{R_2}\left[(\tau - t_{w_2})w + (1-t_{L_2})\frac{R_2L_2}{N_{22}}\right]. \tag{23}$$

In the meantime, firms are not located in the surrounding city. For that reason, the land in the city is used for housing lots only: the behavior of the firm need not be considered when thinking about the equilibrium in the city. Only the land constraint (6) is needed as an equilibrium condition. The land rent of the surrounding city that satisfies this condition, R_2, becomes

$$R_2 = B\frac{w}{L_2},$$

$$B \equiv \frac{q}{p + qt_{L_2}}(\tau - t_{w_2})(N_{21} + N_{22}).$$

When we substitute w of Eq. (18), the rent R_2 is obtainable as

$$R_2 = a^a(1-a)^{1-a}G_1^c A^{a-1}L_1^{1-a}BL_2^{-1}. \tag{24}$$

Using equilibrium conditions from Eqs. (13)–(24), we can examine the characteristics of the equilibrium solutions as

$$\begin{aligned}
&x_{11} = x_{11}(\overset{-}{t_{w_1}}, \overset{+}{w}), && x_{21} = x_{21}(\overset{-}{t_{w_2}}, \overset{+}{w}),\\
&L_{11} = L_{11}(\overset{-}{t_{w_1}}, \overset{-}{R_1}, \overset{+}{w}), && L_{21} = L_{21}(\overset{-}{t_{w_2}}, \overset{-}{R_2}, \overset{+}{w}),\\
&x_{12} = x_{12}(\overset{-}{t_{w_1}}, \overset{-}{t_{L_1}}\ \overset{+}{R_1}, \overset{+}{w}), && x_{22} = x_{22}(\overset{-}{t_{w_2}}, \overset{-}{t_{L_2}}\ \overset{+}{R_2}, \overset{+}{w}),\\
&L_{12} = L_{12}(\overset{-}{t_{w_1}}, \overset{-}{t_{L_1}}\ \overset{-}{R_1}, \overset{+}{w}), && L_{22} = L_{22}(\overset{-}{t_{w_2}}, \overset{-}{t_{L_2}}\ \overset{-}{R_2}, \overset{+}{w}),\\
&L_f = L_f(\overset{+}{N}, \overset{-}{R_1}, \overset{+}{w}),
\end{aligned}$$

where the signs in parentheses indicate the relation to the variables. Moreover, when full employment is assumed, the equilibrium condition of labor and the land market are as follows because $N_f = N$.

$$N^a L_f(N, R_1, w)^{1-a} G_1^c - wN - R_1 L_f(N, R_1, w) = 0, \tag{25}$$

$$L_1 = L_f(N, R_1, w) + N_{11}L_{11}(t_{w_1}, R_1, w) + N_{12}L_{12}(t_{w_1}, t_{L_1}, R_1, w). \tag{26}$$

Considering $(1-a)X - R_1 L_f = 0$ by the characteristics of the Cobb-Douglas production function, the following matrix can show the relations among variables under the equilibrium conditions above.

$$\begin{bmatrix} -L_f & -N \\ Q_1 & Q_2 \end{bmatrix}\begin{bmatrix} dR_1 \\ dw \end{bmatrix} = \begin{bmatrix} -\dfrac{cX}{G_1} \\ 0 \end{bmatrix} dG_1 + \begin{bmatrix} 0 \\ -L_{11} \end{bmatrix} dN_{11}$$

$$+\begin{bmatrix} 0 \\ -\left(N_{11}\dfrac{\partial L_{11}}{\partial t_{w_1}} + N_{12}\dfrac{\partial L_{12}}{\partial t_{w_1}} \right) \end{bmatrix} dt_{w_1} \tag{27}$$

$$+\begin{bmatrix} 0 \\ -N_{12}\dfrac{\partial L_{12}}{\partial t_{L_1}} \end{bmatrix} dt_{L_1},$$

where

$$Q_1 = \frac{\partial L_f}{\partial R_1} + N_{11}\frac{\partial L_{11}}{\partial R_1} + N_{12}\frac{\partial L_{12}}{\partial R_1} < 0,$$

$$Q_2 = \frac{\partial L_f}{\partial w} + N_{11}\frac{\partial L_{11}}{\partial w} + N_{12}\frac{\partial L_{12}}{\partial w} > 0.$$

Therefore, the following relations are obtained under an arbitrary supply level of public goods, G_1, because $D = -L_f Q_2 + NQ_1 < 0$.

$$\left.\frac{\partial R_1}{\partial N_{11}}\right|_{G_1} = \frac{-1}{D} L_{11} N > 0, \tag{28}$$

$$\left.\frac{\partial w}{\partial N_{11}}\right|_{G_1} = \frac{1}{D} L_{11} L_f < 0, \tag{29}$$

$$\frac{\partial R_1}{\partial G_1} = \frac{-1}{D}\frac{cX}{G_1} Q_2 > 0, \tag{30}$$

$$\frac{\partial w}{\partial G_1} = \frac{1}{D}\frac{cX}{G_1} Q_1 > 0, \tag{31}$$

Furthermore, from the equilibrium condition of public goods, Eq. (8),

$$\frac{\partial G_1}{\partial N_{11}} = \left[t_{w_1} w + t_{w_1}(N_{11} + N_{12})\frac{\partial w}{\partial N_{11}} + t_{N_1} L_1 \frac{\partial R_1}{\partial N_{11}} \right] \tag{32}$$

is obtained. Eq. (32) shows the effect that the population growth imparts to the supply level of public goods. The first term in the square bracket of the RHS represents the increment of the income tax revenues by the increase of residents. The second term shows the change of the revenue from income tax by the change of income. The third term means the change of the fixed asset tax income by the change in the rent. The change in N_{11} changes G_1, and influences R_1 and w indirectly, but Eqs. (28) and (29) show the change under arbitrary G_1. Therefore, the entire effect of the change in N_{11} is

$$\frac{\partial R_1}{\partial N_{11}} = \frac{\partial R_1}{\partial N_{11}}\Big|_{G_1} + \frac{\partial R_1}{\partial G_1}\frac{\partial G_1}{\partial N_{11}}, \tag{33}$$

$$\frac{\partial w}{\partial N_{11}} = \frac{\partial w}{\partial N_{11}}\Big|_{G_1} + \frac{\partial w}{\partial G_1}\frac{\partial G_1}{\partial N_{11}}. \tag{34}$$

From this,

$$\begin{aligned}
&\frac{\partial G_1}{\partial N_{11}} > 0 \Rightarrow \frac{\partial R_1}{\partial N_{11}} > 0, \quad \frac{\partial w}{\partial N_{11}}?, \\
&\frac{\partial G_1}{\partial N_{11}} < 0 \Rightarrow \frac{\partial R_1}{\partial N_{11}}?, \qquad \frac{\partial w}{\partial N_{11}} < 0, \\
&\frac{\partial G_1}{\partial N_{11}} = 0 \Rightarrow \frac{\partial R_1}{\partial N_{11}} > 0, \quad \frac{\partial w}{\partial N_{11}} < 0.
\end{aligned}$$

Hence, the overall effect is decided according to the scale of indirect effects by the change in public goods, i.e. the sign of Eq. (32). The utility level of the residents in the central city who can migrate becomes

$$\frac{\partial U^{11}}{\partial N_{11}} = U^{11}_{x_{11}}\frac{\partial x_{11}}{\partial w}\frac{\partial w}{\partial N_{11}} + U^{11}_{L_{11}}\left(\frac{\partial L_{11}}{\partial w}\frac{\partial w}{\partial N_{11}} + \frac{\partial L_{11}}{\partial R_1}\frac{\partial R_1}{\partial N_{11}}\right) + U^{11}_{G_1}\frac{\partial G_1}{\partial N_{11}}. \tag{35}$$

If $\partial G_1/\partial N_{11} < 0$ and the influence of the population changes on rent through provision of public goods is large, the sign of Eq. (35) becomes negative.

In case of surrounding city, we can obtain the following relations From Eq. (24).

$$\frac{\partial R_2}{\partial N_{21}} = \frac{q(\tau - t_{w_2})}{p + qt_{L_1}} \frac{1}{L_2} \left[w - (N_{21} + N_{22}) \frac{\partial w}{\partial N_{11}} \right], \tag{36}$$

$$\frac{\partial G_2}{\partial N_{21}} = \frac{1}{p} \left[t_{w_2} w - t_{w_2} (N_{21} + N_{22}) \frac{\partial w}{\partial N_{11}} + t_{L_2} L_2 \frac{\partial R_2}{\partial N_{21}} \right], \tag{37}$$

$$\frac{\partial U^{21}}{\partial N_{21}} = U^{21}_{x_{21}} \frac{\partial x_{21}}{\partial w} \frac{\partial w}{\partial N_{21}} + U^{21}_{L_{21}} \left(\frac{\partial L_{21}}{\partial R_2} \frac{\partial R_2}{\partial N_{21}} + \frac{\partial L_{21}}{\partial w} \frac{\partial w}{\partial N_{21}} \right) + U^{21}_{G_2} \frac{\partial G_2}{\partial N_{21}}. \tag{38}$$

If $\partial w / \partial N_{11} < 0$, Eqs. (36) and (37) become positive. Although the population of each city was assumed as given above, city residents who are not landowners can migrate by comparing the utility levels of both cities. Therefore, the utility level of a resident who can migrate between cities should be equal when seen from the entire region. Eq. (11) indicates this relation.

The equilibrium solution concerning migration is obtained by calculating the indirect utility functions of both city residents.

$$\left[\frac{p}{p+q} (1 - t_{w_1}) w \right]^p \left[\frac{q}{p+q} \frac{1}{R_1} (1 - t_{w_1}) w \right]^q G_1^r$$
$$= \left[\frac{p}{p+q} (\tau - t_{w_2}) w \right]^p \left[\frac{q}{p+q} \frac{1}{R_2} (\tau - t_{w_2}) w \right]^q G_2^r$$

Consequently, the following equal utility constraint is obtained.

$$\left(\frac{R_1}{R_2} \right)^q = \left(\frac{1 - t_{w_1}}{\tau - t_{w_2}} \right)^{p+q} \left(\frac{G_1}{G_2} \right)^r \tag{39}$$

The population N_{11} that satisfies Eq. (39) is an equilibrium solution in the region. If the N_{11} is determined, then the rent and wage of each city, R_1, R_2, w are determined according to Eqs. (18), (19) and (24) under the population size, N_{11}. Moreover, the scale of public goods of each city is determined using Eqs. (8) and (9) when deciding the equilibrium rent and wage.

Finally, variables of the remainder are obtained under these solutions, $\{x_{11}, x_{12}, x_{21}, x_{22}, L_{11}, L_{12}, L_{21}, L_{22}, L_f\}$.

4.2. Effect of raising the income tax rate, t_{w_1}

The influence that the policy gives to the region is examined in this chapter when the central city government raises the income tax rate for residents. To clarify the characteristics of various solutions obtained on the earlier chapter, a concrete value will be given to the exogenous variables and the parameters[5]. Table 1 shows the change in each equilibrium solution when the income tax rate in the central city is raised.

		Central City		Surrounding City	
N_{11}	—	G_1	?	G_2	+
w	+	R_1	—	R_2	+
L_f	+	x_{11}	—	x_{21}	+
$U^{11}(=U^{21})$	—	x_{12}	—	x_{22}	+
U^{12}	+ → —	L_{11}	—	L_{21}	—
U^{22}	+	L_{12}	—	L_{22}	—
SW	?				

Table 1: effects of raising t_{w1}

When the government of the central city raises t_{w_1}, the supply level of public goods, rent, wage and the residents' disposable incomes are influenced. Moreover, because the surrounding city residents also work at the central city and are obtain their income, the change in the wage influences the surrounding city. Therefore, the population will be distributed again so that the equal utility constraint of (39) is met. Fig. 1 shows the change of the equilibrium population in the central city, N_{11} according to the change of t_{w1}. We can confirm the migration equilibrium stable from this. The lines indicate the ratio of utility level between the mobile residents of two cities, U^{11}/U^{21}. N_{11} is determined where it's value is 1. When the t_{w1} becomes high, N_{11} becomes small since the tenants in the central city move the surrounding city.

[5] The results are obtained for the following parameter values; p=0.6, q=1-p, a=0.6, N=1, L_1=1, L_2=0.2, τ=0.6, N_{12}=0.1, N_{22}=0.1, c=0.05, r=0.05, t_{w2} =0.2, t_{L1}=0.02, t_{L2}=0.02.

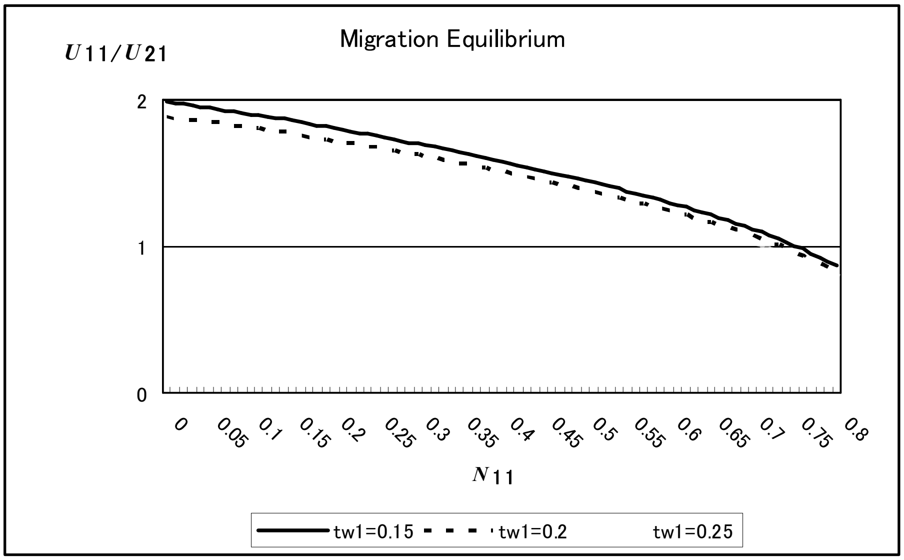

Fig. 1 migration equilibrium

This result is somewhat different from the case of subsidy policy between cities. Even though the utility level of the residents who give subsidy decreases somewhat, if the utility level increase is greater than that for residents of counterpart city, the utility level in the entire region increases according to the subsidy between cities. In case of raising t_{w1}, however, the utility level of the central city residents, U^{11}, decreases even though it brought the increase of wage and the decrease of rent. On the other hand, the utility level of the residents of surrounding city, U^{21}, becomes high because of the increase of wage. Therefore, the difference is generated in the utility level between cities, and that causes the migration to the surrounding city. On the contrary of subsidy policy, the decrease of U^{11} is larger than the increase of U^{21}. So the utility level in equilibrium, $U^{11}(=U^{21})$, becomes low as the t_{w1} becomes high. Fig. 2 shows this.

We should confirm the change of wage and rent more detail in order to understand the total effect of the t_{w1} policy.

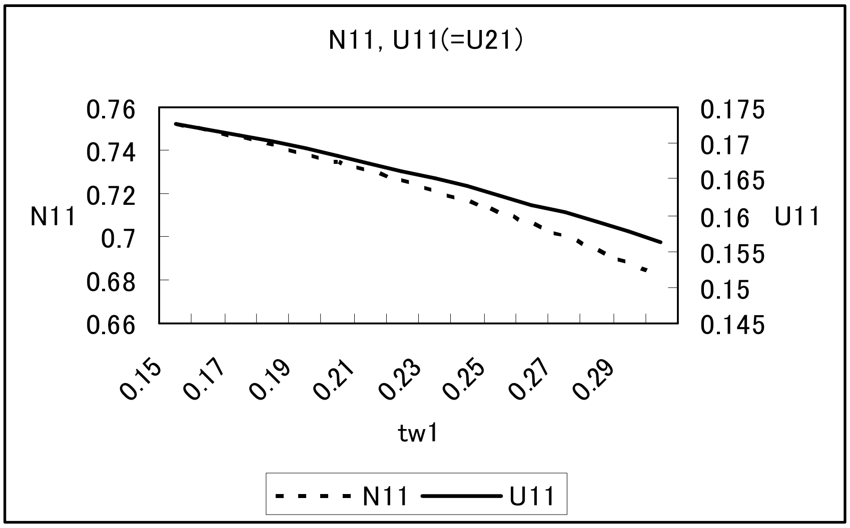

Fig. 2 the change of N_{11}, $U^{11}(U^{21})$

The following is obtained when we examine the change in the wage and the rent, from the matrix shown in (27).

$$\left.\frac{\partial R_1}{\partial t_{w_1}}\right|_{G_1} = \frac{-N}{D}\left(N_{11}\frac{\partial L_{11}}{\partial t_{w_1}} + N_{12}\frac{\partial L_{12}}{\partial t_{w_1}}\right) < 0,$$

$$\left.\frac{\partial w}{\partial t_{w_1}}\right|_{G_1} = \frac{L_f}{D}\left(N_{11}\frac{\partial L_{11}}{\partial t_{w_1}} + N_{12}\frac{\partial L_{12}}{\partial t_{w_1}}\right) > 0.$$

The change in public goods G_1 can be shown as

$$\frac{\partial G_1}{\partial t_{w_1}} = w(N_{11} + N_{12}) + t_{w_1}(N_{11} + N_{12})\frac{\partial w}{\partial t_{w_1}} + t_{L_1}L_1\frac{\partial R_1}{\partial t_{w_1}} + t_{w_1}w\frac{\partial N_{11}}{\partial t_{w_1}}.$$

The first term shows the increment of tax revenue attributable to the rising tax rate, along with tax revenue changes of the second term and the third term, respectively, according to the change in the wage and the rent. The fourth term shows the change of tax revenue attributable to the population change. However, because the comparison related to the largeness and smallness between each term cannot be done in the expression above, the sign cannot be judged. Fig. 3 shows us a clue why it cannot be determined. If the residential area, L_2, is not enough in the surrounding city, the size of migration is not so large. Therefore, G_1 is increased since the third and forth term of above equation, i.e. the decrease of N_{11} and R_1 is not lager than the positive effects that the first and the second term. However, if L_2 is enough large, the negative effects exceed those of the positive effect. We can say that G_1 increases as the t_{w1} increases generally, but when L_2 is large, G_1 decrease if t_{w1} exceeds a certain level. The threshold is t_{w1}=0.28 in this model where t_{w2}=0.2.

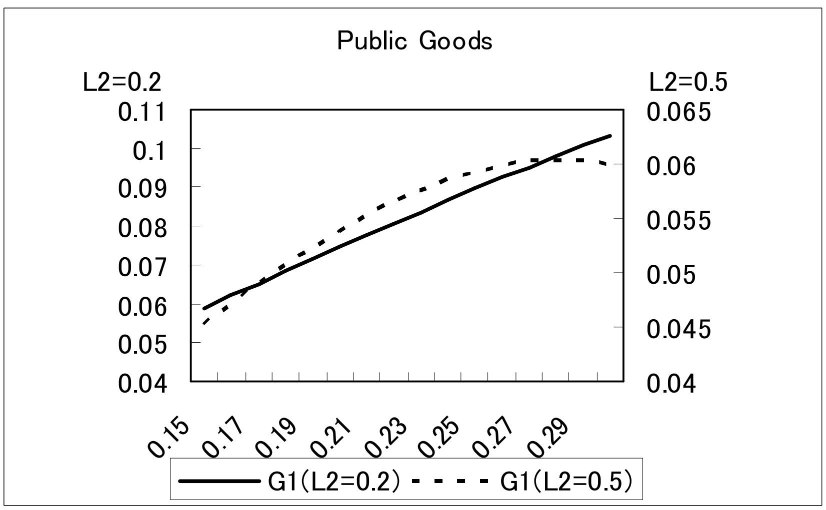

Fig. 3 the change of G_1

The change in the rent is

$$\frac{\partial R_1}{\partial t_{w_1}} = \left.\frac{\partial R_1}{\partial t_{w_1}}\right|_{G_1} + \frac{\partial R_1}{\partial N_{11}}\frac{\partial N_{11}}{\partial t_{w_1}} + \frac{\partial R_1}{\partial G_1}\frac{\partial G_1}{\partial t_{w_1}}. \tag{40}$$

Although it is difficult to judge the second term because the sign of Eq. (32) is not decided, it becomes $\partial R_1/\partial N_{11} > 0$ if we assume that $\partial G_1/\partial N_{11} > 0$. The second term, therefore, is said to be negative. The third term is positive except the case L_2=0.5. It is true that the signature of Eq. (40) is ambiguous even though the numerical simulation shows that it is negative. On the other hand, from Eq. (27), wage *w* becomes

$$\frac{\partial w}{\partial t_{w_1}} = \left.\frac{\partial w}{\partial t_{w_1}}\right|_{G_1} + \frac{\partial w}{\partial N_{11}}\frac{\partial N_{11}}{\partial t_{w_1}} + \frac{\partial w}{\partial G_1}\frac{\partial G_1}{\partial t_{w_1}}. \tag{41}$$

The result of Eq. (41) resembles that of Eq. (40), showing that the case of *w* is larger than the case of R_1, for which the degree of tax rate t_{w_1} produces a negative effect. This can be confirmed from Eq. (17). According to Eq. (17), it becomes

$$\frac{\partial R_1}{\partial t_{w_1}} = \frac{\partial A}{\partial t_{w_1}}\frac{w}{L_1} + \frac{A}{L_1}\frac{\partial w}{\partial t_{w_1}},$$

because the first term of the RHS is negative. For that reason also, it is understood that the rate of increase of the wage is large. This result means L_f increases when we use it for Eq. (12). It does not change by $N_f = N$ in Eq. (12) because full employment is assumed. Therefore, the land consumption will be increased as it is for firms but both rents and wages rise if t_{w_1} rises because the rate of the wage increase is large. The change in the surrounding city can be confirmed easily unlike that to the central city. First, an increase in the population engenders a rent R_2 increase from Eq. (24). The income tax rate increase in the central city raises wages. Moreover, migration to the surrounding city occurs. Because all land of the surrounding city is used for housing lots, the population growth implies increased demand for land, which in turn supports the raising of rent with increased income. It is understood that an increase in the population increases the supply of public goods from the budget constraint for public goods, as in Eq. (9), when this result is used. Therefore, the following results are obtained.

Finally, we define the social welfare function, *SW*, in order to examine the validity of the t_{w1} policy. We assume the *SW* as

$$SW = (N_{11} + N_{21})U^{11} + N_{12}U^{12} + N_{22}U^{22} \tag{42}$$

In general, *SW* decreases if t_{w1} is raised since the weight of the change of U^{11} is higher than others, and it is negative. If the effect of externality from *G*, however, is high, *SW* can be positive.

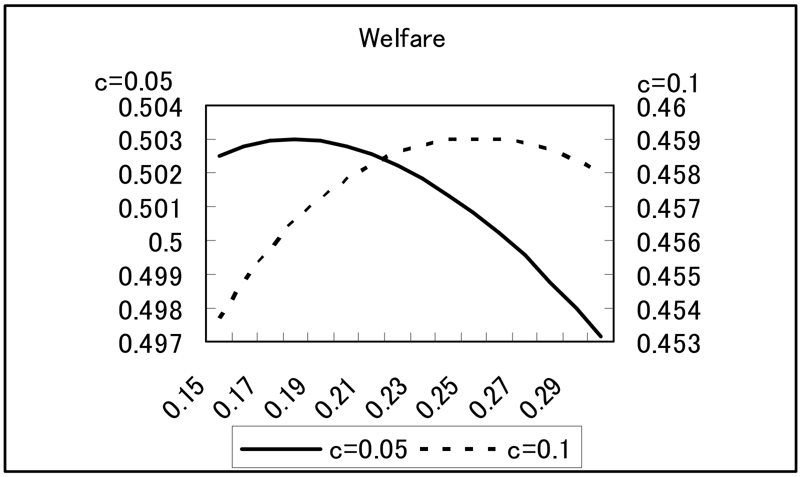

Fig. 4 change of social welfare

Fig. 4 shows the change of social welfare. When the parameter of externality on production, c, is high, SW increases to a certain level of t_{w1}. The optimal tax rate which maximizes the SW is tw1=0.25 where tw2=0.2 in this model.

Result 1. *In a two city model that consists of a central city and its surrounding city, when the income tax rate of the central city is raised, then:*

1. *Migration from the central city to the surrounding city occurs;* N_{11} *decreases.*

2. *The utility level of the resident in the region decreases;* $U^{11}(=U^{21})$ *decreases.*

3. *When the effect of externality by public goods is high, the social welfare is improved if* t_{w1} *is higher than* t_{w2}.

4.3. Effect of raising the fixed asset tax rate, t_{L_1}

In this chapter, we investigate the effect on the region when the government of the central city raises the fixed asset tax rate instead of the income tax rate. Table 2 illustrates that a change in each equilibrium solution is apparent when the value of each exogenous variable and parameters is set similarly to the case of Table 1. Only a positive effect of the increase of public goods exists without influencing the behavior of the residents who are not landowners. For that reason, the rise of the fixed asset tax rate raises the utility level of the residents in the central city, thereby generating migration to the central city. A new population distribution is determined by the equal utility constraint of Eq. (39) in the same way as the case of t_{w_1}. The results are summarized in Table 2. Migration Equilibrium is also stable as is the case of t_{w1}.

		Central City		Surrounding City	
N_{11}	+	G_1	+	G_2	—
w	+	R_1	+	R_2	—
L_f	+	x_{11}	+	x_{21}	+
$U^{11}(=U^{21})$	+	x_{12}	—	x_{22}	—
U^{12}	—	L_{11}	+	L_{21}	+
U^{22}	+	L_{12}	—	L_{22}	+
SW	?				

Table 2: effects of raising t_{L1}

The following relations can be confirmed from Eq. (27),

$$\left.\frac{\partial R_1}{\partial t_{L_1}}\right|_{G_1} = \frac{-1}{D} N N_{12} \frac{\partial L_{12}}{\partial t_{L_1}} < 0,$$

$$\left.\frac{\partial w}{\partial t_{L_1}}\right|_{G_1} = \frac{1}{D} L_f N_{12} \frac{\partial L_{12}}{\partial t_{L_1}} > 0.$$

These relations show changes in the rent and the wage under arbitrary G_1. The change of G_1 is

$$\frac{\partial G_1}{\partial t_{L_1}} = t_{w_1}(N_{11} + N_{12})\frac{\partial w}{\partial t_{L_1}} + t_{L_1} L_1 \frac{\partial R_1}{\partial t_{L_1}} + R_1 L_1 + t_{w_1} w \frac{\partial N_{11}}{\partial t_{L_1}}. \tag{43}$$

The first and the second term of the RHS of Eq. (43) respectively indicate the change of tax revenue according to the changes in the wage and rent. Moreover, the third term shows that revenue increases immediately according to the increase of t_{L_1}. The fourth term shows the effect of the population change. In Table 2, this result is shown to be positive. The comprehensive rent and the wage effects can be examined using this result:

$$\frac{\partial R_1}{\partial t_{L_1}} = \left.\frac{\partial R_1}{\partial t_{L_1}}\right|_{G_1} + \frac{\partial R_1}{\partial N_{11}}\frac{\partial N_{11}}{\partial t_{L_1}} + \frac{\partial R_1}{\partial G_1}\frac{\partial G_1}{\partial t_{L_1}}, \tag{44}$$

$$\frac{\partial w}{\partial t_{L_1}} = \left.\frac{\partial w}{\partial t_{L_1}}\right|_{G_1} + \frac{\partial w}{\partial N_{11}}\frac{\partial N_{11}}{\partial t_{L_1}} + \frac{\partial w}{\partial G_1}\frac{\partial G_1}{\partial t_{L_1}}. \tag{45}$$

Eqs. (44) and (45) portray the trade-off relation between the indirect effect by the change in the population and the public goods, and the direct effect of the tax rate increase on rents and wages when the fixed asset tax rate is raised. These results are also shown to be positive in Table 2.

The social welfare decreases since the utility level of central city's land owner decreases though the utility levels of the other residents increase. As well as the case of t_{w1}, however, if the effects of external economy, r or c, is high, SW becomes higher. SW is maximized when t_{L1}=0.08 in case of r =0.1, for instance. Fig. 5 shows this relation.

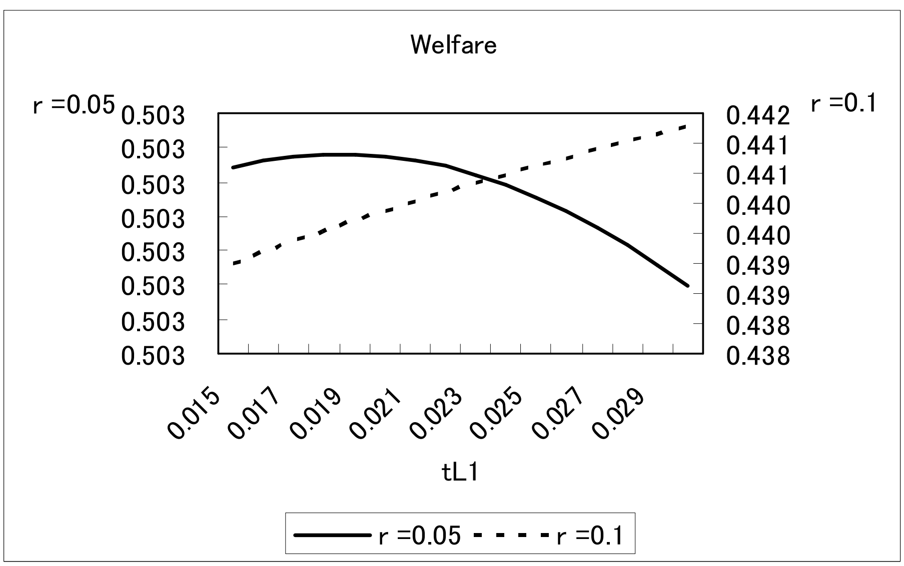

Fig. 5 change of social welfare

The results presented above imply the followings.

Result 2. *In a two-city model including a central city and its surrounding city, when the fixed asset tax rate of the central city is raised, then:*

1. *Concentration of population occurs in the central city;* N_{11} *increases.*

2. *The rent of the surrounding city decreases, but that of the central city increases.*

3. *When the effect of externality by public goods is high, the social welfare is improved if* t_{L1} *is higher than* t_{L2}.

5 Concluding Remarks

Since Tiebout's conceptualization of voting with the feet, many studies have investigated the optimal supply level of local public goods and optimal city size under the assumption that each resident is able to migrate freely between cities. Nevertheless, it is difficult to imagine unfettered immigration in the real world because all migrants face costs and risks. Some studies have introduced imperfect migration in the form of mental or emotional attachment to a region or the existence of migration costs (Mansoorian and Meyers (1993), Meyers and Papageorgiou (1997)).

In this study, land ownership was enumerated as a factor of imperfect migration. It is generalized that the structure of the region of residents comprises a central city and its surrounding city. Cases in which a rewarding work-place does not correspond to a good residential site are not rare. Many residents who work in a central city actually reside in the surrounding city. Therefore, many reasons exist to explain the fact that residents of the surrounding city do not migrate to the central city where they work. Commutation should therefore be considered. Especially, in a metropolitan area like that of Tokyo, growth of the central city might be remarkable and excessive expansion of the central city renders it impossible for residents of the surrounding city to migrate. Nevertheless, some residents who reside in the surrounding city do not consider migration to the central city so much for a local region, although they can migrate if they have a will because the level of the expansion of the central cityis not large. As one reason, the convenience of access to the central city is given.

Convenience has been introduced in this paper in the form of τ . Access to the central city increases concomitant with an increased value of τ . The disadvantages related to the distance to the central city become relatively unimportant. Establishment of a dwelling environment might be another reason. Migration does not occur easily even if the environment in the metropolitan area changes somewhat. Residents already own their land and homes in the surrounding city. Therefore, the landowners of each city are assumed in this paper not to migrate between cities. Another feature of this paper is that no firms exist in the surrounding city: all job opportunities are concentrated in the central city. As a result, various policies in the central city would influence the income of the surrounding city residents directly with an indirect effect of the population migration.

The respective effects on the whole region from a central city government's changes in the income tax rate or the fixed asset tax rate were examined under imperfect migration. We obtained two salient results. First, the rise of the income tax rate in the central city brings the migration to the surrounding city, so the population of central city decreases. The policy is effective, only when the external effects of public goods are high. Moreover, it is socially preferable that income tax rate of central city is higher than that of surrounding city at that time. On the other hand, when the fixed asset tax rate in the central city rises, population migration from the surrounding city to the central city is generated, contrary to the case of the income tax rate. As well as the case of income tax rate, it is also socially preferable that income tax rate of central city is higher than that of surrounding city when the external effects are large.

In this paper, we use Cobb-Douglas functions for production and utility to clarify the result of the analysis. However, the analysis by the function of general form is indispensable to understand the entire economic mechanism accurately. Moreover, we consider the land ownership as the factor of imperfect migration, it is necessary to examine the validity through empirical research as for this. Future research should confirm these.

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