

Public Infrastructure Provision under the Decentralized and Centralized System*

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Abstract

The purpose of this paper is comparison of the optimal provision level for the infrastructure and social welfare under the decentralized and centralized system. A preparedness of infrastructure like a gas facility or a training facility leads to improvement of productivity in the region where it is provided. The infrastructure like this is usually provided by not private firms but the government. This paper shows that comparison of optimal investment level and social welfare under each fiscal system. We can get two main conclusions as follows. One of them is that optimal investment level under the centralized system is equal to that under the decentralized system when the local governments have low type. On the other hand, the optimal investment level under both centralized system is smaller than that under the decentralized system. The other is that the decentralized system is more desirable from the view of social welfare when we take account of the infrastructure like this

JEL classification : H11, R13

1 Introduction

Who should provide a public infrastructure, which is like a gas facility, an industrial facility, a water system, and so on, for each region? Many researchers have discussed this problem in term of various points of view. As they have maintained, provision of infrastructure can influence the productivity growth in a region where it is provided. So it is important for us to decide that provision level. An industrial facility or a technical training center, however, is often provided not by private firms but by the government that can control regions or a

country. Recently the discussion about a provider of the public infrastructure has been done by a lot of researchers. For example, the comparative research of infrastructure provision system between by “Decentralized government” and by “Centralized government” is one of topics of which many researchers take notice. As we can understand in Japanese fiscal system in these days, moreover, we can often see that the scale of public infrastructure decided by the central government is not adequate for the present situation of each region. If we take the situation like this into account, it is significant for us to make a comparative study of the infrastructure provision system. In prior literature, Klibanoff and Morduch (1995) and Akai and Mizuno (1998) analyse it by turning their attention to asymmetric information between a central government and a local government (firm). Ogawa (1998) researches how a central and local government should take charge of responsibility for their accomplishment powers in the proceeding their own projects.

Those articles analyse it in only partial equilibrium model. Rahman (1997) and Takahashi (1998) analyse it in general equilibrium model. Rahman (1997) discusses that a multi-firm city, which has more than one firm, or a company town, which has only one firm, is formed depending on the level of infrastructure provided. In his model a land rent revenue which a developer raises covers the cost of infrastructure provision: the total land rent revenue is equal to the cost of infrastructure provision in equilibrium-the Henry George Theorem. However, his model does not include the information asymmetry problem caused by the existence of hidden private information. Though Takahashi (1998) explains the provision pattern and the optimal tax rate in a two-region model, he does not analyse the decentralized system on which Klibanoff and Morduch (1995) or Akai and Mizuno (1998) focus in their models. Furthermore, he studies his own model assuming that the central government can know the information of regions in a economy completely. So his model includes no information asymmetry problem, too. It is useful for us to use the “Principal-Agent model”, of industrial organization to analyse the optimal contract under the existence of hidden private information. We attempt to apply this model for the fiscal system under the central government. We consider the case that each local government received subsidy from the central government carry out that project. Though Akai and Mizuno (1998) and so on use this model, their analyses are partial equilibrium models. Then, Takahashi (1998) and Rahman (1997) do not take account in the fiscal system or asymmetric information. This paper studies these points which are not included in their models.

The organization of this paper is as follows: Section 2 presents the model. We consider two regions model and deals with the level of infrastructure provided as give, then attempt

to characterize the model; Section 3 explains the optimal infrastructure provision under the decentralized system. Under this system each local government collects a residents' tax from his own residents and determines the amount of infrastructure provision in his region; Section 4 presents it under the centralized system. Under this system, the central government which controls two regions collects a national tax from residents in both regions and determines each region's infrastructure provision level. Then, it gives local governments subsidies and have them proceed those projects. Then, we attempt to compare the social welfare and infrastructure provision level under decentralized system with them under centralized system ; Section 5 contains the conclusion and the subjects after this.

2 The Model

2.1 Production Sector

We consider the economy composed of two regions labeled by i ($i=1, 2$). There is a local government which controls his region in each region and is a central government controls two regions. As Akai and Mizuno (1998) defined, we define the decentralized system as the case that each government determines the infrastructure level and tax rate in his region. The central government does not interfere in the local governments' decision in this system. On the other hand, we define the central government system as the case that the central government determines the infrastructure provision level in each region and national tax rate. As we showed in introduction, we attempt to discuss the equilibrium conditions when we deal with the infrastructure level as given for the first time. After considering the equilibrium conditions in the model, we analyse its provision level under each system.

2.1.1 Private Goods

We consider two private goods in our model. These goods are labeled by i ($i=1, 2$), respectively. Two input factors are required in order to produce each good, that is, one of them is labor and the other is infrastructure. The former is a variable input factor and the latter is a fixed input. We assume that the market of each good is competitive and that each price is given by p_1, p_2 , respectively. The production function in our model is similar to Takahashi (1998). The technologies used in the private goods production exhibit constant

returns to scale for the labor input. Moreover, the fixed input, which private goods producer can not operate, is $(G_i)^\beta$. Though two goods can be produced in each region, the infrastructure is used by the region where it is provided. So the private goods producer in region i ($i=1, 2$) cannot use the infrastructure in region j ($j=1, 2, i \neq j$). Then, we set up production function as follows. When good i ($i=1, 2$) is produced in region i ($i=1, 2$),

$$f_i^i(L_i, G_i) \equiv L_i (G_i)^\beta \quad (i=1, 2) \quad (1)$$

On the other hand, when good i ($i=1, 2$) is produced in region j ($j=1, 2, j \neq i$),

$$f_i^j(L_j, G_j) \equiv L_j (G_j)^{\beta/\sigma} \quad (i, j=1, 2, i \neq j) \quad (2)$$

We assume $\sigma > 1$. This implies that, in the production of good i , a region i has an advantage in good i production one region j ($j \neq i$). As a result, each region specializes in one of good. Now let X_i ($i=1, 2$) present the amount of production good i . As we assume that each good faces on the competitive market, the optimal amount of each good is determined from the following conditions

$$p_1 (G_1)^\beta = w_1 \quad (3)$$

$$p_2 (G_2)^\beta = w_2 \quad (4)$$

The amount of produced goods is determined by the above equations. Furthermore, we can determine the wage rate in both regions endogenously. In Akai and Mizuno (1998) model, the level of infrastructure does not change the income level in each region, that is, Akai and Mizuno (1998) do not deal with these wage rate as endogenous variables. When we imagine a public infrastructure like a library, we can use their model. But we cannot make use of their model setting in our model, because the level of infrastructure affects wage rate in each region. This is the point which we attempt to extended.

2.1.2 Infrastructure

The production of each good also requires the fixed input, that is, the infrastructure. Let G_i ($i=1, 2$) represent the amount of capital in region i . To determine the level for infrastructure in each region means the decision of the amount of investment for infrastucture. As for amount of infrastructure and investment, we assume as follows.

Assumption 1 *The level of infrastructure in one region has no spillover effect on the other*

region.

Assumption 1 is appropriate by some reasons. One of them is that facilities like industrial blocks do not effect the other.¹⁾ Moreover, it is meaningless for us to take account in zero infrastructure level i our model. If no infrastructure is provided, residents can get their income.²⁾

The government under each system determine the grant for infrastructure and tax rate required in our model. $(G_i)^\beta$ units from one unit of grant, that is, when we denote amounts supplied as $F_i(G_i)$ the production function of infrastructure is as follows.

$$F_i(G_i) = G_i^\beta, \quad (5)$$

where $0 < \beta < 1$. Each price of capital in a region is given by c_{im} , ($i=1, 2$, $m=l, h$). Here we assume $c_{il} < c_{ih}$. There are two kinds of G_i ($i=1, 2$), that is, higt type or low type. Let c_{il} represent the low marginal cost type, which means the effcient capital. On the other hand, Let c_{ih} represent the higt marginal cost type, which means the ineffcient capital. G_i is produced by using labor in region i , L_i^G ($i=1, 2$). We assume this production function as follows.

$$G_i = G_i(L_i^G) = L_i^G \quad (i=1, 2) \quad (6)$$

The first order conditions for profit maximization are as follows, respectively.

$$w_i^{Gi} = C_k \quad (i=1, 2, k=l, h) \quad (7)$$

2.2 Consumers

We assume that all residents own common preference and one unit of labor. Each resident supplies it for firms in the region where helives inelastically. Let L_1 and L_2 be the population of private goods production worker in region i . Let L_1^G and L_2^G represent the population of capital production in region i . Residents in each region pay their residents' (or national) tax. Then, they distribute their own disposable income to private goods. When x_1 and x_2 denote the amounts of consumption for each good, we specify residents' utility function as follows.

$$U_i = x_1^\alpha x_2^\gamma \quad (i=1, 2), \quad (8)$$

where is $\alpha + \gamma = 1$. If we do not take the transportation cost of goods into account, each

budget constraint of a resident is

$$(w_i - t_i) = p_1 x_1 + p_2 x_2, w_i^{G_i} - t_i = p_1 x_1 + p_2 x_2 \quad (i=1, 2) \quad (9)$$

where w_i and $w_i^{G_i}$ ($i=1, 2$) are wage rates in region i .³⁾ Taking account of their utility maximization problem, we can derive demand function in each good, x_i ($i=1, 2$), as follows.

$$x_1^i = \frac{\alpha (w_i - t_i)}{p_1}, x_1^{G_i} = \frac{\alpha (w_i^{G_i} - t_i)}{p_1} \quad (i=1, 2) \quad (10)$$

$$x_2^i = \frac{\gamma (w_i - t_i)}{p_2}, x_2^{G_i} = \frac{\gamma (w_i^{G_i} - t_i)}{p_2} \quad (i=1, 2) \quad (11)$$

The market for good “1” clears if

$$L_1 x_1^1 + L_1^G x_1^{G1} + L_2 x_1^2 + L_2^G x_1^{G2} = L_1 (G_1)^\beta \quad (12)$$

moreover, that for good “2” clears if

$$L_1 x_2^1 + L_1^G x_2^{G1} + L_2 x_2^2 + L_2^G x_2^{G2} = L_2 (G_2)^\beta \quad (13)$$

Thus, solving the system that consists of (3), (4), (7), (10), (11), (12), (13) variables, w_i , $w_i^{G_i}$ ($i=1, 2$), x_i^j ($i, j=1, 2$), X_i ($i=1, 2$), are determined. Finally, we can also derive each resident's indirect utility function as follows.

$$v_i = \frac{\alpha^\alpha \gamma^\gamma (w_i - t_i)}{p_1^\alpha p_2^\gamma}, v_i^G = \frac{\alpha^\alpha \gamma^\gamma (w_i^{G_i} - t_i)}{p_1^\alpha p_2^\gamma} \quad (i=1, 2) \quad (14)$$

3 Decentralization System

We showed some equilibrium conditions when we deal with the amount of infrastructure as given in section 2. In this section, we attempt to discuss the optimal level of infrastructure in each region under the decentralized system.⁴⁾ Recall that the local governments collect their residents' tax to supply their infrastructure. Thus the budget constraint of each local government is given by

$$(L_i + L_i^G) t_i = c_{ik} G_i \quad (i=1, 2, k=l, h) \quad (15)$$

To simplify our model, we suppose about population as follow.

Assumption 2 *There is no migration between two regions.*

Taking account above situation into account, we can rewrite a resident's indirect utility in region i , (12), as follow.

$$v_i = \frac{\alpha^\alpha \gamma^\gamma (p_i G_i^\beta - t_i)}{p_1^\alpha p_2^\gamma}, v_i^G = \frac{\alpha^\alpha \gamma^\gamma (c_k - t_i)}{p_1^\alpha p_2^\gamma} \quad (16)$$

Here we define social welfare in region i as the sum of an resident's indirect utility in region i . Let \hat{V}_i represent social welfare in region, that is,

$$\begin{aligned}\hat{V}_i &\equiv L_i v_i + L_i^G v_i^G \\ &= \frac{\alpha^a \gamma^\gamma (L_i^G c_k + L_i P_i G_i^\beta - (L_i + L_i^G) t_i)}{p_1^a p_2^\gamma}\end{aligned}\quad (17)$$

Since each local government's objective is to maximize the welfare in his region, each attempts to maximize it subject to his budget constraint.⁵⁾ The maximization problem in region i 's government is given by

$$\begin{aligned}\max_{G_i} \quad & \frac{\alpha^a \gamma^\gamma (L_i^G c_k + L_i P_i G_i^\beta - (L_i + L_i^G) t_i)}{p_1^a p_2^\gamma} \\ \text{s.t.} \quad & (L_i + L_i^G) = c_k G_i\end{aligned}$$

We can rewrite this maximization problem as the problem without the constraint by substituting it into the objective function. When we consider the rewritten maximization problem, the first order condition for maximizing is,

$$\frac{d\hat{V}_i}{dG_i} = \frac{\alpha^a \gamma^\gamma}{p_1^a p_2^\gamma} \left[\beta L_i p_i G_i^{\beta-1} - c_k \right] = 0. \quad (18)$$

Therefore, we can derive the optimal investment level of infrastructure, that is,

$$G_i^* = \left[\frac{\beta p_i L_i}{c_k} \right]^{\frac{1}{1-\beta}} \quad (i=1, 2) \quad (19)$$

As the local budget constraint is defined by (13), the optimal tax rate in region i is derived as follows.

$$t_i = \left[\frac{L_i^\beta \beta p_i}{c_k^\beta} \right]^{\frac{1}{1-\beta}} \quad (20)$$

Analysing comparative statics as to optimal investment level of infrastructure under the decentralized system, (19), we can derive as a lemma.

Lemma 1 *Under the decentralized system, the optimal level of infrastructure is decreasing in the marginal cost and increasing in that population.*

$$\frac{\partial G_i^*}{\partial c_k} < 0, \quad \frac{\partial G_i^*}{\partial L_i} > 0 \quad (21)$$

Finally, it is very important for us to define social welfare function in this economy under the decentralized system in order to compare with that under the centralized system we

discuss in next section. Let \hat{V}^{L*} represent it. It is given by

$$\hat{V}^{L*} \equiv V_1 + V_2 \quad (22)$$

Substituting (17) into (20),

$$\hat{V}^{L*} = \sum_{i=1}^2 \frac{\alpha^a \gamma^y}{p_1^a p_2^y} \left[L_i^G c_k + p_i L_i \left(\frac{\beta p_i L_i}{c_k} \right)^{\frac{\beta}{1-\beta}} - c_k \left(\frac{\beta p_i L_i}{c_k} \right)^{\frac{1}{1-\beta}} \right] \quad (k = l, h) \quad (23)$$

4 Centralization System

4.1 The Optimal Provision Level

We analysed the case of optimal investment level of infrastructure under the decentralized system in the previous section. We attempt to discuss the case under the centralized system in this section. Each local government imposes his residents on the resident's tax and determines its level under the decentralized system. We consider the case that there is the central government which can control two regions and local government. A local government can not decide the level of investment and tax rate of infrastructure under the system like this. The central government imposes the national tax, which is based on the cost offered by each local government, on residents in two regions and determines the optimal level of infrastructures in both regions to maximize the social welfare of economy.⁶⁾ The central government gives local governments a menu and have them proceed that menu project.

What is the most important difference between the decentralized system and the centralized? It is the central government do not have the correct information of the cost of production of G_i ($i=1, 2$). Local governments have the knowledge of cost of G in their own region. Thus we need not take an information asymmetry problem into account. The central government, however, has no correct knowledge about it. So this information about the cost is the hidden private information, that is, it is information asymmetry between the central government and each local government. We set some assumptions about this information asymmetry as follows.

Assumption 3 *Under the centralized system, the central government knows the fact that there are two types of cost in a local government.*

Assumption 4 *Under the centralized system, the central government knows the distribution of a local government's cost type; the probability of type low is ν and that of type high is $1 - \nu$.*

Moreover, we assume that the central government is risk neutral. When there is the information asymmetry like this, how does the central government behave? In this case, it attempts to make a menu to maximize the expected social welfare in the economy. We have a useful method to analyse this situation, that is the “Principal-Agent model”. We can make a second best menu by applying principal-agent model for our model. The central government gives local governments any menu; it is (S_l, G_l) or (S_h, G_h) .

Since the central government collects a national tax to give local governments subsidies for the infrastructure provision. Therefore, the budget constraint of the central government is given by

$$S_{1m} + S_{2n} = (L_1 + L_1^G + L_2 + L_2^G) t \quad (m, n=l, h), \quad (24)$$

where S_{1m} is the subsidy for the type m ($m=l, h$) in region 1 and S_{2n} is that for the type n ($n=l, h$) in region 2. As the objective of the central government is a social welfare maximum, he attempts to determine G_i ($i=1, 2$) and S_i ($i=1, 2$) to maximize it. We define the social welfare as follow.

$$\hat{V}_c \equiv V_1 + V_2, \quad (25)$$

where \hat{V}_c denotes the social welfare under the centralized system.⁷⁾ The central government knows the distribution of the type in both local governments. So the expected social welfare, $E\hat{V}_c$ is as follow.

$$E\hat{V}_c = \sum_{m=l,h} \sum_{n=l,h} r \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} (L_1^G C_m + L_1 p_1 G_{1m} + L_2^G C_n + L_2 p_2 G_{2n} - S_{1m} - S_{2n}), \quad (26)$$

where r is as follows:

- $r = vv$ when both regions are type l
- $r = v(1-v)$ when one region is type l and the other is type h
- $r = (1-v)(1-v)$ when both regions are type h

Then that maximization problem is

$$\begin{aligned} & \max_{(S_{1m}, G_{1m}), (S_{2n}, G_{2n})} E\hat{V}_c \\ \text{s.t.} \quad & S_{il} - c_l G_{il} \geq S_{ih} - c_l G_{ih} \quad (\text{IC for type } l) \\ & S_{ih} - c_h G_{ih} \geq S_{il} - c_h G_{il} \quad (\text{IC for type } h) \\ & S_{il} - c_l G_{il} \geq 0 \quad (\text{IR for type } l) \\ & S_{ih} - c_h G_{ih} \geq 0 \quad (\text{IR for type } h) \\ & (i=1, 2) \end{aligned}$$

IC and IR mean “Incentive compatibility condition” and “Individual rationality condition”, respectively. We can derive some lemmas from these four restraints.

Lemma 2 *Under the optimal contract (menu), we can ignore individual rationality constraint for type “low”.*

(proof)

Recall our assumption $c_l < c_h$. Whenever the incentive compatibility constraint is satisfied, it must be as follows.

$$S_{il} - c_l G_{il} \geq S_{ih} - c_l G_{ih} > S_{ih} - c_h G_{ih}$$

Taking individual rationality constraint, $S_{ih} - c_h G_{ih} \geq 0$, into account for high type, the following inequality is derived, that is,

$$S_{il} - c_l G_{il} > 0$$

This inequality implies that individual constraint for low type is not binding. Thus we can ignore it under the optimal menu.

Lemma 3 *Under the optimal menu, the infrastructure level of the low type is at least as much as that of high type.*

(proof)

We can rewrite two incentive compatibility constraints as follows.

$$S_{il} \leq S_{il} + c_l G_h - c_l G_l$$

$$S_{ih} \geq S_{il} + c_h G_h - c_h G_l$$

Hence the following inequality is satisfied.

$$(c_i - c_h) G_{il} \geq (c_h - c_l) G_{ih}$$

Therefore,

$$G_{il} \geq G_{ih}$$

If we suppose $G_{ih} > G_{il}$ in the optimal menu, it does not satisfy incentive compatibility conditions.

Lemma 4 *Under the optimal menu, individual rationality condition for “high” type is binding.*

(proof)

The central government wants to decrease S_{ih} without any effect on individual rationality. So it can decrease S_{ih} by c_{ih} . Thus, $S_{ih} - c_h G_{ih} = 0$, that is, individual rationality constraint is binding.

Lemma 5 *Under the optimal menu, incentive compatibility constraint for “low” type is binding.*

(proof)

Taking account in Lemma 4, incentive compatibility constraint for low type can be rearranged as follow.

$$S_{il} \geq c_l G_{il} + (c_h - c_l) G_{ih}$$

The central government attempt to decrease S_{il} as small as possible without violating incentive compatibility constraint for low type. Therefore it does S_{il} by the amount which is equal to $c_l G_{il} + (c_h - c_l) G_{ih}$. So incentive compatibility constraint for low type is binding.

When $S_{il} = c_l G_{il} + (c_h - c_l) G_{ih}$ is satisfied, what does the second term in right hand mean? It is a information rent. Comparing the decentralized system with centralized system, we can see that this social inefficiency is caused by a information rent.

Lemma 6 *Under the optimal contract (menu), we can ignore incentive compatibility constraint for “high” type.*

(proof)

Now let us assume that incentive compatibility constraint for type high is binding, that is,

$$S_{ih} - c_h G_{ih} = S_{il} c_h G_{il}$$

Recall two constraints are binding, that is,

$$S_{ih} = c_h G_{ih}$$

$$S_{il} = c_l G_{il} + (c_h - c_l) G_{ih}$$

By substituting these equations into above equation we can rewrite it as follows.

$$c_l (G_{il} - G_{ih}) = c_h (G_{il} - G_{ih})$$

This equation violates the single crossing property. Thus this constraint is not satisfied as an equality. ⁸⁾

So we can ignore this constraint.

Taking account of the above lemmas, the maximization problem of expected social welfare can be rearranged as

$$\begin{aligned} \max_{(S_{1m}, G_{1m}), (S_{2n}, G_{2n})} \quad & E\hat{V}_c \\ \text{s.t.} \quad & S_{il} = c_l G_{il} + (c_h - c_l) G_{ih} \\ & S_{ih} = c_h G_{ih} \\ & (i=1, 2) \end{aligned}$$

Moreover we can consider the expected social welfare function as that of G_{1m}, G_{2m} ($m, n=l, h$) by substituting two constraints into the expected social welfare. Maximizing this rearranged expected social welfare function as to G_{1m}, G_{2m} ($m, n=l, h$), the first order conditions are given by

$$\frac{\partial E\hat{V}_c}{\partial G_{1l}} = \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} \left\{ (\nu(1-\nu)) \left[\beta L_1 p_1 G_{1l}^{\beta-1} - c_l \right] + \nu \left[\beta L_1 p_1 G_{1l}^{\beta-1} - c_l \right] \right\} = 0. \quad (27)$$

$$\frac{\partial E\hat{V}_c}{\partial G_{2l}} = \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} \left\{ (\nu(1-\nu)) \left[\beta L_2 p_2 G_{2l}^{\beta-1} - c_l \right] + \nu \left[\beta L_2 p_2 G_{2l}^{\beta-1} - c_l \right] \right\} = 0. \quad (28)$$

$$\frac{\partial E\hat{V}_c}{\partial G_{1h}} = \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} \left\{ (\nu(1-\nu)) \left[\beta L_1 p_1 G_{2h}^{\beta-1} - c_l \right] + \nu (c_h - c_l) \right\} = 0. \quad (29)$$

$$\frac{\partial E\hat{V}_c}{\partial G_{2h}} = \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} \left\{ (\nu(1-\nu)) \left[\beta L_2 p_2 G_{2h}^{\beta-1} - c_h \right] + \nu (c_h - c_l) \right\} = 0. \quad (30)$$

Solving these first order conditions, the optimal level of G_{1m}, G_{2n} ($m, n=l, h$) are derived as follows.

$$G_{il}^{c*} = \left[\frac{\beta L_i p_i}{c_l} \right]^{\frac{1}{1-\beta}} \quad (i=1, 2) \quad (31)$$

$$G_{ih}^{c*} = \left[\frac{(1-\nu)\beta L_i p_i}{c_h - c_l} \right]^{\frac{1}{1-\beta}} \quad (i=1, 2) \quad (32)$$

We derived an optimal amount of investment for infrastructure in region i ($i=1, 2$) under the decentralized system, (17). Comparing an optimal amount of investment under the decentralized system with that of investment under the centralized system, the following proposition is derived.

Proposition 1 *If the local government is “low” type under the centralized system, the optimal investment level for infrastructure is equal to that for infrastructure under the decentralized system. On the other hand, if the local government is “high” type, the optimal investment*

level for infrastructure is smaller than that for infrastructure under the decentralized system.

(proof)

The case in low type is obvious. So we attempt to proof the case in high type.

$$\begin{aligned} \left[\frac{\beta L_i p_i}{c_h} \right]^{\frac{1}{1-\beta}} &> (<) \left[\frac{(1-\nu) \beta L_i p_i}{c_h - c_l} \right]^{\frac{1}{1-\beta}} \\ -c_h - \nu c_l &> (<) c_h - \nu c_h \\ -c_h &> (<) c_l \end{aligned}$$

The relation between high marginal cost type and low marginal cost type is assumed like $c_h > c_l$. Therefore, the optimal investment level under the centralized system is smaller than that under the decentralized system.

4.2 Welfare Comparison under Each System

Optimal investment level for infrastructure under each system are given by (19), (31), and (30). We can compare social welfare under each system. It is very important for us to compare with welfare under each system. When optimal investment is provided under the centralized system, the social welfare is given by⁹⁾

$$\hat{V}^{c*} = \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} (L_1^G c_m + p_1 L_1 G_{1m}^{c*} - S_{1m} + L_2^G c_n + p_2 L_2 G_{2n}^{c*} - S_{2n}). \quad (32)$$

the social welfare is as follows.

- when both local government are high type,

$$\hat{V}^{c*} = \sum_{i=1}^2 \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} (L_i^G c_h + p_i L_i (G_{ih}^{c*})^\beta - c_h (G_{ih}^{c*})) \quad (33)$$

- when the local government in region 1 is low type and the other is high,

$$V^{c*} = \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} (L_1^G c_l + p_1 L_1 (G_{1l}^{c*})^\beta - c_l (G_{1l}^{c*}) - (c_l - c_l) (G_{1h}^{c*}) + L_2^G c_h + p_2 L_2 (G_{2h}^{c*})^\beta - c_h (G_{2h}^{c*})) \quad (34)$$

- when the local government in region 1 is high type and the other is low,

$$\hat{V}^{c*} = \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} (L_1^G c_h + p_1 L_1 (G_{1h}^{c*})^\beta - c_h (G_{1h}^{c*}) + L_2^G c_l + p_2 L_2 (G_{2l}^{c*})^\beta - c_l G_{2l}^{c*} - (c_h - c_l) G_{2h}^{c*}) \quad (35)$$

- when both local governments are low type,

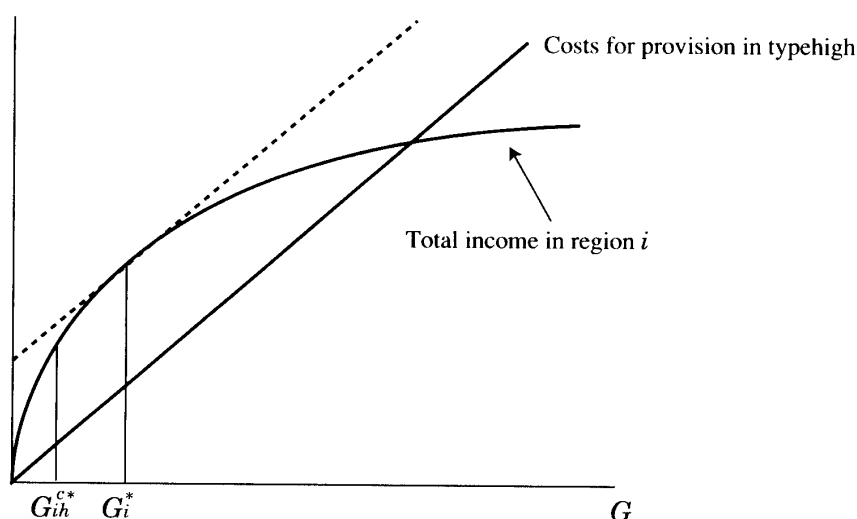
$$\hat{V}^{c*} = \sum_{i=1}^2 \frac{\alpha^\alpha \gamma^\gamma}{p_1^\alpha p_2^\gamma} (L_i^G c_l p_i L_i (G_{ih}^{c*})^\beta - c_l G_{il}^{c*} - (c_h - c_l) G_{ih}^{c*}) \quad (36)$$

From proposition 1 we derived that optimal investment for infrastructure is same in both system when a local government is low type. Therefore residents receive the same income in spite of each system. However, as for the cost for that optimal investment the cost under the centralized system is higher than that under the decentralized system. As the result, the social welfare under the centralized system is lower than that under the decentralized system. Thus the following proposition is derived,

Proposition 2 *If each local government is low type, social welfare under the centralized system is lower than that under the decentralized system.*

Furthermore, we attempt to analyse the case that both local governments are high type. We derived social welfare under each system by (23) and (33) when both local governments are high type. It is useful for us to use a graph in order to make a comparison of social welfare between under the decentralized system and the centralized system. An optimal amount of investment for infrastructure in region “ i ” is determined on the point where the marginal increases of total income in region “ i ” is equal to the marginal increases of cost for the infrastructure provision. This point is the investment level where the gap between the total income and the cost for infrastructure provision is largest. An optimal amount of investment for infrastructure under the centralized system is smaller than that under the decentralized system. Therefore that is not the point where the gap between the total income and the cost for infrastructure provision is largest. It is easy to find that the social welfare under the centralized system is smaller than that under the decentralized system

Figure 1



when each local government is high type. Thus we derive the following proposition.

Proposition 3 *When both local governments in the economy are high type, the social welfare under the centralized system is smaller than that under the decentralized system.*

Deriving proposition 2 and proposition 3, in each region, we showed that the gap between the total income and the cost for infrastructure provision under the centralized system is smaller than that under the decentralized system in spite of local government's type. When we take account of the infrastructure like this, the decentralized system is more desirable than the centralized system. Why does the inefficiency like this cause in the centralized government system? Needless to say, it is caused by information asymmetry between the central government and the local government. This inefficiency appears as the information rent, that is, $(c_h - c_l)G_h^*$. As the difference of $(c_h - c_l)$ increases, that inefficiency caused by the information asymmetry is larger.

5 Conclusion

Finally, we attempt to conclude the paper by outlining its contributions and possible directions for further research. By modeling the public infrastructure like an electric facility or an industrial facility which affects the productivity in the region where it is provided, we can show the case, which previous papers do not analyze, under the decentralized system and the centralized system. If we take such an infrastructure into account, it is impossible for us to use the theory of public goods in Akai and Mizuno (1998). As for that point, we can give some contribution to the further research. We take account of a kind of this infrastructure and showed the optimal infrastructure provision under two systems; the decentralized system and the centralized system. When a local government is low type, an amount of optimal provision level for infrastructure is same in spite of fiscal system. On the other hand, if a local government is high type, the optimal level is smaller than it under the decentralized system. Moreover, we compared with the social welfare under the centralized and decentralized system. So we showed that the decentralized system is more desirable than the centralized system. This conclusion gives us the motivation of promoting the decentralization which many people maintain in these days in Japan. We construct the mechanism design in adverse selection in this paper. As many people know, however, a lot of local government officers go to the central ministries in order to lobby; ("chinjo" in Japanese). If we try to introduce this action into this model, it is possible to study it by

using not an adverse selection model but a signaling model.

We set some assumptions in order to simplify our model. One of them is the point that we do not take the migration between regions into account, that is, we analyse the case in short run. But if we consider the model in long run, we have to take account of the inseparability of infrastructure. Another is the point that we assume that there is no spillover effect between infrastructures. However, recently the spatial network system, which is like a telecommunication technology, has been developing. So it is interesting for us to consider externality like this. As we focused on an optimal level of investment for the infrastructure and the comparison social welfare between under the decentralized system and under the centralized system, we ignore land market or transportation cost to commute to resident's job place. If we introduce urban economics model where it is possible to analyse land market into our model, there are some other directions to extend my model. Moreover, though we assume two private goods, we can extend multi-goods market model.

Finally, we do not attempt to analyse empirical research. It is interesting to compare the results in theoretical model with that in empirical model. These issues are our subjects after this.

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Notes

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- 1) Since, in the facility like that, an amount of public good in one region effects it in the others, we have to take any spillover effect into account when we consider the facility like a library. See Akai and Ihori (1998) about the analysis of the case that public goods have any externality to others.
- 2) See Takahashi (1998) as to the case of zero provision.
- 3) Needless to say “ t_i ” included in this restraint means the residents’ tax in region i . If we consider the centralized system, common national tax, t , is imposed on all residents. t is equal to total subsidy divided by total population. As for national tax, see later section.
- 4) Of course, there is no asymmetric information problem. This is because each local government know their own provision cost exactly.
- 5) If there is any spillover between two regions infrastructure, each local government takes the other level as given and determines “ G ” to maximize his social welfare.
- 6) This tax is common rate for both regions.
- 7) V_i included in this definition is a total welfare in region i ($i=1, 2$) under the centralized system.
- 8) This property of preference, as known a single crossing property, is that those isoprofit curves cross only once. and the isoprofit curve of low type has somller slope. As for the single crossing property, it is useful for us to confirm it by using the figure which adopts (S, G) as the horizontal and vertical axis. See Mas-Collel (1995) in details.
- 9) $S_{ih} = c_h G_{ih}^{f*}$ ($i=1, 2$) and $S_{il} = c_l G_{il}^{f*} + (c_h - c_l) G_{ih}^{f*}$ ($i=1, 2$)