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Private Good provided by Local Governments

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Abstract:

This paper investigates the outcome of decentralized decision making by local governments in provision of private good, and examines its efficiency. In the setting of a two-region economy, each local government decides whether to provide the service, then chooses user fees and taxes, so as to maximize the utility of its residents. At equilibrium, the local government imposes discriminatory fees for service users from other region. There exists four patterns of provision as Nash equilibrium, including the case of multiple equilibria, and conditions for each emerging are derived. We formulate and solve the optimizing problem to obtain Pareto-efficient allocation with respect to patterns of provision, user fees and taxes. Comparing equilibrium and optimal solutions, it turns out that competition among governments may lead to either over-provision or under-provision, depending on the degree of scale economies and population distribution.

1.Introduction

The literature on local public economics has focused on the provision of public good as a main role of local governments. In reality, however, many services provided by local governments do not necessarily have the property of public good. For example, schools, gymnasiums, recreational facilities and museums are considered as private good in an economic sense: providers of these services can exclude free-riders whereas the marginal cost for providing the service to an additional user is significantly positive. Many local governments provide these services since they generate externalities or for other reasons that they are not efficiently provided by private firms.

In an economy consisting of many regions, while each local government makes decisions considering only the welfare of residents in its jurisdiction, policy of one local government affects benefits and costs of other regions. Concerning the public good provision, there is already a substantial body of literature that investigates the consequences of decentralized decision making by local governments (see Wildasin (1987) for an overview). On the other hand, despite the significance in the real world, relatively little attention has been paid in the literature to private good provision by local governments. One distinctive feature of private good provision is that it involves the decision on pricing (i. e., setting the user fees for such services). It is unclear whether decentralized decision-making by local governments with respect to provision of private good and user fee setting is socially desirable. Answering this question is the objective of this paper.

Public provision of private good has been studied by a few scholars, such as Besley (1991), Besley and Coate (1991), Munro (1991), and Epple and Romano (1996). However, they mainly deal with the case when everyone consumes a uniform amount of the service and fees are not charged (such as elementary and secondary education). We instead focus on the case that each individual chooses the consumption level of the service provided by the local government. This case seems more relevant to the services provided by local governments, such as a concert hall, a stadium, a gymnasium, and education in public universities. In this case, pricing is an important policy instrument for local governments, which does not arise in the case of public good provision. Although the literature of public sector pricing has dealt with related problems, it has mainly focused on the situation of natural monopoly, such as electricity, water supply, or transportation (Bös (1985), Vogelsang (1990)). We need to develop a model for the economy with many regions, in which services are provided not by single but by multiple public agents[1]. Note that, in an economy with multiple regions, people easily visit other regions to use the service provided there. In the case of public good, this is the spill-over problem, and many efforts have been devoted to deal with this problem, *inter alia* by Williams(1966), Kuroda (1989), Tsukahara(1995), and Cremer, Marchand and Pestieau (1997). In the case of private good, however, the characteristics of the problem are different: the local government as a provider can charge the fees for users from other regions. It is even possible to charge higher fees for users from other regions if each user can be identified. Such discriminatory pricing are implemented in the real world. Table 1 demonstrates an example of public universities in Japan. The table shows that students from other regions have to pay higher entrance fees than those in the university's home region. It is more advantageous to have service users from other regions and raise the fee revenue than to exclude those uses. We present a formal economic model describing the phenomenon reported above[2].

Table 1

The paper is organized as follows. Section 2 presents a model of a two-region economy in which each local government decides whether to provide the service, then chooses fee of the service and the tax, so as to maximize utility of its residents. We investigate the properties of the equilibrium solutions as the outcome of decentralized decision making by local governments. In Section 3, we formulate and solve the planning problem to obtain Pareto-efficient allocation with respect to patterns of provision, user fees and taxes. Comparing Nash equilibria with efficient solutions, we evaluate the efficiency of decentralized provision. Section 4 concludes the paper.

[1] It is considered in the literature that competition among public enterprises is quite rare (Vogelsang (1990)). Instead, a growing number of researchers are interested in mixed oligopoly market where the public enterprise competes with private firms.

[2] Takahashi (2000) investigates spatial competition between two governments in provision of excludable good with non-rivalry. In his model, oligopolistic price competition is a source of distortion. Our model has a different mechanism that discriminatory pricing leads to inefficient provision.

2.The Model

2-1 The setting

Suppose that the economy consists of two regions, each of which has its own local government. There are N households in the economy and the number of households in each region is exogenously given. Thus $N = n_1 + n_2$ holds, where n_i (i=1,2) is the number of households in region i. They are identical with respect to preferences and income.

We concentrate our attention to the private good provision as a role of local government; other activities are omitted in the analysis. We assume that the private good considered in this paper is not essential for human living. Universities and recreational facilities correspond to such type of services. This assumption allows the case that such a service might not be provided by any of the regions. We further assume that the quality of the service is identical regardless of the place of provision.

Each local government seeks to maximize utility levels of its residents. It decides whether to provide the service, then chooses a fee for the service and the tax to finance the expenditures for its provision.

2-2 Behavior of a household

Utility of a household depends on the consumption of composite good (numeraire), x, and the service provided by local government, g. Household income, y, is exogenously given. We assume that users of the service provided by local government incurs the travel cost, so the quantity of the service used is equivalent to the frequency of visits. Travel cost is equal to k if a user visits the other region to use the service, while no travel cost is incurred for the service within the same jurisdiction as the user's residence. Each household chooses the quantity of the consumption good and the publicly provided service so as to maximize its utility. The behavior of the household is described as follows.

$$\max_{x,g} \quad u(x, g) \tag{1}$$

$$\text{s. t.} \quad y - t = x + g(f + k) \tag{2}$$

where t: head tax

f : user fee for a unit of service

k : travel cost required for service use.

By solving the above problem, the demand functions for x and g are obtained.

$$x = x(f + k, y - t) \tag{3a}$$

$$g = g(f + k, y - t) \tag{3b}$$

The indirect utility function of the resident is defined as follows.

$$V(f + k, y - t) \equiv u(x(f + k, y - t), g(f + k, y - t)) \tag{4}$$

2-3 Behavior of a local government

Each local government seeks to maximize the utility of its residents, subject to budget constraint. Expenditures to provide the service are financed by revenue from user fees and taxes. The cost for provision consists of a fixed-cost and a variable cost. Fixed costs represent scale economies in providing the service.

The behavior of a local government is described as a two-stage decision making. At the first stage, a local government decides whether to provide the service or not. The second stage decision is to choose the amount of user fees and taxes, in the case that it decides to provide the service in the first stage.

We first formulate below the second stage behavior, choice of fees and taxes, given the decision of the first stage. Note that the decision of the local government in one region depends on the policy of another region. Thus from the viewpoint of the government in region i, the following four cases are possible outcomes of the first stage decisions by two governments (i and j indicate the home region and the other region, respectively) .

[Case A]: The service is provided in both i and j.

[Case B]: The service is provided in i but not in j.

[Case C]: The service is provided in j but not in i.

[Case D]: Both local governments don't provide the service.

Hereafter, superscripts of the variables such as A, B, C and D indicate the cases stated above, and subscripts indicate the regions. For instance t_i^A means the tax rate in region i under Case A, V_i^A is the utility level of a resident in region i under Case A.

[Case A]: The service is provided in both i and j

In this case, residents in each region use the service provided within their region's jurisdiction.

Since the quality of the services is the same, there is no reason to use the service in the other region given an additional travel cost. The user fee included in the indirect utility function (4), f, is replaced by f_i^A, the fee charged by its own government. Since residents use the service within their home region, no travel cost is required, i.e., $k=0$.

Therefore, the problem to be solved by the government in i is formulated as follows.

$$\max_{f_i^A, t_i^A} V(f_i^A, y - t_i^A) \tag{5}$$

$$\text{s. t.} \quad t_i^A n_i + f_i^A n_i g_i = F + \gamma n_i g_i \tag{6a}$$

$$g_i = g(f_i^A, y - t_i^A) \tag{6b}$$

where n_i: population in region i.

g_i: quantity of service use by a household in region i

F : fixed cost for provision.

γ : marginal cost

From the first-order conditions for optimization, we have

$$\frac{V_{f_i^A}}{V_{t_i^A}} = \frac{n_i g_i + f_i^A n_i g_{if_i^A} - \gamma n_i g_{if_i^A}}{n_i + f_i^A n_i g_{it_i^A} - \gamma n_i g_{it_i^A}}$$

where. $V_{f_i^A} = \dfrac{\partial V}{\partial f_i^A}$, $V_{t_i^A} = \dfrac{\partial V}{\partial t_i^A}$, $g_{if_i^A} = \dfrac{\partial g}{\partial f_i^A}$, $g_{it_i^A} = \dfrac{\partial g}{\partial t_i^A}$.

Applying Roy's identity, $g_i = V_{f_i^A} / V_{t_i^A}$, the above equation is rewritten as

$$n_i (g_i g_{it_i^t} - g_{if_i^A})(f_i^A - \gamma) = 0$$

This implies

$$f_i^A = \gamma \tag{7}$$

And substituting Eq. (7) to (6a) yields

$$t_i^A = \frac{F}{n_i} \tag{8}$$

The financing scheme described by Eq.(7) and (8) is equivalent to the two-part tariff: the fee is equal to the marginal cost and the fixed-cost is covered by the tax.

Finally, the utility level for Case A is obtained as

$$V_i^A = V(f_i^A, y - t_i^A) \tag{9}$$

[Case B]: The service is provided in i but not in j.

In this case, the service provided in region i may be used by residents in both regions. The local government can impose discriminatory fees for users from two regions. The problem to be solved by the government in region i is formulated as follows.

$$\max_{f_i^B, t_i^B, f_i^{'B}} V(f_i^B, y - t_i^B) \tag{10}$$

$$\text{s.t. } t_i^B n_i + f_i^B n_i g_i + f_i^{'B} n_j g_j = F + \gamma(n_i g_i + n_j g_j) \tag{11a}$$

$$g_i = g(f_i^B, y - t_i^B) \tag{11b}$$

$$g_j = g(f_i^{'B} + k, y) \tag{11c}$$

where $f_i^{'B}$ is the fee applied to users from the other region.

Following the procedure similar to Case A, we have

$$f_i^B = \gamma \tag{12}$$

$$f_i^{'B} = \gamma - \frac{g_j}{g_{j f_i^{'B}}} \tag{13}$$

$$t_i^B = \frac{F}{n_i} + \frac{g_j^2 n_j}{g_{j f_i^{'B}} n_i} \tag{14}$$

Comparing Eq. (12) with (13), it turns out that $f_i^{'B} > f_i^B$, because $g_j / g_{j f_i^{'B}} < 0$. This implies that the local government charges higher fees for users from the other region. This is consistent with the real world practices, such as the case shown in Table 1. On the other hand, in Eq. (14), it is seen that $t_i^B < F/n_i$, because $g_j^2 / g_{j f_i^{'B}} < 0$. In other words, tax rate for residents in region i is lower than that in Case A $(= F/n_i)$, since extra revenue from user fees paid by residents from the other region partly covers the expenditure for the fixed cost.

The utility level is obtained by

$$V_i^B = V(f_i^B, y - t_i^B) \tag{15}$$

[Case C]: The service is provided in j but not in i.

Since the service is not available within the home region (*i*), households use the service in another region (*j*). In this case, the resident incurs a travel cost, k, to use the service. Users have to pay the fee, $f_j^{'B}$, that is charged by the local government providing the service.

As the government in i does not incur the expenditure for providing the service, it is not necessary to collect taxes, i.e., $t_i^C = 0$.

Incorporating the above discussion into Eq. (4), the utility level is obtained as follows.

$$V_i^C = V(f_j^{'B} + k, y) \tag{16}$$

[Case D]: Both local governments don't provide the service.

When the service is not provided in both regions, residents have no opportunity to use the service. This case is equivalent to the situation when $f + k = \infty$. Consequently, households derive utility only from consumption of a composite good.

Incorporating the above discussion and applying $t_i^D = 0$ to Eq. (4), the utility level of a household is obtained by

$$V_i^D = V(\infty, y) \tag{17}$$

2-4 Strategies with respect to the provision of the service

Each local government has following two alternative strategies:

[Strategy S]; provide the service within the jurisdiction, and

[Strategy N]; not provide the service.

Each government chooses the strategy that achieves higher utility level of residents in its jurisdiction.

Note that the utility level of one region depends on the strategy of the local government in the other region. We need to investigate the combinations of strategies taken by two local governments. Table 2 summarizes possible patterns of strategies and corresponding utility levels in the form of a pay-off matrix.

Table 2 The strategy patterns of two local governments

region 1 / region 2	Provide (S)	Not provide (N)
Provide (S)	(V_1^A, V_2^A)	(V_1^B, V_2^C)
Not provide (N)	(V_1^C, V_2^B)	(V_1^D, V_2^D)

In the table, there exists four patterns of strategies, which are expressed hereafter as (S, S), (S, N), (N, S), (N, N). For example, (S, N) indicates that region 1 government provides the service but region 2 government doesn't. Each cell of the table shows utility levels of two regions. For example, (V_1^B, V_2^C) shown for the pattern (S, N) means that the utility levels of region 1 and 2 are equal to V_1^B and V_2^C, respectively.

2-5 Nash equilibrium patterns of provision

In this section, we investigate the conditions that each pattern is realized as a Nash equilibrium. To obtain explicit solutions, we specify the form of the utility function as follows.

$$u(x, g) = x + g^{\alpha} \tag{18}$$

where α is a constant with a value within the range of $0 < \alpha < 1$.

Applying the specification of Eq. (18) to Eqs. (9)(15)(16)(17), the utility levels of the two regions are calculated for each strategy pattern. The details are given in appendix A.

The conditions that each pattern in Table 2 is realized as a Nash equilibrium are stated as follows

Pattern (S, S): $V_1^A > V_1^C$ and $V_2^A > V_2^C$

Pattern (S, N): $V_1^B > V_1^D$ and $V_2^C > V_2^A$

Pattern (N, S): $V_1^C > V_1^A$ and $V_2^B > V_2^D$

Pattern (N, N): $V_1^D > V_1^B$ and $V_2^D > V_2^B$

Detailed expressions of these conditions under the functional form specified by Eq. (18) are given in Appendix B.

Based on the above, we depict in Figure 1 the range of parameters within which each pattern is realized as a Nash equilibrium.

Figure 1

F/N is the ratio of the fixed cost to the total population in the economy, which represents the degree of scale economy for service provision. P is the ratio of the population in region 1 to the total population ($= n_1/N$). The horizontal axis represents the population distribution between two regions. Both governments provide the service, i.e., Pattern (S, S) emerges, when the degree of scale economy is small, and the population distribution is relatively even. On the other hand no governments provide the service (i. e., Pattern (N, N) emerges), when the degree of scale economy is very large. Patterns that only one of the two governments provides the service, such as (S, N) and (N, S), are realized when population distribution is uneven. For example, the Pattern (S, N) is likely to emerge as the population of region 1 is relatively large. Multiple equilibria occur if parameters take values within the area CDFE in Figure 1, where either Pattern (S, N) or (N, S) can be equilibrium. Pattern (S, N) is more efficient than (N, S) if $P > 1/2$, and vice versa. In other words, within this range of parameters, it is more efficient that the service is provided in the region with a larger population size. Nevertheless, Nash equilibrium may lead to an inefficient location such that the service is provided in the smaller region.

Let us examine the effects of travel cost, k, on the parameter range shown in Figure 1. An increase in travel cost, k, causes expansions of the areas of Patterns (S, S) and (N, N), but shrinkages of the areas of Patterns (S, N) and (N, S). As a consequence, the area of multiple equilibria, CDFE shrinks. Higher travel costs discourage the use of the service by crossing the border between jurisdictions. Therefore, patterns involving trips for service use in the other region, such as (N, S) and (S, N), are less likely. Note that the area of multiple equilibria vanishes as k approaches infinity: points C, D, E and F converge to $(P, F/N) = \left(1/2, 1/2(1-\alpha)(\gamma/\alpha)^{\alpha/(1-\alpha)}\right)$. Service uses from other region are completely eliminated.

3. Socially efficient allocation

In this section, we formulate and solve the problem to obtain the Pareto optimal provision of private good in a two-region economy as a whole, and compare it with the decentralized provision obtained in the previous section. Pareto optimum is defined as the situation when the utility of residents in region 1 is maximized holding the utility of residents in region 2 at a given level.

As in the previous section, there exist four possible patterns of provisions as follows:

[Pattern (S, S)]: The service is provided in both regions.

[Pattern (S, N)]: The service is provided only in region 1.

[Pattern (N, S)]: The service is provided only in region 2.

[Pattern (N, N)]: No service is provided in this economy

We solve the problem by two stages: the first stage is to choose the pattern of provision; the second stage is to set the levels of user fees and taxes. The problem is solved backward: given each pattern of provision, solve the second stage problem first, then compare the values of the objective functions for four patterns, and finally choose the optimal pattern of provision.

3-1 Optimal fees and taxes for each pattern

Pattern (S, S)

In this case, residents in each region use the service provided within the home jurisdiction. Thus we consider the problem

$$\max_{f_1, f_2, t_1, t_2} V_1 = V(f_1, y - t_1) \tag{19}$$

$$\text{s.t. } V(f_2, y - t_2) = \overline{V} \tag{20a}$$

$$t_1 n_1 + t_2 n_2 + f_1 n_1 g_1 + f_2 n_2 g_2 = 2F + \gamma(n_1 g_1 + n_2 g_2) \tag{20b}$$

$$g_1 = g(f_1, y - t_1) \tag{20c}$$

$$g_2 = g(f_2, y - t_2) \tag{20d}$$

where $\overline{V}$ is the utility level that residents in region 2 should attain. Eq.(20b) is the budget constraint for the two-region economy as a whole.

The first order conditions for maximization are reduced to the following

$$f_i = \gamma \quad (i = 1,2) \tag{21}$$

$$t_1 = \frac{2F - \bar{t} n_2}{n_1} \tag{22}$$

$$t_2 = \bar{t} \tag{23}$$

where, $\bar{t}$ is the tax rate that is determined so as to satisfy Eq. (20a). Note that Eq. (21) is equivalent to Eq. (7), and $t_i = F/n_i$ is a special case of Eqs. (22) and (23). This implies that the user fee and tax rate are set efficiently when Pattern (S, S) emerges in equilibrium.

Pattern (S, N)

In this case, the service provided in region 1 may be used by residents in both regions. Users from region 2 incur the travel cost k, and have to pay the fee f_1'. Thus the problem to be solved in this case is formulated as follows.

$$\max_{f_1, f_1', t_1, t_2} V_1 = V(f_1, y - t_1) \tag{24}$$

$$\text{s.t. } V(f_1' + k, y - t_2) = \overline{V} \tag{25a}$$

$$t_1 n_1 + t_2 n_2 + f_1 n_1 g_1 + f_1' n_2 g_2 = F + \gamma(n_1 g_1 + n_2 g_2) \tag{25b}$$

$$g_1 = g(f_1, y - t_1) \tag{25c}$$

$$g_2 = g(f_1' + k, y - t_2) \tag{25d}$$

From the first order conditions for optimization, we have

$$f_1 = \gamma \tag{26}$$

$$f_1' = \gamma \tag{27}$$

and Eq. (22) and (23)

The result of Eq. (26), (27) implies that the fees for users in region 1 and 2 should not be differentiated, and should be equal to the marginal cost for provision. This is in contrast with the results obtained in the previous section that local government charges a discriminatory fee for users from the other region. In other words, the discriminatory pricing is not efficient.

Pattern (N, S)

This pattern is symmetry to pattern (S, N). Thus we omit the discussion.

Pattern (N, N)

Since no service is provided in this case, the control variables are taxes set by each government which are needed to adjust the utility levels of two regions. Therefore, the problem to be solved is formulated as follows.

$$\max_{t_1, t_2} \; V_1 = V(\infty, y - t_1) \tag{28}$$

$$\text{s. t. } \; V(\infty, y - t_2) = \overline{V} \tag{29a}$$

$$t_1 n_1 + t_2 n_2 = 0 \tag{29b}$$

The values of control variables, t_1 and t_2, are determined autonomously by Eq. (29a) and (29b), as follows

$$t_1 = -\frac{n_2}{n_1}\bar{t} \tag{30}$$

$$t_2 = \bar{t} \tag{31}$$

The transfer between the two regions should be made so that the utility level of region 2 is equal to $\bar{V}$.

3-2 Optimal pattern of provision

The analysis in this section is based on the specification of Eq. (18). Let us denote by $\hat{V}_1^{(S,S)}$, $\hat{V}_1^{(S,N)}$, $\hat{V}_1^{(N,S)}$, $\hat{V}_1^{(N,N)}$ the values of each objective function, i.e., the utility levels of region 1 for the four provision patterns, which are maximized with respect to user fees and taxes. Appendix C provides the detailed expressions.

The conditions for which each pattern becomes an optimal solution are stated as follows.

Pattern (S, S): $\hat{V}_1^{(S,S)} - \hat{V}_1^{(S,N)} > 0$, $\hat{V}_1^{(S,S)} - \hat{V}_1^{(N,S)} > 0$ and $\hat{V}_1^{(S,S)} - \hat{V}_1^{(N,N)} > 0$

Pattern (S, N): $\hat{V}_1^{(S,N)} - \hat{V}_1^{(S,S)} > 0$, $\hat{V}_1^{(S,N)} - \hat{V}_1^{(N,S)} > 0$ and $\hat{V}_1^{(S,N)} - \hat{V}_1^{(N,N)} > 0$

Pattern (N, S): $\hat{V}^{(N,S)} - \hat{V}^{(S,S)} > 0$, $\hat{V}^{(N,S)} - \hat{V}^{(S,N)} > 0$ and $\hat{V}^{(N,S)} - \hat{V}^{(N,N)} > 0$

Pattern (N, N): $\hat{V}^{(N,N)} - \hat{V}^{(S,S)} > 0$, $\hat{V}^{(N,N)} - \hat{V}^{(S,N)} > 0$ and $\hat{V}^{(N,N)} - \hat{V}^{(N,S)} > 0$

Detailed expressions of these conditions under the functional form specified by Eq. (18) are given in Appendix D.

Based on the above, we depict in Figure 2 the range of parameters within which each pattern is Pareto optimum.

Figure 2

Providing the service in both regions (i.e., Pattern (S, S)) is optimal when the degree of scale economies is smaller, and the population distribution is relativity even. On the other hand, no provision (i.e., Pattern (N, N)) is optimal when the degree of scale economies is larger. Providing the service in one of two regions, such as (S, N) and (N, S), is optimal when the degree of scale economies is moderate. In this case, the rule is that the service should be located in the region with the larger size.

The effects of travel cost, k, on the parameter range of each pattern are qualitatively similar to the situations in equilibrium: the areas of patterns involving the service uses in the other region shrink as travel cost increase.

3-3 Comparison between optimum and equilibrium

Figure 3 is obtained by superposing Figure 2 on Figure 1.

Figure 3

In Figure 3, areas of each pattern in equilibrium do not coincide with those in optimum. The area of Pattern (S, S) in equilibrium is larger than that in optimum. When the parameters take values within the area CBIA, the service is provided in both regions in equilibrium while it would be efficient that only one of two regions has the service. This implies that the decentralized decision making causes over-provision of services. Recall that the local government providing the service charges discriminatory fees for users from the other region. This induces the local government to have the service itself so as to avoid welfare reduction of residents within its jurisdiction due to the discriminatory fee. When the scale economy is relatively small, the benefit of avoiding a discriminatory fee is likely to exceed the provision cost from the viewpoint of individual government. On the other hand, the area of pattern (N, N) at equilibrium is larger than that in optimum. When the parameter values fall within the area JHFG, the service is not provided in both regions in equilibrium while it is efficient that one of two regions has the service, implying under-provision in decentralized decision making.

When multiple equilibria occur, decentralized decision making may lead to an extremely inefficient outcome: for example, within the area FCD, the service may be located in region 1 while it is efficient that the service is located in region 2.

Areas of equilibrium and optimal patterns coincide when $k = \infty$.

4. Conclusion

This paper focuses on the role of local governments in providing services which are categorized into private good. We investigate the equilibrium solution as an outcome of decentralized decision making by local governments and evaluate social efficiency of such equilibrium. The results obtained are summarized as follows:

(1) In the case that only one of two regions provides the service under decentralized provision, the local government acting as provider imposes discriminatory fees for users from the other region. This is consistent with real world practice (see Table 1), but such

pricing is inefficient.

(2) Decentralized decision making with respect to provision is not necessarily efficient: either over-provision or under-provision may occur depending on the degree of scale economy.

(3) There exists the possibility of multiple equilibria under decentralized provision. In this situation, inefficient location of the service may emerge.

The decentralized decision making causes inefficient allocation as shown above. One policy response is that the central government itself provides such services. This scheme attains the first best allocation by choosing the fee and the tax in such a way as was derived in Section 3, as long as the central government is sufficiently capable and rational. Such situation is unthinkable, and advocating centralization is not our intention. We need to develop the second best policy under which the central government intervenes in the decision process of local governments by means of tax-subsidy or other instruments. It is essential to affect pricing policies of local governments, in order to correct distortion with respect to the pattern of provision.

Introducing externality effects into the analysis is also an important extension. In many cases, presence of externality is the main reason that local governments provide the services categorized as private good. It would be interesting to see how such extensions affect the results obtained in this paper.

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Appendix A: The utility levels under decentralized decision making for each provision pattern

Pattern (S, S)

region 1 $$V_1^A = y - \frac{F}{n_1} + (1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{A1a}$$

region 2 $$V_2^A = y_2 - \frac{F}{n_2} + (1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{A1b}$$

Pattern (S, N)

region 1 $$V_1^B = y - \frac{F}{n_1} + (1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + \frac{n_2}{n_1}\alpha\left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{A2a}$$

region 2 $$V_2^C = y + (1-\alpha)\left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}} \tag{A2b}$$

Pattern (N, S)

region 1 $$V_1^C = y + (1-\alpha)\left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}} \tag{A3a}$$

region 2 $$V_2^B = y - \frac{F}{n_2} + (1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + \frac{n_1}{n_2}\alpha\left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{A3b}$$

Pattern (N, N)

region 1 $$V_1^D = y \tag{A4a}$$

region 2 $$V_2^D = y \tag{A4b}$$

Appendix B: Conditions for each provision pattern to emerge as an equilibrium solution

Let us define $P = n_1 / N$, and use the relation $N = n_1 + n_2$ in the process of derivation.

Pattern (S, S)

$$\frac{F}{N} < P(1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} - \left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{B1a}$$

$$\frac{F}{N} < (1-P)(1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} - \left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{B1b}$$

Pattern (S, N)

$$\frac{F}{N} < P(1-\alpha)\left(\frac{\gamma}{S}\right)^{\frac{\alpha}{\alpha-1}} + (1-P)\alpha(1-\alpha)\left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}} \tag{B2a}$$

$$\frac{F}{N} > (1-P)(1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} - \left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{B2b}$$

Pattern (N, S)

$$\frac{F}{N} > P(1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} - \left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{B3a}$$

$$\frac{F}{N} < (1-P)(1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + P\alpha(1-\alpha)\left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}} \tag{B3b}$$

Pattern (N, N)

$$\frac{F}{N} > P(1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + (1-P)\alpha(1-\alpha)\left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}} \tag{B3a}$$

$$\frac{F}{N} > (1-P)(1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + P\alpha(1-\alpha)\left(\frac{\gamma+k}{\alpha^2}\right)^{\frac{\alpha}{\alpha-1}} \tag{B3b}$$

Appendix C: The utility level of region 1 in Pareto optimum for each provision pattern

Pattern (S, S)

$$\hat{V}_1^{(S,S)} = \left(1+\frac{n_2}{n_1}\right)\left\{y + (1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}}\right\} - \frac{2F}{n_1} - \frac{n_2}{n_1}\overline{V} \tag{C1}$$

Pattern (S, N)

$$\hat{V}_1^{(S,N)} = \left(1+\frac{n_2}{n_1}\right)y + (1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + \frac{n_2}{n_1}\left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}}\right\} - \frac{F}{n_1} - \frac{n_2}{n_1}\overline{V} \tag{C2}$$

Pattern (N, S)

$$\hat{V}_1^{(N,S)} = \left(1+\frac{n_2}{n_1}\right)y + (1-\alpha)\left\{\frac{n_2}{n_1}\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + \left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}}\right\} - \frac{F}{n_1} - \frac{n_2}{n_1}\overline{V} \tag{C3}$$

Pattern (N, N)

$$\hat{V}_1^{(N,N)} = \left(1+\frac{n_2}{n_1}\right)y - \frac{n_2}{n_1}\overline{V} \tag{C4}$$

Appendix D: Conditions for each provision pattern to be the optimal solution

Pattern (S, S)

$$\frac{F}{N} < (1-P)(1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} - \left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{D1a}$$

$$\frac{F}{N} < P(1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} - \left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{D1b}$$

Pattern (S, N)

$$\frac{F}{N} > (1-P)(1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} - \left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{D2a}$$

$$P > 1/2 \tag{D2b}$$

$$\frac{F}{N} < P(1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + (1-P)(1-\alpha)\left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{D2c}$$

Pattern (N, S)

$$\frac{F}{N} > P(1-\alpha)\left\{\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} - \left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}}\right\} \tag{D3a}$$

$$P < 1/2 \tag{D3b}$$

$$\frac{F}{N} < (1-P)(1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + P(1-\alpha)\left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{D3c}$$

Pattern (N, N)

$$\frac{F}{N} > P(1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + (1-P)(1-\alpha)\left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{D4a}$$

$$\frac{F}{N} > (1-P)(1-\alpha)\left(\frac{\gamma}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} + P(1-\alpha)\left(\frac{\gamma+k}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{D4b}$$

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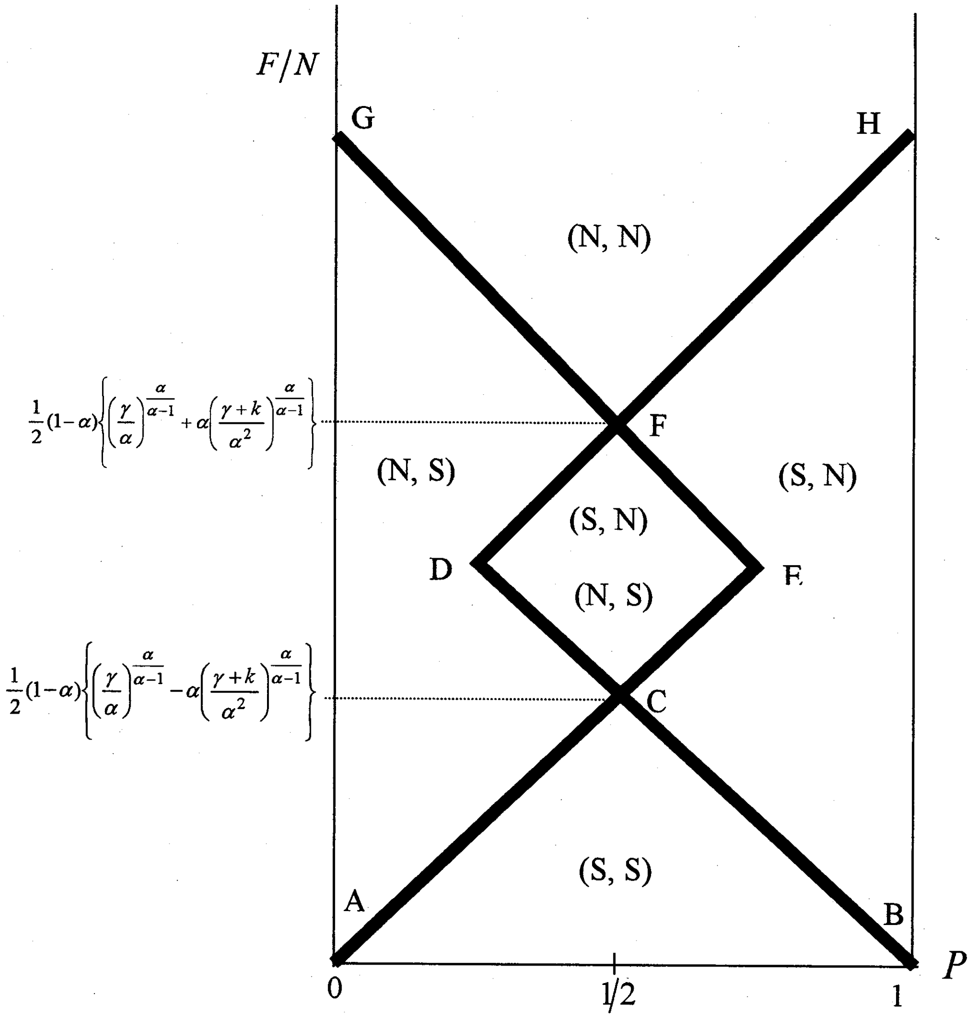
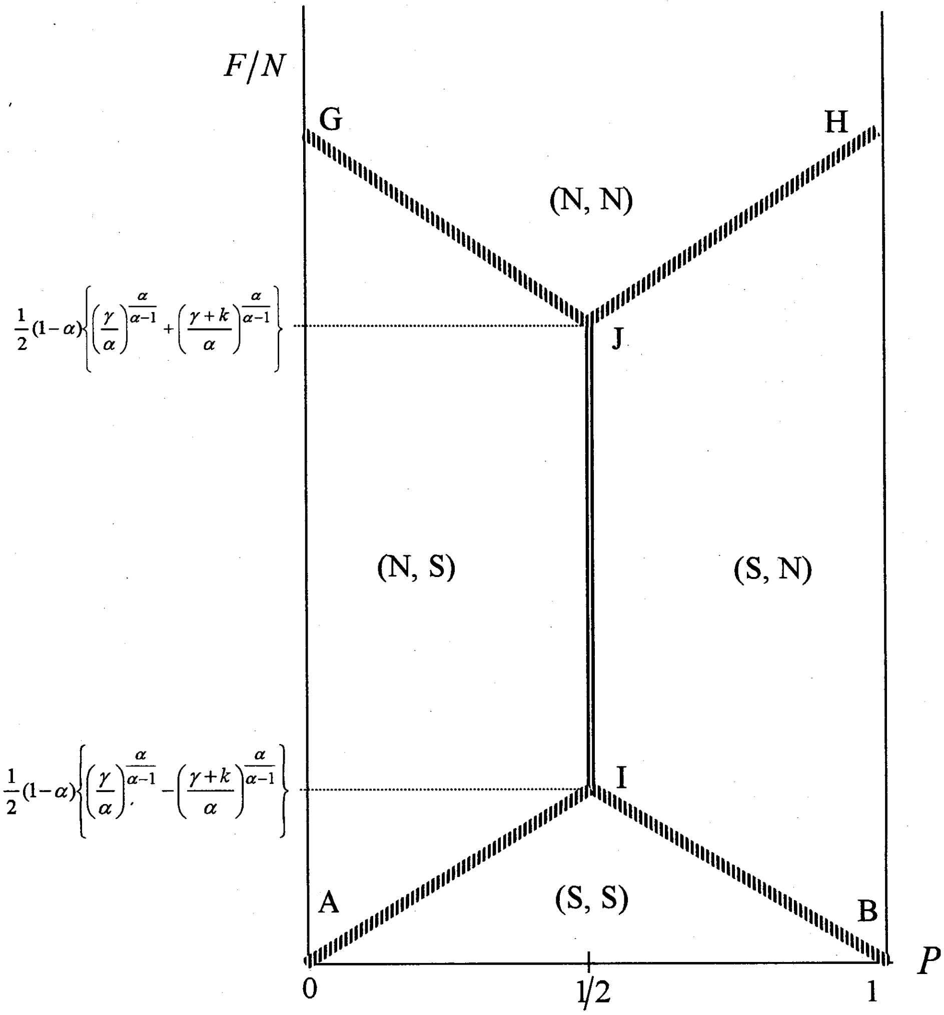
Table-1 Entrance fees for local public universities in Japan

	For student from home region	For student from other regions
Fukushima medical university	¥275,000	¥830,000
Nara Medical University	¥275,000	¥795,000
Wakayama Medical College	¥275,000	¥745,000
Ibaraki Prefectural University of Health Sciences	¥275,000	¥640,000
The University of Aizu	¥275,000	¥550,000
Aomori Public College	¥152,800	¥305,600
Prefectural University of Kumamoto	¥202,000	¥404,000
Siebold University of Nagasaki	¥172,500	¥345,000
Kochi Women's University	¥137,500	¥275,000
Saitama Prefectural University	¥206,200	¥412,500
University of Shizuoka	¥137,500	¥275,000
Shimonoseki City University	¥137,500	¥275,000
Takasaki City University of Economics	¥137,500	¥275,000
Tsuru University	¥137,500	¥275,000
Tokyo Metropolitan University	¥137,500	¥270,000



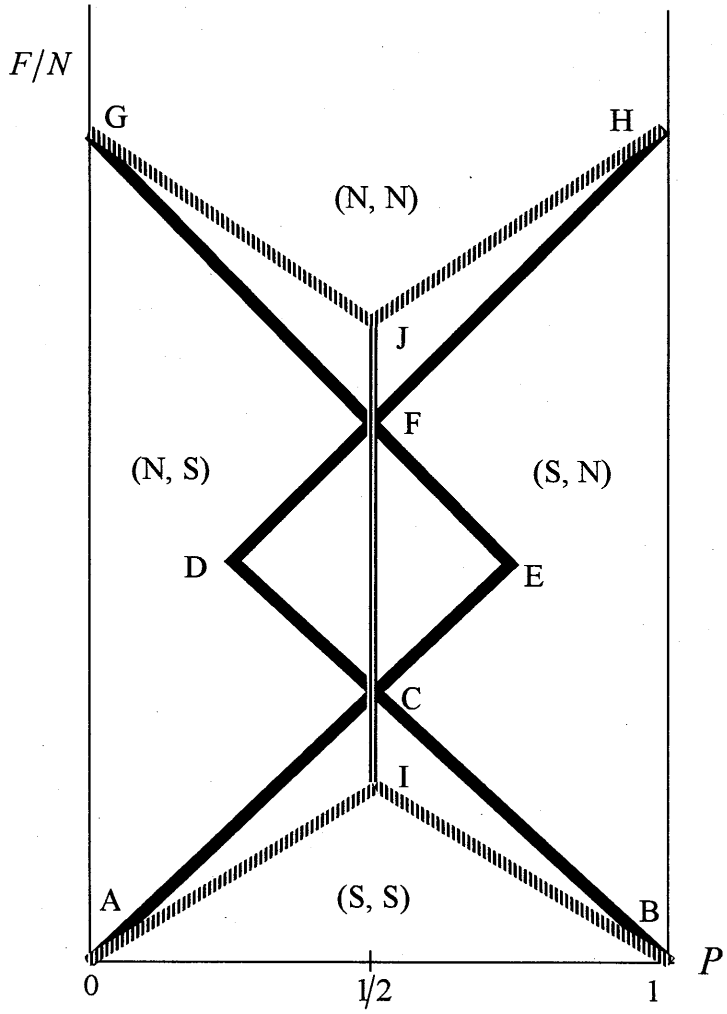
Pattern (S, S) emerges when parameters fall within the area ACB.
Pattern (S, N) emerges when parameters fall within the area BDH.
Pattern (N, S) emerges when parameters fall within the area AGE.
Pattern (N, N) emerges when parameters fall within the area above the line GFH.

Fig. 1 Parameters and patterns of decentralized provision



Pattern (S, S) emerges when parameters fall within the area AIB.
Pattern (S, N) emerges when parameters fall within the area BIJH.
Pattern (N, S) emerges when parameters fall within the area AIJG.
Pattern (S, N) emerges when parameters fall within the area above the line GJH.

Fig.2 Parameters and patterns of socially optimal provision



Boundary dividing parameter ranges of different patterns in equilibrium

Boundary dividing parameter ranges of different patterns for optimum

Fig. 3 Comparison between decentralized equilibrium and social optimum