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Abstract

This paper analyzes the effect of industrial location on the provision of local public goods in two regions. Initially two regions are asymmetric because industrial firm agglomerates in one region and the other region do not provide a local public good. When industrial firms disperse across regions, the local government that does not provide it gets the larger revenue. In this case, this paper analyzes whether the local government provides it or not.

The results depend on the population through the land rent. When the population is large, the local government in the periphery does not always provide the local public good. On the other, when the population is smaller, the local government always provides it. Only when the population belongs to some range, through industrial dispersion, does the local government change the behavior toward the local public good. In this case, the industrial distribution affects the local government policy.

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1 Introduction

The local public good in one region is consumed by residences not only in the region but also in the other region if it is not provided in the other. Following Braid (2010), events on national holidays, sports facilities, libraries, zoos and museums are that good. If residents in the other want to consume it, they should travel to the region.

The local government does not supply some local public goods when the cost for providing these goods is greater compared to the revenue of the local government. For supplying those goods, it is necessary to decrease the cost or increase the revenue. If the residents and firms increases, the tax revenue increases. Consider the industrial distribution. There are two regions (city and periphery). Initially, the industrial firms concentrate in the city. The local government in the city gets the larger tax revenue because of that agglomeration. However, if some industrial firms relocate in the periphery, the government's revenue decreases and the revenue in the periphery increases. It is possible that some firms relocate without the public sector intervention. For example, if trade costs decrease through technological development, the relocation is attractive to some firms. In this case, the local government in the periphery may supply the local public goods.

This paper analyzes the effect of industrial location on the provision of local public goods in two regions. Initially two regions are asymmetric because industrial firms agglomerates in one region and the other region does not provide the local public good. When industrial firms disperse across regions, the local government that does not provide it gets the larger revenue. In this case, this paper analyzes whether the local government provides it or not. If the local government starts to provide it, the industrial distribution affects the behavior of the local government. On the other hand, if the local government does not, the industrial distribution does not affect that behavior. Then, the central government should intervene with local government behavior if it is desirable that the local government provides it.

This paper is organized as follows. Section 2 examines the model. Section 3 analyzes the optimal and equilibrium local government behavior. Section 4 shows the effect of industrial location on the local public good. Section 5 concludes this paper.

2 The model

There are two regions (region 1 and region 2) in one economy. In this economy, individuals consume four goods - manufacture good, agriculture good, residence and local public good.

The manufacture good is produced with the intermediate good as the input. The producer provides this good in the national market. In each region, the intermediate good can be produced, and is traded at the transport cost between regions. The production of the intermediate good is subject to monopolistic competition and requires the labor force in the region in which the producer locates. Initially, all manufacture producers locate in region 1. That is, the manufacture sector agglomerates in region 1. The manufacture producer can relocate to region 2. When a part of the manufacture producer relocates, in equilibrium, the manufacture sector disperses in each region.

The agriculture good is produced with the land as the input. The good is numeraire and can be traded across regions without cost. It is possible that the agriculture good is not produced in each region since the land can be used as residence. In this case, two regions do not supply the agriculture good and purchase the good that is produced in the other economy. The landowner provides the land that is not traded between regions.

Initially, it is assumed that the local public good is provided only in region 1. In this region, the local public good is always provided. Individuals in each region utilize the good as the pure public good. Only the landowner in region 2 should bear the commuting cost if they consume the good.

In the economy, two types of individuals exist. One is the worker who supplies one unit of labor and the other is the landowner. Workers can migrate across regions without cost. In this economy, there are L workers. A landowner supplies one unit of land. Landowners cannot migrate across regions and should bear the commuting cost if they commute to the other region for consuming the local public good. In each region, there are H landowners.

In each region, the local government exists. The local government supplies the local public good financed by the tax. This tax is imposed on houseowners. Following Roos (2004), the object of the local government is maximizing the immobile landowners utility in its own region.

2.1 Model specification

Individuals in region i have the following utility function U_i :

$$U_i = \left[\alpha^{-\alpha}\beta^{-\beta}\gamma^{-\gamma}\right] {x_i}^{\alpha} {z_i}^{\beta} {h_i}^{\gamma} G_i \tag{1}$$

where $\alpha + \beta + \gamma = 1$. x_i is the manufacture good, z_i is the agriculture good, h_i is the land for residence and G_i is the local public good.

The budget constraint of individuals in region i is

$$Y_i = p_x x_i + p_z z_i + r_i h_i \tag{2}$$

where p_x , p_z are prices of each good and r_i is the land rent. Y_i is the income of individuals. For the worker, Y_i equals w_i, that is the wage. For the landowner, Y_i equals $(1 - t_i)r_i$ where t_i is the tax rate.

Initially, the manufacture sector is produced only in region 1. The production function of the manufacture good is as follows:

$$X_i = \left\{ \int_0^{N_1} q_j^{\rho} dj \right\}^{\frac{1}{\rho}} \tag{3}$$

where q_j is the intermediate good and N_i is the variety of the intermediate good. The manufacture good is freely tradable across the national market and is provided under perfect competition. Then, the producer behaves

$$p_{qk} = p_x \left[\int_0^{N_1} q_j^{\rho} dj \right]^{\frac{1}{\rho}-1} q_k^{\rho-1} \tag{4}$$

where p_{qk} is the price of the intermediate good k . From this equation and the production function, the aggregate demand of the intermediate good k, q_k^d is

$$q_k^d = \frac{p_k^{\frac{1}{\rho-1}}}{\left[\int_0^{N_1} p_n^{\frac{\rho}{\rho-1}} dn \right]^{\frac{1}{\rho}}} X_i = \frac{p_k^{\frac{1}{\rho-1}}}{B_i^{\frac{1}{\rho-1}}} X_i \tag{5}$$

where $B = \left[\int_0^{N_1} p_n^{\frac{\rho}{\rho-1}} dn \right]^{\frac{\rho-1}{\rho}}$ is a price index.

The intermediate good is produced with the labor as the input. The amount of labor to produce q_k units of the intermediate good k is

$$L_{qk} = f + bq_k \qquad k \in [0, N_1] \tag{6}$$

where f is the fixed labor input and b is the marginal labor input. Each producer faces the demand (5) and takes the price index and the total amount of the manufacture good as given. Since the intermediate good is subject to monopolistic competition, the first order condition for profit maximization is

$$p_k = \frac{w_i b}{\rho} \tag{7}$$

Since producers can enter the intermediate sector freely, the profit is zero in equilibrium.

$$p_k q_k = w_i(f + bq_k) \tag{8}$$

Then, in the equilibrium, the output of intermediate good and labor input are obtained as

$$q_k = \frac{\rho f}{b(1-\rho)} \qquad L_{qk} = \frac{f}{1-\rho}$$

Next, consider the case that the manufacture sector disperses in each region. Then, the production function of the manufacture good is

$$X_i = \left\{ \int_0^{N_i} q_{ij}^{\rho} dj + \int_0^{N_{-i}} q_{-ij}^{\rho} dj \right\}^{\frac{1}{\rho}} \tag{9}$$

where i is the index of its own region and $-i$ is the index of another region.

Since the manufacture sector exists in each region, the producer utilizes intermediate goods that are supplied in each region. The intermediate good can be traded across regions with the transport cost. This cost is the iceberg transport cost, that is, τ ($\tau > 1$) units of good is required to provide one unit of good in another region. Similar to the agglomerated case, the producer behaves

$$p_{ik} = p_x \left[\int_0^{N_i} q_{ij}^{\rho} dj + \int_0^{N_{-i}} q_{-ij}^{\rho} dj \right]^{\frac{1}{\rho}-1} q_{ik}^{\rho-1} \tag{10}$$

$$p_{-ik}\tau = p_x \left[\int_0^{N_i} q_{ij}^{\rho} dj + \int_0^{N_{-i}} q_{-ij}^{\rho} dj \right]^{\frac{1}{\rho}-1} q_{-ik}^{\rho-1} \tag{11}$$

The intermediate good is the same as the agglomerated case. Then, the first-order condition for profit maximization and equilibrium output and labor input are the same.

The production function of agriculture good z^s is

$$z^s = h_z \tag{12}$$

where h_z is the land input. This good is provided in the national market where the price is numeraire. The land can be used as residence and cannot be traded across regions. When all land supply is utilized as residence in one region, the region does not produce the agriculture good. There are H landowners in one region, that is, the land supply in the region is H .

The local public good is produced by the local government. The production function is

$$G_i = \left[\alpha^{-\alpha}\beta^{-\beta}\gamma^{-\gamma}\right] x_g^{\alpha} z_g^{\beta} h_g^{\gamma} \tag{13}$$

This function is the same as the utility. Following Riou (2006), this means that the behavior of the local government does not affect the market price. The local government has the budget constraint:

$$t_i r_i H = p_x x_G + p_z z_G + r_i h_G \tag{14}$$

2.2 Equilibrium

First, consider the case in which the manufacture sector is located only in region 1. From the model specification, the market clearing conditions for intermediate goods, labor and land are as follows:

$$\begin{aligned}
\frac{\rho f}{(1-\rho)b} &= q_k^d \qquad k \in [0,1] \\
L_1 &= N_1 L_{qk} \\
H - h_{G_1} &= \gamma \frac{w_1 L_1 + (1-t_1) r_1 H}{r_1} \\
H - h_{G_2} - h_z &= \gamma \frac{(1-t_2) r_2 H}{r_2}
\end{aligned}$$

From the market of intermediate good and labor, the equilibrium variety of intermediate good is

$$N_1 = \frac{L(1-\rho)}{f}$$

Then, the amount of manufacture product and the wage are

$$X_1 = \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}} \frac{\rho}{b} L^{\frac{1}{\rho}} \tag{15}$$

$$w_i = p_x \frac{\rho}{b} \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}} L^{\frac{1-\rho}{\rho}} \tag{16}$$

In this model, p_x is exogenously defined. Rearranging the market clearing condition for land, the land rent is as follows:

$$r_1 = \frac{\gamma w_1 L_1}{(1-\gamma)H} \tag{17}$$

In region 2, the land rent is 1 because the land is utilized for providing the agriculture good.

Second, the case that the manufacture sector disperses in each region is analyzed. Similar to the agglomerated case, the market clearing conditions are as follows:

$$
\begin{aligned}
\frac{\rho f}{(1-\rho)b} &= q_{ik} + q_{-ik}\tau \qquad k \in [0,1] \\
L_i &= \frac{L}{2} = N_i L_{qk} \\
H - h_{G_1} &= \gamma \frac{w_1 L_1 + (1-t_1) r_1 H}{r_1} \\
H - h_{G_2} &= \gamma \frac{w_2 L_2 + (1-t_2) r_2 H}{r_2}
\end{aligned}
$$

In the equilibrium, the intermediate good and labor market are symmetric.

Corresponding to the agglomerated case, varieties of intermediate good in each region are

$$N_1 = N_2 = \frac{L(1-\rho)}{2f}$$

The amount of manufacture product and the wage are

$$X_i = \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}} \frac{\rho}{b}\left[\frac{L}{2}\right]^{\frac{1}{\rho}}\left(1+\tau^{\frac{\rho}{\rho-1}}\right)^{\frac{1-\rho}{\rho}} \tag{18}$$

$$w_i = p_x \frac{\rho}{b}\left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}}\left[\frac{L}{2}\right]^{\frac{1-\rho}{\rho}}\left(1+\tau^{\frac{\rho}{\rho-1}}\right)^{\frac{1-\rho}{\rho}} \tag{19}$$

The aggregate product of manufacture good is

$$X = X_1 + X_2 = \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}} \frac{\rho}{b} L^{\frac{1}{\rho}} \left(\frac{1+\tau^{\frac{\rho}{\rho-1}}}{2}\right)^{\frac{1-\rho}{\rho}} \tag{20}$$

Compared to the agglomerated case, this product is smaller. For the manufacture product, the agglomeration is better than the dispersed case.

The land rent is obtained as

$$r_1 = \frac{\gamma w_1 L_1}{(1-\gamma)H} \qquad r_2 = \frac{\gamma w_2 L_2}{(1-\gamma)H}$$

The worker behaves as if the local public good in each region is given. Then, the utility of the worker is

$$U_i = p_x^{-\alpha} \left[\frac{\gamma}{(1-\gamma)H}\right]^{-\gamma} G_i \left[p_x \frac{\rho}{b} \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}} \left\{1 + \left(\frac{1}{\tau}\right)^{\frac{\rho}{1-\rho}}\right\}^{\frac{1-\rho}{\rho}}\right]^{1-\gamma} L_i^{\frac{(1-\rho)(1-\gamma)}{\rho}-\gamma}$$

The equilibrium is stable when $1-\gamma-\rho$ that satisfies $\frac{dU_i}{dL_i} < 0$. In the following, it is assumed that the condition holds.

Considering the model of public sector, the utilities of the worker in each case are

$$\begin{aligned} U_{1ag} &= p_x^{-2\alpha} H^{2\gamma} \left[\frac{1-\gamma}{\gamma}\right]^{2\gamma-1} \left[p_x \frac{\rho}{b} \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}}\right]^{2(1-\gamma)} L^{\frac{2(1-\gamma)}{\rho}-1} t_1 & (21) \\ U_{1d} &= p_x^{-2\alpha} H^{2\gamma} \left[\frac{1-\gamma}{\gamma}\right]^{2\gamma-1} \left[p_x \frac{\rho}{b} \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}}\right]^{2(1-\gamma)} \\ &\times \left\{\frac{L}{2}\right\}^{\frac{2(1-\gamma)}{\rho}-1} \left\{1 + \left(\frac{1}{\tau}\right)^{\frac{\rho}{1-\rho}}\right\}^{\frac{2(1-\rho)(1-\gamma)}{\rho}} t_1 & (22) \end{aligned}$$

2.3 Local government behavior

The local government exists in each region. It provides the local public good to maximize the landowners utility in its own region. The local public good is financed by the tax imposed on landowner's income.

In region 1, the local government always provides the local public good. From the previous sections model, the landowners utility is as follows

$$
\begin{aligned}
U_1 &= p_x^{-2\alpha}\left\{\frac{\gamma w_1 L_1}{1-\gamma}\right\}^{2(1-\gamma)} H^{2\gamma}(1-t_1)t_1 \\
&= p_x^{-2\alpha} r_1^{-2\gamma}(r_1 H)^2(1-t_1)t_1
\end{aligned}
\tag{23}
$$

The local government maximizes the utility where it takes the prices and the population of the worker as given. Then, the tax rate is $t^* = \frac{1}{2}$.

In region 2, the local government can decide whether to provide the local public good or not. When the local government provides the local public good, it maximizes the utility

$$
U_2 = p_x^{-2\alpha} r_2^{-2\gamma}(r_2 H)^2(1-t_2)t_2 \tag{24}
$$

and $t^* = \frac{1}{2}$.

Second, consider the case that the local government does not provide the local public good. In this case, the local government does not impose the tax. For consuming the local public good, the landowner in region 2 should commute to region 1 with the commuting cost. The commuting cost is T_r . When the manufacture good is not produced in region 2, the landowner's utility is

$$
U_{2n} = p_x^{-2\alpha}[H - T_r]\frac{H}{2} r_1^{1-\gamma} \tag{25}
$$

where $r_2 = 1$, because the land demand of workers is zero. When the manufacture sector located in region 2, the landowners utility is

$$U_{2nm} = p_x^{-\alpha} r_2^{-\gamma} [r_2 H - T_r] \left[\frac{p_x^{-\alpha} H r_1^{1-\gamma}}{2} \right] \tag{26}$$

3 Equilibrium and optimal behavior of local governments

3.1 Case agglomerated manufacture product

This section analyzes the equilibrium and optimal behavior of local governments. First, we investigate the case in which the manufacture sector agglomerates in region 1. From the previous section, the local government in region 1 sets the tax rate as $t = \frac{1}{2}$.

In region 2, the local government decides whether it supplies the local public good or not. From the model, the relative landowners utility in each case is obtained as

$$\frac{U_2}{U_{2n}} = \frac{H}{2(H - T_r) r_1^{1-\gamma}} \qquad \left(r_1 = \frac{\gamma}{(1-\gamma)H} p_x \frac{\rho}{b} \left\{ \frac{1-\rho}{f} \right\}^{\frac{1-\rho}{\rho}} L^{\frac{1}{\rho}} \right) \tag{27}$$

When (27) is larger than unity, the local government supplies the local public good and sets the tax rate as $t = \frac{1}{2}$. Conversely, when (27) is smaller than unity, it does not.

Now, analyzing the optimal behavior that maximizes the welfare which comes from the sum of landowners utility.

$$W = HU_1 + HU_2 \tag{28}$$

$$= p_x^{-\alpha} r_1^{-\gamma} (1 - t_1) r_1 H G_1 + p_x^{-\alpha} r_2^{-\gamma} [(1 - t_2) r_2 H - T_r] G_1 \tag{29}$$

First, considering the case in which the local public good in region 2 is not produced, the constraints are given by

$$t_1 r_1 H + t_2 r_2 H = p_x^{\alpha} r_1^{\gamma} G_1 \tag{30}$$

$$r_1^{-\gamma}(1-t_1) r_1 H = r_2^{-\gamma}[(1-t_2) r_2 H - T_r] \tag{31}$$

The first constraint is the budget constraint where the tax is imposed on each landowner. The second constraint is that the utility among landowners that consume the same local public good is equalized. From the maximization problem, it follows that

$$t_1 = \frac{2r_1^{1-\gamma} + r_1 - 1 + \frac{T_r}{H}}{2r_1(1+r_1^{-\gamma})} \qquad t_2 = \frac{-r_1^{1-\gamma} + r_1^{-\gamma} + 2 - \frac{T_r}{H}(2 + r_1^{-\gamma})}{2r_1(1+r_1^{-\gamma})} \tag{32}$$

$$G_1 = \frac{(1+r_1)H - T_r}{2} p_x^{-\alpha} r_1^{-\gamma} \tag{33}$$

In the equilibrium, $G_1 = \frac{r_1 H}{2} p_x^{-\alpha} r_1^{-\gamma}$. This means that the output level of local public good in equilibrium is smaller than the optimal case. When only the local government in region 1 provides the local public good, it is underproduced in the economy. The welfare is given by

$$W_{NA} = p_x^{-2\alpha} \frac{H^2}{2} \frac{r_1^{-2\gamma}}{1+r_1^{-\gamma}} \left[1 + r_1 - \frac{T_r}{H}\right]^2 \tag{34}$$

When each local government supplies the local public good, the constraint is as follows:

$$t_1 r_1 H = p_x^{\alpha} r_1^{\gamma} G_1 \qquad t_2 r_2 H = p_x^{\alpha} r_2^{\gamma} G_1 \tag{35}$$

Similar to the first case, it follows that

$$t_1 = t_2 = \frac{1}{2} \tag{36}$$

From the above analysis, the equilibrium outcome is desirable. In the optimal case, the welfare is as follows:

$$W_A = p_x^{-2\alpha}\left(\frac{H}{2}\right)^2\left[r_1^{2(1-\gamma)}+1\right] \tag{37}$$

The optimal behavior of local governments is derived from the relative welfare. It is obtained as

$$\frac{W_A}{W_{NA}} = \frac{(r_1^2 + r_1^{2\gamma})(r_1^{-\gamma}+1)}{2\left[r_1 + 1 + \frac{T_r}{H}\right]^2} \tag{38}$$

When (38) is larger than unity, the optimal behavior is that each local government supplies the local public good. Conversely, when (38) is smaller than unity, it is optimal that the local government in region 2 does not provide the local public good.

From (27) and (38) , the following lemma is obtained

Lemma 1 When the manufacture sector agglomerates in region 1, the following conditions hold:

(i) Suppose that $r_1 > \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$.

In equilibrium, the local government in region 2 does not provide the local public good and that behavior is optimal.

(ii) Suppose that $r_1 < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$ and $\frac{(r_1^2+r_1^{2\gamma})(r_1^{-\gamma}+1)}{2[r_1+1-T_r/H]} < 1$.

In equilibrium, the local government in region 2 provides the local public good though it is optimal if it does not provide the local public good.

(iii) Suppose that $r_1 < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$ and $\frac{(r_1^2+r_1^{2\gamma})(r_1^{-\gamma}+1)}{2[r_1+1-T_r/H]} > 1$.

In equilibrium, the local government in region 2 provides the local public good and that is optimal.

Lemma 1 shows that the local government in region 2 does not underprovide the local public good. That is, it is not happen that the local government does not provide the local public good though providing the local public good is optimal.

3.2 Case dispersed manufacture product

When the manufacture sector disperses among two regions, similar to the previous section, the local government in region 1 sets the tax rate as $t = 1/2$.

In region 2, the local government does not provide the local public good when the landowners utility is larger than the case that it provides. The relative utility is as follows:

$$
\begin{aligned}
\frac{U_2}{U_{2nm}} &= \frac{r_2 H}{2(r_2 H - T_r)} \qquad (39)\\
r_2 &= \frac{\gamma}{(1-\gamma)H} p_x \frac{\rho}{b}\left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}}\left\{\frac{L}{2}\right\}^{\frac{1}{\rho}}\left[1+\tau^{\frac{\rho}{\rho-1}}\right]^{\frac{1-\rho}{\rho}}\\
&= 2^{-\frac{1}{\rho}}\left[1+\tau^{\frac{\rho}{\rho-1}}\right]^{\frac{1-\rho}{\rho}} r_1
\end{aligned}
$$

When (39) is larger than 1 , the local government supplies the local public good and sets the tax rate as $\frac{1}{2}$. Conversely, when (39) is smaller than 1, it does not.

Now, consider the optimal policy. When each local government provides the local public good, the welfare in the optimal case is as follows

$$W_d = p_x^{-2\alpha} \frac{H^2}{2} r_d^{2(1-\gamma)} \tag{40}$$

Conversely, when the local government in region 2 does not provide the local public good, the optimal welfare is

$$W_{nd} = p_x^{-2\alpha} r_d^{-2\gamma} \frac{[2r_d H - T_r]^2}{4} \tag{41}$$

The relative welfare in each case is

$$\frac{W_d}{W_{nd}} = 2 \left[\frac{r_d H}{2r_d H - T_r} \right]^2 \tag{42}$$

When (42) is larger than 1, it is optimal that each local government provides the local public good. In the opposite case, the local government in region 2 should not provide the local public good.

From (39) and (42), the following lemma is obtained.

Lemma 2 When the manufacture sector disperses in each region, the following condition holds.

(i) Suppose that $r_2 > 2\frac{T_r}{H}$ and $r_2 > \frac{1}{2-\sqrt{2}} \frac{T_r}{H}$.

In equilibrium, the local government in region 2 does not provide the local public good and that behavior is optimal.

(ii) Suppose that $2\frac{T_r}{H} > r_2 > \frac{1}{2-\sqrt{2}} \frac{T_r}{H}$.

In equilibrium, the local government in region 2 provides the local public good, though it is optimal if it does not provide the local public good.

(iii) Suppose that $r_2 < \frac{1}{2-\sqrt{2}} \frac{T_r}{H}$.

In equilibrium, the local government in region 2 provides the local public good and that is optimal.

Lemma 2 shows that when the land rent is determined in the range $\left(\frac{1}{2-\sqrt{2}} \frac{T_r}{H}, 2\frac{T_r}{H} \right)$, the equilibrium and optimal policy are different. The local government overprovides the local public good. When the local government in region 2 does not provide the public good, its policy is always optimal. However, in this case, the local government in region 1 underprovides the local public good. That is, because of the region 1's local government policy, the equilibrium policy is not optimal.

4 Effect of location pattern

The previous section examines the local government's equilibrium and optimal policy where the location pattern of the manufacture sector is taken as given. This section analyzes the policy when the location pattern changes.

Initially, the manufacture sector and the worker agglomerate in region 1. The worker migrates to region 2 when the utility increases. As a result, the manufacture sector disperses. This dispersed case is realized in equilibrium when the worker's utility in the dispersed case is larger than the agglomerate case. When the manufacture sector agglomerates in region 1, the workers utility is rewritten as

$$U_{1a} = p_x^{-2\alpha} H^{2\gamma} \left[\frac{1-\gamma}{\gamma}\right]^{2\gamma-1} \left[p_x \frac{\rho}{b} \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}}\right]^{2(1-\gamma)} \frac{L^{\frac{2(1-\gamma)}{\rho}-1}}{2} \tag{43}$$

From the symmetry in equilibrium, if the manufacture sector distributes across regions, the worker's utility is

$$U_{1d} = \frac{p_x^{-2\alpha} H^{2\gamma}}{2} \left[\frac{1-\gamma}{\gamma}\right]^{2\gamma-1} \left[p_x \frac{\rho}{b} \left\{\frac{1-\rho}{f}\right\}^{\frac{1-\rho}{\rho}}\right]^{2(1-\gamma)} \left\{\frac{L}{2}\right\}^{\frac{2(1-\gamma)}{\rho}-1} \left\{1 + \left(\frac{1}{\tau}\right)^{\frac{\rho}{1-\rho}}\right\}^{\frac{2(1-\gamma)(1-\rho)}{\rho}} \tag{44}$$

The relative utility in each case is

$$\frac{U_{1a}}{U_{1d}} = \frac{2^{\frac{2(1-\gamma)}{\rho}-1}}{\left[1 + \left(\frac{1}{\tau}\right)^{\frac{\rho}{1-\rho}}\right]^{\frac{2(1-\gamma)(1-\rho)}{\rho}}} \tag{45}$$

When (45) is larger than 1, the manufacture sector agglomerates in region 1. Conversely, if (45) is smaller than 1, the manufacture sector disperses in each region. When (45) is equal to 1, the location pattern is indifferent. (45) is the increasing function of τ . This means that if the transport cost for intermediate goods decreases, the location pattern changes to the divergence case.

Now, the government policy when the location pattern changes is analyzed. For analyzing the policy, (27) and (39) are utilized. If $T_r < \frac{H}{2}$, (27) < 1 and (39) < 1 . This means that the local government in region 2 does not always supply the local public good. Conversely, if $T_r > \frac{H}{2}$, the land rent determines the local government policy. In the following, it is assumed that $T_r > \frac{H}{2}$. That is, the commuting cost that the landowner should bear for consuming the local public good is larger.

If $r_{1a} < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$ and $r_{1a} < \frac{2^{\frac{1}{\rho}}}{\left[1+\tau^{\frac{\rho-1}{\rho}}\right]^{\frac{1-\rho}{\rho}}}\frac{2T_r}{H}$, (27) > 1 and (39) > 1 . Then local government always supplies the local public good. If $r_{1a} > \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$ and $r_{1a} > \frac{2^{\frac{1}{\rho}}}{\left[1+\tau^{\frac{\rho-1}{\rho}}\right]^{\frac{1-\rho}{\rho}}}\frac{2T_r}{H}$, (27) < 1 , (27) < 1 and (39) < 1 . The local government does not always supply the local public good. In these cases, the local government does not change the policy when the location pattern changes.

In the following case, the local government changes the policy when the location pattern changes. If $r_{1a} > \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$ and $r_{1a} < \frac{2^{\frac{1}{\rho}}}{\left[1+\tau^{\frac{\rho-1}{\rho}}\right]^{\frac{1-\rho}{\rho}}}\frac{2T_r}{H}$, (27) < 1 and (39) > 1 . When the manufacture sector agglomerates, the region 2's local government does not supply the local public good. However, if the manufacture sector disperses across regions, the local government supplies the good. The local government begins to provide. Conversely, when $\frac{2^{\frac{1}{\rho}}}{\left[1+\tau^{\frac{\rho-1}{\rho}}\right]^{\frac{1-\rho}{\rho}}}\frac{2T_r}{H} < r_{1a} < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$, (27) > 1 and (39) < 1 . For example, if T_r is sufficiently large, this case arises. Those equations mean that the local government in region 2 stops providing the local public good when the location pattern changes.

To summarize these results, the following proposition is obtained:

Proposition 1 (i) If the land rent in region 1 is sufficiently large, the local governmet does not always provide the local public good.

(ii) Suppose that $\left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}} < r_{1a} < \frac{2^{\frac{1}{\rho}}}{\left[1+\tau^{\frac{\rho-1}{\rho}}\right]^{\frac{1-\rho}{\rho}}}\frac{2T_r}{H}$.

If the industry disperses, the region 2's local government changes the policy of the local public good. the local government begins to provide it.

(iii) Suppose that $\frac{2^{\frac{1}{\rho}}}{\left[1+\tau^{\frac{\rho-1}{\rho}}\right]^{\frac{1-\rho}{\rho}}}\frac{2T_r}{H} < r_{1a} < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$.

If the industry disperses, the region 2's local government changes the policy of the local public good. The local government stops providing it.

(iv) If the land rent in region 1 is sufficiently small, the local government always provides the local public good.

Figure 1 depicts the case of (ii) and (iii) where $A = \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$ and $B = \frac{2^{\frac{1}{\rho}}}{\left[1+\tau^{\frac{\rho-1}{\rho}}\right]^{\frac{1-\rho}{\rho}}}\frac{2T_r}{H}$. The dotted line represents the landowner's utility in the case of the agglomerated manufacture sector, (27) . The solid line represents the dispersed case, (39) . If the relative utility is larger than 1, the local government provides the local public good. When $A < B$ and the land rent is determined in (A, B) , the local government begins to provide the local public good when the manufacture sector disperses across a region. On the other, when $B < A$ and the land rent is determined in (B, A) , the local government stops providing it when the manufacture sector disperses across a region.

(45) is the increasing function of τ . This means that if the transport cost for intermediate goods decreases, it is possible that the manufacture sector disperses. When $(45) = 1$,

$$\tau = \left\{2^{\frac{2(1-\gamma)-\rho}{2(1-\gamma)(1-\rho)}} - 1\right\}^{\frac{\rho-1}{\rho}} = \tau^* \tag{46}$$

If the transport cost is τ^* , the location pattern is indifferent. Moreover, region 2's local government policy is as follows. If $\left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}} < r_{1a} < 2^{\frac{1}{2(1-\gamma)}}\frac{2T_r}{H}$, region 2's local government begins to provide the local public good in the case that the manufacture sector disperses. If $2^{\frac{1}{2(1-\gamma)}}\frac{2T_r}{H} < r_{1a} < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$, region 2's local government stops providing the local public good. For example, if T_r is sufficiently large, this case arises. When r_{1a} is sufficiently large, it does not always provide. Conversely, when r_{1a} is sufficiently small, it always provides.

When $\tau > \tau^*$, (45) > 1 . That is, the manufacture sector agglomerates in the city. Then, the local government policy depends on (27) . If $\left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}} < r_{1a}$, the local government does not provide the local public good. On the other hand, when $\tau < \tau^*$, (45) < 1 . That is, the manufacture sector disperses. Then the local government policy in region 2 depends on (39) . From (39) , when $\frac{\left[1+\tau^{\frac{\rho}{\rho-1}}\right]^{\frac{1-\rho}{\rho}}}{2^{\frac{1}{\rho}}} r_{1a} < \frac{2T_r}{H}$, the local government provides the local public good.

As a result, proposition 2 is obtained:

Proposition 2 (i) Consider the case $\tau > \tau^*$ that the manufacture sector agglomerates in region 1. The local government in region 2 provides the local public good when $r_{1a} < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$. Conversely, when $r_{1a} > \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$, it does not.

(ii) Suppose that $\tau = \tau^*$, the location pattern is indifferent.

- If $\left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}} < r_{1a} < 2^{\frac{1}{2(1-\gamma)}}\frac{2T_r}{H}$ and the location pattern changes to the dispersion case, the local government in region 2 begins to provide the local public good.

- If $2^{\frac{1}{2(1-\gamma)}}\frac{2T_r}{H} < r_{1a} < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$ and the location pattern changes, it stops providing.

- When the land rent is sufficiently large, it does not provide it. When the land rent is sufficiently small, it provides it.

(iii) Consider the case $\tau < \tau^*$ that the manufacture sector disperses across regions. The local government in region 2 provides the local public good when $\frac{\left[1+\tau^{\frac{\rho}{\rho-1}}\right]^{\frac{1-\rho}{\rho}}}{2^{\frac{1}{\rho}}} r_{1a} < \frac{2T_r}{H}$.

Figure 2 depicts the case of (a) $\left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}} < r_{1a} < 2^{\frac{1}{2(1-\gamma)}}\frac{2T_r}{H}$ and (b) $2^{\frac{1}{2(1-\gamma)}}\frac{2T_r}{H} < r_{1a} < \left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}}$ on the space of the relative utility and τ . The dotted line represents the relative landowners utility in the case of the agglomerated manufacture sector, (27) . The solid line represents the dispersed case, (39) . When relative utility is larger than 1, the local government provides the local public good. In the case of (a), if the manufacture sector disperses because of decreasing transport cost, the local government begins to provide the public good. However, if $\frac{\left[1+\tau^{\frac{\rho}{\rho-1}}\right]^{\frac{1-\rho}{\rho}}}{2^{\frac{1}{\rho}}} r_{1a} > \frac{2T_r}{H}$ and the transport cost is sufficiently small, the local government stops providing it. Figure 2 (2) shows the case. On the other hand, Figure 2 (3) shows the case of (b). For example, when T_r is sufficiently large, this case arises. If the manufacture sector disperses because of the decreasing transport cost, the local government stops providing it.

Proposition 2 indicates that the local government in region 2 always provides the local public good if the land rent in region 1 is sufficiently small whether the manufacture sector agglomerates or not. Conversely, the local government does not provide it if the land rent is sufficiently large whether agglomeration is caused or not.

When the land rent in region 1 is determined in a certain range, the local government in region 2 changes the policy of local public good when the location pattern changes. For example, consider the case that T_r is smaller, then $\left\{\frac{H}{2(H-T_r)}\right\}^{\frac{1}{1-\gamma}} < 2^{\frac{1}{2(1-\gamma)}\frac{2T_r}{H}}$. If the manufacture sector disperses, the local government begins to provide the local public good. Conversely, if T_r is larger, the local government stops providing it in the case that the manufacture sector disperses.

The transport cost affects the location pattern of the manufacture sector. When that cost decreases, the manufacture sector disperses across regions. However, that cost does not always affect the local government behavior. Only if the land rent in region 1 is determined in a certain range, does it affect that behavior. On the other case, it does not.

Recently, the transport cost for intermediate goods decreases because the communication cost decreases (Anas and Xiong (2003), (2005)). Then, the behavior of the local government depends on the land rent. The land rent increases if the population increases through the demand of residence. Therefore, the population affects the behavior of local governments. Alesina and Spolaore (1997) analyze the effect of the population on the national governments. When the population is sufficiently large, the local government does not always provide the local public good. Then, the local government in region 1 only produces a local public good that is underprovided. In this case, it is not a problem that region 2's local government does not provide it. On the other, when the population is sufficiently small, the local government always provides it. For the local public good, this case is optimal.

If the population is determined in some range, industrial distribution affects the local government's behavior. In recent days, one region's residents consume some local public goods of another region. Then, if industry disperses among regions, the local government provides the local public good and that is optimal. But, if τ decreases sufficiently, the local government may not provide the local public good. Then, only in region 1 is it produced, and the amount of the good is smaller than optimal. For providing the optimal amount, the local government in region 1 should be encouraged to provide the optimal level.

5 Conclusion

This paper analyzes the effect of industrial location on the provision of local public goods in two regions. Initially, the manufacture sector agglomerates in one region. The other region does not supply the local public good and residents should travel to the other region if they want to consume it. When the tax revenue increases through industrial dispersion, would the government supply it?

The results depend on the population through the land rent. When the population is large, the local government in the periphery does not always provide the local public good. On the other, when the population is smaller, the local government always provides it. Only when the population belongs to some range, through industrial dispersion, does the local government change the behavior of a local public good. In this case, the industrial distribution affects the local government's policy.

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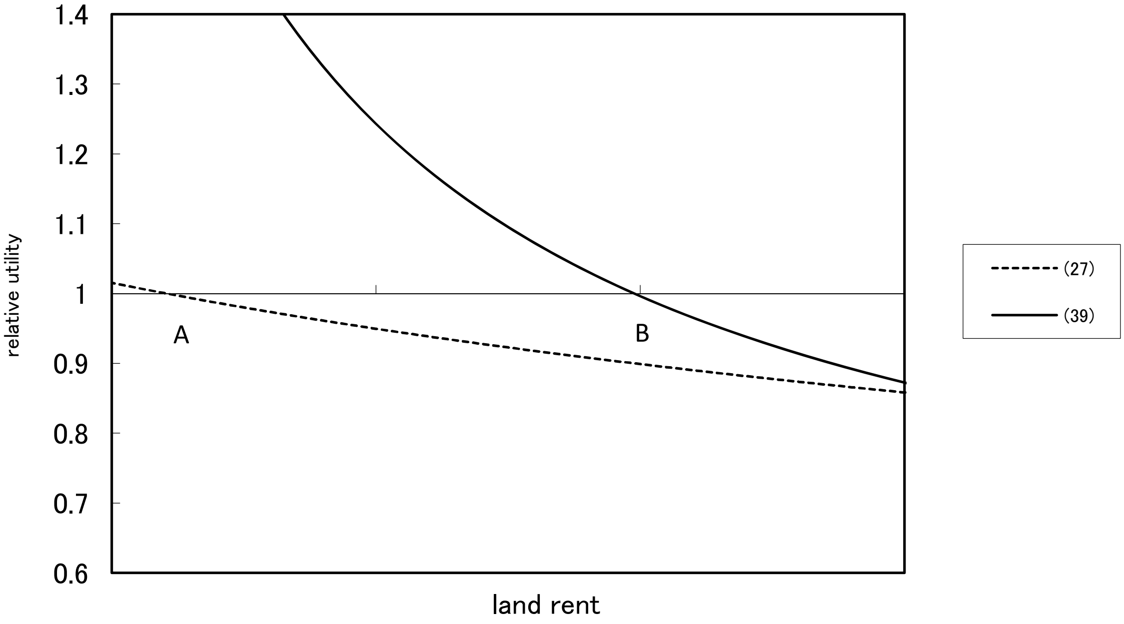
Figure 1

(1) the case of (ii)



(2) the case of (iii)

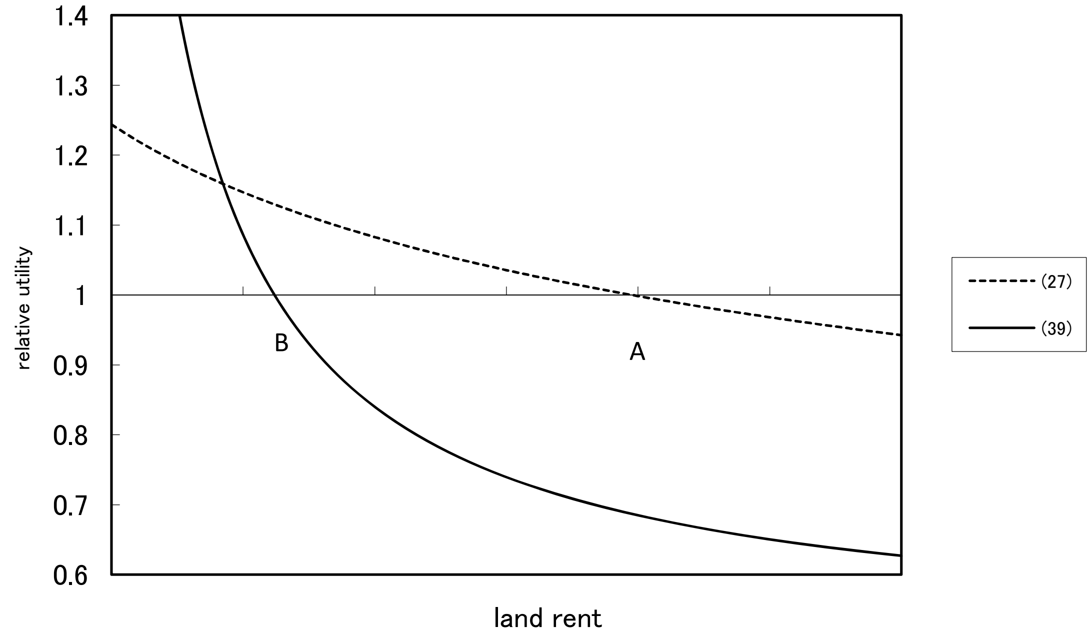
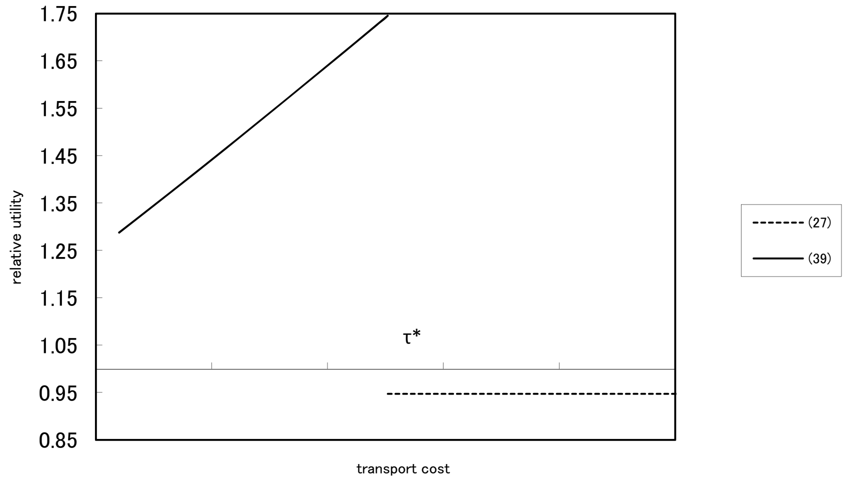
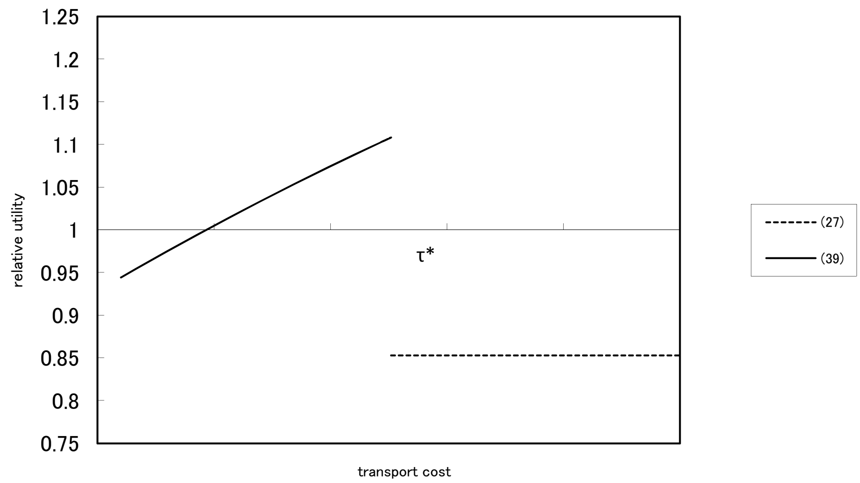


Figure 2

(1) the case of (a)



(2) the case of (a) (other case)



(3) the case of (b)