Section One

Theory of a Flowchart Approach to Industrial Cluster Policy

Akifumi Kuchiki

1. Introduction

Policy for forming an industrial cluster, or industrial cluster policy, plays an important role in developing a region in the EU countries. Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, and associated institutions in a particular field that are present in a nation or region. One of them is the case of Western Scotland. There are a number of examples which show practical application of industrial cluster model and policy measures in East Asia. METI, the ministry in charge of economy, trade, and industry in Japan, approved 19 industrial cluster plans (see Mitsui (2003)). Malaysia's the Second Industrial Master Plan 1996-2005 takes policies to promote development of competitive clusters in the electronics industry. The Industrial Estate Authority of Thailand (IEAT) is the state enterprise under the jurisdiction of the Ministry of Industry, established in 1972 to carry out the country's industrial development policy. Thailand's NESDB (National Economics and Social Development Board) is planning and IEAT (Industrial Estate Authority of Thailand) is implementing its regional development policy by forming industrial clusters. In June, 2004, the NESDB announced to intend to form eight clusters as the cores of the automobile and electronics industries in four regions within three years. The IEAT is planning to establish industrial zones specified for industrial clusters such as the automobile cluster of the Eastern Sea Board Industrial Zone.

Porter (1990) recommended his diamond approach, showing that the four points of the diamond represent the 4 basic attributes: factor conditions, demand conditions, related industries, and firm strategy/rivalry. The four points of the diamond represent the four basic attributes that affect regional productivity and innovation. Each of the four attributes is self-reinforcing, has a unique and important role to play in a regions business environment and they all operate together as a system. But the diamond approach is not industrial cluster policy since the four factors do not make clear roles of government.

Markusen (1996) classified four types of industrial agglomeration, but they cannot directly explain common patterns of the Asian experiences of regional development. Kuchiki (2003) found that conditions of forming new clusters in northern Vietnam were (a) industrial zones, (b) capacity building of physical infrastructure and institutional reforms in investment procedures, (c) anchor firms in the manufacturing industry, and (d) related firms, showing that industrial zones together with the combination of infrastructure and institutions played crucial roles in an industrial agglomeration. But no paper has discussed theoretical aspects of sufficient conditions to succeed in industrial cluster policy.

The purpose of this paper is to show "a flowchart approach to industrial cluster policy" by proposing sufficient conditions of forming industrial clusters typical in the manufacturing industry in Asia and theoretically proving sufficiency of the conditions to enhance regional economic growth. We theorize the typical pattern of forming industrial clusters in East Asia by defining 'quasi-public goods', prove that the industrial cluster policy enhances economic growth under a production function of 'increasing returns to scale', and show critical amounts of production of 'scale economies' for firms to decide to invest in clusters. Concepts of quasi-public goods, increasing returns to scale, and economies of scale are crucial to our proof. The sufficient conditions are to establish industrial zones, to build capacity, and to invite anchor firms together with their related firms. First, industrial zones as quasi-public goods are provided by both organizations in the quasi-public sector and firms in the private sector. Second, industrial cluster policy can enhance regional economic growth in cases that an anchor firm operates under increasing returns to scale. Markets for sales in Asia are large enough for anchor firms to attain increasing returns to scale. Third, fixed capital of companies related to the anchor company decides the minimum optimal size of car production of economies of scale. A flowchart approach to industrial cluster policy emphasizes the importance of ordering and timing of policy measures. The flow of policy implementation is to establish an industrial zone, to invite an anchor company, and to promote its related companies to invest in the industrial zone.

It is noted that industrial cluster policy is different from industrial policy, and that industrial policy is national policy to intervene in markets to foster specified industries as picked winners while industrial cluster policy is regional development policy part. It is important to make clear roles of local governments on industrial cluster policy to form industrial clusters. Though Kuchiki (2003) and (2004) illustrated successful cases of the flowchart approach of industrial cluster policy in industrial clusters of northern Vietnam and Tianjin in China, we need more examples to reduce to a prototype model of the flowchart approach in East Asia. We will apply the flowchart approach to other cases in Asia.

Section 2 defines “quasi-public goods” and applies the definition to industrial zones and capacity building. Section 3 proves that our industrial cluster policy in East Asia can enhance regional economic growth in cases that anchor firms operate under a production function of “increasing returns to scale”. Section 4 explains that markets in China are large enough for firms related to anchor firms to attain economies of scale. Section 5 concludes this paper.

2.1 Roles of Quasi-public Goods of Industrial Zones on Industrial Cluster Policy

This section defines the quasi-public goods and clarifies the roles of the local governments in implementing their industrial cluster policy. Both the private and quasi-public sectors can optimally provide the quasi-public goods for industrial cluster policy.

Samuelson (1954) made a polar distinction between pure public and pure private goods of the real world. Between those extremes fall the quasi-public (non-pure) goods of the real world. There are some goods which seem to have a mixture of the characteristics of pure public and pure private goods. It has been conceded by Samuelson (1958) that many goods commonly defined public goods do not fit his definition. Many articles have been published which allow us to move one step forward in closing Samuelson's gap between pure private and pure public goods.

This section attempts to make clear the confusion that has arisen in discussing public goods by revealing the implicit assumptions of Samuelson's model. For that purpose we define three criteria which characterize goods. The taxonomy of these articles can be made by our criteria.

Our attention will be concentrated on the criteria of non-excludability or excludability, non-rivalness or rivalness, and non-optionality or optionality. Mathematically we will formulate each characteristic, and build a formulation of a model involving public goods which covers quasi-public goods. We will argue the optimality conditions of goods in terms of the three characteristics at the same time.

Then we will result in some propositions and the implications. Even if a good is rival, if it is non-excludable and non-optional, market failures occur. We refer to the vertically-added demand curves. Even though a good is non-excludable and non-rival, if it is optional, all of individual marginal rate of substitution need not be added vertically. Moreover, we will have a clue to solve the TV dispute between Samuelson (1964) and Minasian (1964). The important point is that the property of non-optionality is crucial in optimality conditions.

We define "quasi-public optional goods" as non-excludable or non-rival, and optional. Our conclusion is that from the point of inequality the quasi-public optional goods should be decentralized according to people's preferences. We are told that the mixed economy consists of the public sector and the private sector. On the other hand it seems that the importance of quasi-public sector which belong to neither public nor private sector has been recently magnified. Then the concept of quasi-public optional goods will be useful to make clear the role of the quasi-public sector. In this section we will illustrate the quasi-public goods that are desirable to be supplied by both the quasi-public sector and the private sector.

Table 1. Export Processing Zones as Quasi-public Goods

	NR or R	NE or E	NO or O
I. Industrial zone (200 ha)	R	NE	O
II. Infrastructure			
(1) Electricity	R	E	O
(2) Roads	NR	NE	O
(3) Water supply	R	E	O
III. Institutions			
(1) Tax preferences	NR	E	O
(2) One-stop services	NR	E	O
	Rivalness	Excludable	Optional

Note: NR, R, IND, D, NE, E, NO, and O denote nonraval, rival, nonexcludable, excludable, nonoptional, and optional, respectively.
Source: Author's.

Section 2.2 presents four criteria for classifying goods. In section 2.3 we build the model which includes some kinds of quasi-public goods. Section 2.4 contains the optimality conditions. Finally, section 2.5 explains that industrial zones with tax incentives and one-stop services have property of quasi-public goods.

2.2 Criteria for Classifying Goods

In this section we define nonexcludability, nonrivalness, nonoptional, and nonindivisibility.

[NE] Nonexcludability, [E] Excludability:

A nonexcludable good is one whose supplier is not free of excluding individuals from using at small or zero costs once the good is produced. Suppose that a good (X) is produced x units and that the available ratio of an individual (i) is k_i ($o \leqq k_i \leqq 1$). Then the available level of X to the individual is xk_i. A nonexcludable good is one whose k_i is determined at the same time when the good X is produced and given to the supplier and whose supplier cannot change k_i. An excludable good is one whose k_i can be changed by the supplier at nearly zero costs if he intends to. That is, k_i is not constant but variable to suppliers.

[NO] Nonoptional, [O] Optional:

A nonoptional good is one which a demander i cannot change consumption level (x_i) freely once that an available consumption level is determined as xk_i. A constraint of a demander i is as follows. The demander must consume all available level of X in the case of a nonoptional good. The available level is xk_i. So that $x_i = xk_i$. In the case of an optional good, the maximum available level is also xk_i, but demanders can change their levels of consumption. The demander can choose value k_i from zero to one. That is, $0 \leqq k_i \leqq 1$.

As Dorfman (1969) says,

> "There are certain goods that have the peculiarity that they are available to everyone, and no one can be precluded from enjoying them whether he contributed to their provision or not." In other words, "A nonoptional good is

one for which some positive consumption level is exogenously imposed, and any attempt to deviate, either upward or downward, requires additional expenditures”(James (1969)).

[NR] Nonrivalness and [R] Rivalness:

A nonrival good is one, ”which all enjoy in common in the sense that each indinidual’s comsumption of such a good leads no substruction from any other individual’s consumption of that good” (Samuelson (1954)). In general nonrivalness does not mean that precisely the same product quality is available to each demander. For example, the demander 1 who lives close to the police station is considered to have better protection than the demander 2 who lives far away from it., That is,

$$k_1 > k_2.$$

It is therefore deduced that:

In the case of a rival good, the following must hold,

$$k_r = \left\{ k_i \middle| \sum k_i \leq 1, \qquad 0 \leq k_i \leq 1 \right\}$$

In the case of a nonrival good, on the other hand, the possibility is

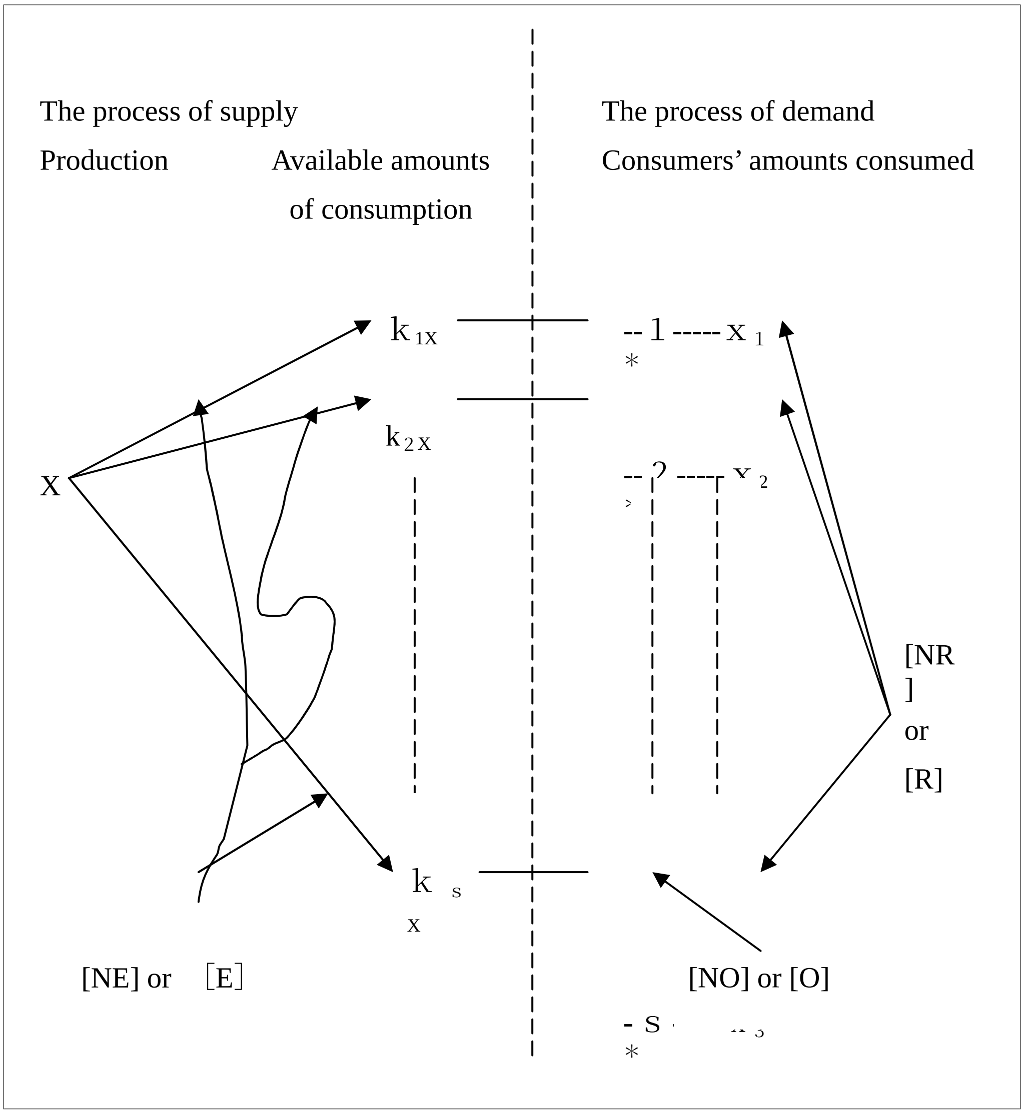
$$k_n = \left\{ k_i \middle| \sum k_i > 1 \quad \text{or} \quad \sum k_i \leq 1, \quad 0 \leq k_i \leq 1 \right\}.$$

［ID］ Indivisibility, [D]Divisibility

Goods may be had only in discrete units, some of them quite large of “lumpy”. Usually we define an indivisible commodity as “integer” (see Gomory and Baumo1 (1960), Frank (1969) etc.).

Figure 1 depicts the process from production to consumption, and explains which process relates to each characteristic. Either nonexcludability or excludability relates to the process of supply, and either nonoptionality or optionality to the process of demand. Using these characteristics, we can review articles in the theory of quasi-public goods. To cite few examples, Holtermann (1972) corresponds to [D] [NE] [R] [O] [ID], and Davis and Whinston [2] to [ID] [NE] [R] [O]. Samuelson's pure collective goods are [NE], [NO] and [NR], $k_i = 1$, for all i. Theoretical studies of indivisible goods appear in print with increasing frequency, for those are more relevant for solving real world problems. It is necessary to analyze the cases which remain untouched. Attention will be hereafter paid to [NE] or [E], [NR] or [R], and [NO] or [O]. (See Appendix 1 and Appendix 2)

Figure 1. Definition of goods



2.3. The Model

We take up all of the cases which can be considered, and show some examples corresponding to each case:

V: [NE] [NR] [NO] ---national defense, national security (self-sufficiency of food)

X: [NE] [R] [O] -------oxygen in a limited space

W: [NE] [NR] [O] ---television broadcasting, radio waves

Y: [NE] [R] [O] ------outdoor circuses, green utilities (agriculture)

T: [NE][NR][O]------research

Z: [E] [R] [O] ---------bread.

Notice the following proposition.

Proposition 1: If a good is excludable, each k_i is a variable for the demander i. Each demander must determine the optimal value of k_i, otherwise k_i remains indeterminable. Therefore it cannot be nonoptional.

The economy has six kinds of goods including two kinds of pure public and private goods V, Z, and four kinds of non-pure goods W, Z, Y, T, where (V_1,-----V_j; W_1,---------,W_k ; X_1,----------,X_l; Y_1,--------,Y_m; Z_1,-------,Z_n; T_1,---------,T_p)=(V,W,X,Y,Z,T). In the following superscripts refer to persons and subscripts to goods.

When we consider the properties of goods, the constraints of these goods are as follows:

$$V_a^i = v_a^i V_a \qquad (1)$$

where $0 \le v_a^i \le 1$, v_a^i are constants, and $\sum_i v_a^i > 1$ are possible,

for all i, a=1, ---, j.

$$W_b^i \le w_b^i W_b, \qquad (2)$$

where w_b^i correspond to v_a^i in (1).

$$\sum_i Z_e^i \le Z_e, \quad e=1, ------, n \qquad (3)$$

For example, constraint (2) indicates that no more of the goods can be consumed than is allowed by the quantity of the goods available to the individual i. Here we use v_a^i, w_b^i, x_c^i and y_d^i corresponding to k_i in section 2.2. Now we get two propositions.

Proposition 2: The optimality condition of T in which nonrivalness plays a crucial role is the same as that of W. In the case of T, however, it is always necessary that t_f^i corresponding to k_i are equal to unity for all i. (See Appendix 3)

Proposition 3: Whether a good is rival or nonrival will not result in essential differences in the optimality condition between W and Y. The result is akin to the relationship between V and X . (See Appendix 3)

We assume that the production possibilities for the economy are described by a well-behaved transformation locus

$$F\ (V, W, Z) \leq 0.$$

Here V are pure public goods, W are non excludable, nonrival and optional goods, and Z are pure private goods. We hereafter omit T because of Proposition 2. Also, our attention is concentrated on V and W because of Proposition 3.

Moreover, we assume that both each individual's utility function (u^i) and the social welfare function (U) are the same as those of Samuelson (1964) (The maximization problem is written in Appendix 4).

2.4. Optimality Conditions

The results of V and Z are well known to us. That is, if the pure private goods Z are chosen, then an individual should consume that amount which equates his weighted marginal utility to the price of the good (The multipliers can be interpreted as shadow prices). For each pure public good V, the sum of the marginal rate is equal to the inverse of that private good in the consumption of the pure. The distinction between public goods and private goods has been held to lie in the nonrivalness characteristic of public good (Musgrave (1969)). But the crucial characteristics are not that of nonrivalness, but those of nonoptionality and nonexcludability (Appendix 4). Musgrave (1969) says,

> "Due to the non-rivalness of consumption, indinidual demand curves are added vertically rather than horizontally as in the case of private goods."

But this statement is not always right in terms of our definitions.

Proposition 4: Even if a good is nonexcludable and nonrival, if it is optional, the optimality condition does not require

$$\sum MRS^{i} = MRT,$$

where MRS and MRT denote marginal rate of substitution and marginal rate of transformation, respectively.

In the extreme

$$MRS^{i} = MRT, \quad \text{for } i \in M_b .$$

It is possible that "benefit principle" holds in the case of optional goods W. Probably the way of charging of the tolls succeeds from the point of the optimal allocation of resources, for the users cannot choose but reveal true preferences. A similar argument also applies to nonexcludable, rival, and optional goods Y.

Proof: The Kuhn-Tucker conditions with respect to W are:

$$A = (\partial U / \partial u^{i})(\partial u^{i} / \partial W_b^{i}) - \beta_b^{i} \leq 0、 A \cdot W_b^{i} = 0、 W_b^{i} \geq 0、$$

$$i=1, \text{---------}, s, \qquad b=1, \text{-------}, T. \qquad (4)$$

$$B = \sum_i \beta_b^{i} - \alpha \cdot W_b^{i} \cdot \partial F / \partial w_b \leq 0、 B \cdot W_b = 0、 W_b \geq 0 \quad (5)$$

$$C = -(W_b^{i} - w_b^{i} W_b) \geq 0、 C \cdot \beta_b^{i} = 0、 \beta_b^{i} \geq 0 \qquad (6)$$

We define

$$M_b = \{i \mid W_b^i / w_b^i = \max(W_b^1 / w_b^1 、 ---、 W_b^s / w_b^s)\}$$

$$M_t = \{1, ------s\}$$

$$N_b = M_t - M_b$$

The Sets M_b cannot be empty, since the constraint (6) must be binding during some persons in order to have a rational allocation of resources. So that the multipliers β_b^i(for i $\in M_b$) become positive. The strict inequalities,

$$-(W_b^i - w_b^i W_b) < 0, \quad \text{for} \quad i \in N_b,$$

must be held in (6). Therefore, from (6)

$$\beta_b^i = 0, \quad \text{for } i \in N_b$$

Notice that whether the individual belongs to M_b or N_b also depends on w_b^1. In this process, w_b^1 play an important role. Suppose that some set M_b consists of an element. That is, let us consider the extreme case where the maximum is an only person. The strict inequality must hold in (6) except the person. Then we find that

$$\partial U / \partial u^i \cdot \partial u^i / \partial W_b^i = \alpha \cdot W_b^i \cdot \partial U / \partial W_b, \; i \in M_b$$

It is possible enough to suppose that such situations will occur. In general, however, the sets M_b will consist of some persons. Attention may be concentrated on the sets M_b alone. Here it is very important that, in the process of getting the optimality conditions, we can neglect those who belong to the sets N_b, or relatively do not want to consume the goods W.

This proposition has some implications. First, Samuelson (1955) argues that "A point on the efficiency frontier requires equality between the vertically-added marginal rates of substitution of all men for the public and private goods."

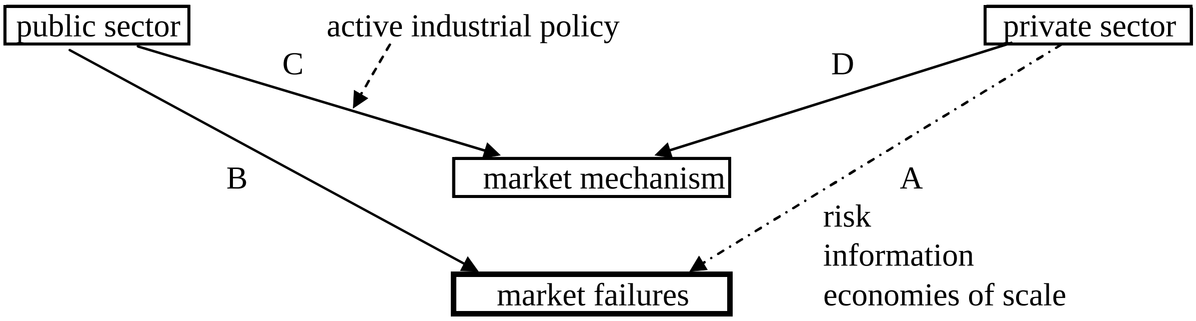
But it is possible that in the case of W([NE][NR][O]) or Y([NE][R][O]) we need not add different individuals' MRS vertically. It is possible to leave out of consideration those who do not belong to the sets M_b.

2.5. Industrial Zones as quasi-public goods

Let us consider (i) an export processing zone with (ii) one-stop services and (iii) tax reductions and exemptions to promote exports. (i) The zone, which is constructed as a single unit within a 300-hectare plot, has a town equipped with infrastructures. A town of the zone consisting of factories, housings, amusement facilities is indivisible, but it is also excludable and optional to each company. (ii) An office at the zone provides services of procedures for companies to establish their plants. One-stop services are rival and optional. (iii) Taxes such as incomes and import tariffs of companies are reduced or exempted. Tax incentives in an export processing zone are "nonrival" and nonoptional. So we denote G the total of government investment in an export processing zone in the next section.

The Asian experience of economic growth shares two characteristics. As for the first characteristic, we suppose that the economic sector is separated into the private sector and the public sector. Moreover, goods are categorized into goods subject to "market competition" and goods that generate "market failures." The private sector bears the responsibility for market competition (Arrow D in Figure 2), whereas the public sector bears the responsibility for market failures (Arrow B in Figure 2). Intervention in the private sector by the public sector is active industrial policy of Arrow C in Figure 2. This is the textbook approach in economics.

Figure 2.The Role of a Private Sector for Market Failures
(Importance of Economic Agents)



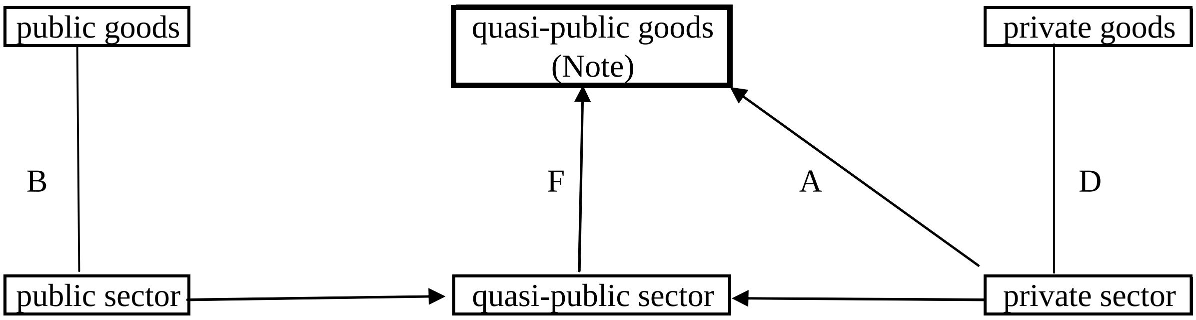
Source: Kuchiki(1998).

Figure 2 shows the role of the public sector in market failures, as relatively and sufficiently analyzed by economics. Experiences in Asian, however, show that private-sector corporations are covering market failure losses as Arrow A in Figure 2. The Arrow A is a new activity under globalization. For example, multinational corporations, which are called “IPPs” (Independent Power Producers), supply electrical power to Asian countries. “BOT” (Build- Operate- Transfer) is a system by which the private sector supplies infrastructures. Certain infrastructures are categorized as public goods and thus represent one type of market failure. For example, Japanese trading corporations supply infrastructures using this system in Asia.

Next, as shown in Figure 3, the author will clarify the role in economic growth played by the quasi-public sector, which is positioned midway between the private and public sectors. Arrow F in Figure 3 shows roles of the quasi-public sector to provide the quasi-public goods. The “Industrial Estate Authority of Thailand” in the quasi-public sector played an important role during the construction of industrial zones in Thailand in the latter half of the 1980s. These industrial zones effectively functioned to introduce foreign investment to Thailand. The point that requires emphasis here is that quasi-public goods supplied by the quasi-public sector played a leading role at the early stage of economic development. It is noted that Arrow

A shows roles of the private sector to provide the quasi-public goods. Multinational corporations establish export processing zones.

Figure 3. Importance of Quasi-Public Goods



Note: Excludable vs. nonexcludable, rival vs. nonrival, and divisible vs. indivisible.
Source: Kuchiki (1998).

Regarding the second characteristic, we point out that the quasi-public sector plays an important role in the process of economic development, as shown in Figure 3. One typical example of a market failure is a pure public good. A purely public good possesses three properties. That is, it is non-exclusive, non-competitive, and indivisible as explained in section 2.2. Numerous quasi-public goods such as export processing zones exist, however, which do not possess all three properties but do possess one or two properties. We must distinguish roles of the quasi-public sector from those of the private sector by taking into account property of quasi-public goods when the government takes industrial cluster policy.

In some cases, it is desirable for quasi-public goods to be supplied by economic agents in the quasi-public sector which is positioned midway between the private and public sectors. So far, discussion has been centered on the roles of the state or government without sufficient analysis of "quasi-public goods" that should be supplied by economic agents in the quasi-public sector.

3.1. A Regional Growth Model: Increasing Returns to Scale: Anchor Firms

Asian experiences in the 1980s showed that industrial zones or export processing zones (EPZ) in East Asia contributed to generate employment opportunities. EPZs limit job opportunities to people around sites of EPZs. A question is whether EPZs as quasi-public goods could enhance aggregate growth of a region by forming industrial clusters.

Hamada (1974) analyzed EPZ as a pioneer work. Grossman and Helpman (1991) built a model which takes into considerations both innovators and imitators of new technology. The purpose of this section is to find conditions under which EPZs can enhance aggregate growth, and examine whether reduction in foreign investors' tax rates is effective in enhancing aggregate growth. For that purpose, this section applies a model of Grossman and Helpman to EPZs.

Based on experiences in East Asia, we build an EPZ model to explain a growth mechanism in East Asia, in which industrial zones or export processing zones linked multinationals pursuing cost reduction to governments of recipient countries implementing deregulation and preferential tax treatment. We focus on a role of the EPZs in East Asia and apply a behavioral theory to multinationals that invested in EPZs.

Constructing a macroeconomic growth model to analyze effectiveness of EPZs in enhancing aggregate growth of a nation, we conclude that national income can be increased by reducing a profit tax if production functions of final goods of multinationals in EPZs are increasing returns to scale, and that a government should invite multinationals to EPZs if costs of invitation are much cheaper than those of imitation, or if number of intermediate goods of multinationals is larger.

This section is organized as follows. Section 3.2 builds a growth model of an industrial cluster with industrial zones, and examines a case where multinationals of country 1 are innovators, and local firms of country 2 imitate innovations of the multinationals by paying the fee for imitation. Section 3.3 analyses a case where, in addition to section 2, multinationals of country 1 make a decision whether they invest in EPZs of country 2. Section 3.4 concludes the section.

3.2. A case where a country imitate innovations of multinationals

In this section, we construct a model of an industrial cluster with industrial zones, and show that the region can grow at high growth rates by adopting a preferential tax policy(t).

This section analyses the following two cases:

Case 1: multinationals of country 1 are innovators, and local firms of country 2 imitate the innovations of the multinationals at the cost of imitation, ν.

Case 2: In addition to Case 1, multinationals of country 1 make a decision whether they invest in EPZs of country 2 by themselves.

First, we consider Case 1. We assume that innovative products are intermediate inputs into the production of a single final good. The final good Y can be consumed by households. The technology for producing final output requires intermediate goods and input of labor. Intermediate goods are produced by labor alone, and labor also is the sole input into R&D.

We follow Romer (1990) by writing the production function of the firms in industrial zones in Guangzhou to imitate firms in country 1 as

$$Y_2 = A_2 L_2^{1-\alpha} \sum_{j=1}^{n_1} X_{2j}^{\alpha} \quad ,$$

where $0 < \alpha < 1$, n_1 is the number of variety of intermediate goods, A_2 is a productivity parameter, L_2 is a labor input, and X_{2j} is the employment of the j th type of intermediate good. We suppose that the government runs a balanced budget financed by a proportional tax at a rate of t. Here an innovator in country 1 is an intermediate good producer. An imitator in country 2 is a final good producer.

The profit of the producer in country 2 of final good (π_{2F}) is

$$\pi_{2F} = Y_2 - wL_2 - \sum_{j=1}^{n_1} P_j X_{2j} \quad ,$$

where w is the wage rate, and P_j is the price of the intermediate good j. The condition to maximize the profit is

$$X_{2j} = L_2 (A_2 \alpha / P_j)^{1/(1-\alpha)} \quad . \qquad (7)$$

Next, we assume monopolistic competitions in intermediate goods. The profit of producers in country 2 of intermediate good is

$$\pi_{M2j} = P_j(X_{2j}) \cdot X_{2j} - X_{2j} \quad . \qquad (8)$$

The solution for the monopoly price is

$$P_j = 1/\alpha \quad . \qquad (9)$$

Hence, if we substitute for P_j and X_{2j} from (7) and (9) into (8), then

$$\pi_{M2j} = \{(1-\alpha)/\alpha\} \, L_2 \, A_2^{1/(1-\alpha)} \alpha^{2/(1-\alpha)} \quad . \qquad (10)$$

We assume that there is free entry into the business to imitate the j th intermediate good so that anyone can pay the imitation cost ν to secure (in the unit of Y) the net present value $V_j(T)$ at time T which can be obtained by time γ from T to infinity:

$$V_j(T) = \int_T^{\infty} \pi_{M2j} \, e^{-r(\gamma - T)} d\gamma \, , \qquad (11)$$

where r is the interest rate and constant. The free-entry condition requires that

$$V_j(T) = \nu. \qquad (12)$$

The equations (11) and (12) give

$$\pi_{M2j} / V_j = r \quad ,$$

that is

$$r = (L_2 / \nu) \{(1-\alpha)/\alpha\} A_2^{1/(1-\alpha)} \alpha^{2/(1-\alpha)} \quad . (13)$$

We assume that households maximize utility over an infinite horizon:

$$U = \int_0^\infty \{(c^{1-\delta} - 1)/(1-\delta)\} e^{-\rho\gamma} d\gamma$$

where ρ is the constant rate of time preference, δ is the coefficient of risk aversion, γ is time, and c is consumption (Here we assume that the rate of population growth is 0).

The growth rate of consumption is, as well known,

$$\dot{c} / c = (1/\delta) \cdot (r - \rho) \quad . \qquad (14)$$

We assume the balanced growth, so that Equations (13) and (14) yield the growth rate of country 2

$$\begin{aligned} g_0 &= \dot{c}/c = \dot{Y}/Y, \\ &= (1/\delta)\left[(L_2/\nu)\{(1-\alpha)/\alpha\}A_2^{1/(1-\alpha)}\alpha^{2/(1-\alpha)} - \rho\right] \end{aligned} \qquad (15)$$

3.3. A case where multinationals invest in export processing zones

We consider Case 2: Firms from country 1 make decision whether they invest in an export processing zone (EPZ) in country 2 and decide to invest.

Let G represent the total of government investment in an export processing zone as we explained (Barro and Sarai-i-Martin (1995)). The production function of final good Y of the firms from country 1 in the EPZ is

$$Y_1 = A_2 L_1^{\gamma} (\sum_{j=1}^{n_1} X_{1j}^{\alpha}) G^{\beta}$$

where L_1 is a labor input, and X_{1j} is the employment of the jth type of intermediate good. The profit for the firms in the EPZ of final good before taxation is

$$\pi_{2F} = \theta Y_1 - wL_1 - \sum_{j=1}^{n_1} P_{2j} X_{1j} \quad ,$$

where w is a wage rate, and θ is a country risk in the EPZ to the firms of country 1 which we explained in the previous section and is different from the productivity parameter A_2.

Whether multinationals make a decision to invest in the EPZ depends on whether the country risk θ is lower than the threshold rate. The value of threshold is determined by a key variable, that is, a tax rate t, which depends on the government of country 2. The lower the government of country 2 make the tax rate, the more easily the firms of country 1 invest in the EPZ in country 2. We will emphasize the importance of the role of government in providing the quasi-public goods below.

Here we consider the case of foreign investment of the firms from country 1 in the EPZ. The profit of firms from country 1 of intermediate good in terms of the currency of country 2 before taxation is

$$\pi_{M1j} = \{(1-\alpha)/\alpha\} (\theta A_2)^{1/(1-\alpha)} \alpha^{2/(1-\alpha)} L_1 .$$

Then, the tax revenue for the government of country 2 is

$$t\,\pi_{M1j} . \qquad (16)$$

The total flow of monopoly profit of country 2 from the imitation of a new product of country 1 and the invitation to the EPZ in country 2 is the sums of the flows shown in the Equations (10), (15) and (16):

$$R_{2j} = \{(1-\alpha)/\alpha\} A_2^{1/(1-\alpha)} \alpha^{2/(1-\alpha)} L_2 + t\{(1-\alpha)/\alpha\} X_{1j} + \frac{\gamma}{\alpha^2} X_{1j},$$

where the second term is profit tax revenue and the third term is labor income per industry.

We assume that the government of country 2 expended the cost λ to invite firms from country 1 to the EPZ. So, the total cost of country 2 is

$$\nu + \lambda.$$

The rate of return in country 2 is

$$R_{2j}/(\nu+\lambda).$$

Then the growth rate of country 2 is

$$g_1 = (1/\delta)\{R_{2j}/(\nu+\lambda) - \rho\}. \qquad (17)$$

Setting,

$$g_1 - g_0 = K - 1,$$

where

$$K = \frac{\nu}{\lambda} \cdot \alpha^{\frac{2\alpha\beta}{(1-\alpha-\beta)(1-\alpha)}} (\theta A_2)^{\frac{\beta}{(1-\alpha-\beta)(1-\alpha)}} \{n(1-\alpha-\gamma)\}^{\frac{\beta}{1-\alpha-\beta}} \frac{L_1^{\frac{\gamma}{1-\alpha-\beta}}}{L_2} \times \left\{t + \frac{\gamma}{\alpha(1-\alpha)}\right\} t^{\frac{\beta}{1-\alpha-\beta}} - 1.$$

So that the sign of $g_1 - g_0$ depends of the sign of K. The larger are $\frac{\nu}{\lambda}$, and n, the more probably the sign of $g_1 - g_0$ is positive. In other words, the government should invite FDI to EPZs if the cost of invitation is much cheaper than that of imitation, or if the number of intermediate goods is larger.

We suppose that the government runs a balanced budget financed by a proportional tax at rate t. That is,

$$t\,\pi_{2F} = G,$$

The conditions for the maximization of the firm in country 2 in the EPZs is

$$wL_1 / n_1 = \gamma(\theta A_2 L_1^{\gamma} X_{1j}{}^{\alpha} G^{\beta}), \qquad (18)$$

and

$$P_j = \alpha\theta A_2 L_1^{\gamma} X_{1j}{}^{\alpha} G^{\beta}, \qquad (19)$$

Using equation (9), (18), and (19), we can obtain the following wage revenue of jth industry:

$$wL_1 / n = \gamma X_{1j} / \alpha^2. \qquad (20)$$

We will show in what condition the recipient country should set the tax rate to be higher in order to enhance aggregate growth rate by inviting multinationals to county 2 and reducing the profit tax. We will The partial derivative of K with respect to t is

$$\frac{\partial K}{\partial t} = H \cdot t^{a-1} \cdot \left\{ t + \frac{\beta\gamma}{\alpha(1-\alpha)^2} \right\} \cdot \frac{1-\alpha}{1-\alpha-\beta}$$

where $H = \frac{L_1^{\frac{\gamma}{1-\alpha-\beta}}}{L_2} \frac{\nu}{\lambda} \alpha^{\frac{2\alpha\beta}{(1-\alpha-\beta)(1-\alpha)}} (\theta A_2)^{\frac{\beta}{(1-\alpha-\beta)(1-\alpha)}} \{n(1-\alpha-\gamma)\}^{\frac{\beta}{1-\alpha-\beta}}$.

The sign of $\frac{\partial K}{\partial t}$ is negative in the case of $1-\alpha-\beta<0$ and $\alpha<1$ (i.e. A production function of this case is increasing returns to scale.).

Suppose that the production function of final good Y of the firms from country 1 in the EPZ is increasing returns to scale, that is, $1<\alpha+\beta$. Then national income is increased by the reduction in the profit tax. We found that the lower the tax rate, the lower the growth rate is.

3.4. Conclusions

We have two conclusions. First, national income is increased by reducing a profit tax if production functions of final goods of multinationals in EPZs of a developing country are increasing returns to scale. Second, a government of a developing country should invite multinationals to its EPZs if costs of invitation are much cheaper than costs of imitation, or if the number of intermediate goods of multinationals is larger.

In the Hamada (1974) model, the welfare effects of an EPZ depend on factor intensity of protected sectors in the domestic economy. Our result shows that they depend on whether multinationals' industry is increasing returns to scale or not. If the industry is the case, a government has a crucial role in inviting multinationals to their EPZ and enhancing aggregate growth by reducing tax rates.

4. Sufficient Condition for Establishing a New Plant at a Cluster

This section illustrates a case of increasing returns to scale with fixed capital. Suppose that firms use indivisible fixed capital. Fixed costs are costs needed at a level of very little production. Average costs are decreasing when fixed costs are large and marginal variable costs are small. Average cost function may have U-shaped curve when fixed costs exist, that is, average costs initially decrease and then increase. There exists its optimal size of production where the marginal costs are equal to the average costs.

An anchor company of assembling cars has a group of component companies since a standard car is assembled from more than 25 thousand of components. This fact is applied not only to Japanese companies but also to Hyundai of a Korean company and General Motor of an American company. Clusters in the automobile industry are forming in Guangzhou in southern China, Shanghai in central China, and Tianjin and Beijing in northern China. Distances from Shanghai to Tianjin and from Shanghai to Guangzhou are respectively 12 hundred and 20 hundred kilometers. So component companies must locate near anchor companies when anchor companies exceed certain levels of production. For example, Toyota has a group called Kyohokai which its related companies belong to. The objective of Kyohokai is, together with Toyota Motor Corporation and its member companies, to produce cars to sell to people near their plants.

We interviewed Japanese firms in both Shanghai and Guangzhou on their optimal sizes. We found the following three different types of component companies (see Tables 2 and 3). Component companies Type I belong to a group of an anchor company and must locate their plant near their anchor company regardless the production size of their anchor companies. Component companies Type II do not locate near their anchor companies since their products produce a variety of products and are not specific to their anchor company. Component companies Type III locate their plants near their anchor company only if it operates at their minimal optimal size of production. We found that their minimal optimal sizes range from 100 thousand to 700 thousand.

Table 2. Industrial Cluster in Shanghai

Relationship with the anchor company	Name of the company	Product	Characteristics
Type I	Company P	Audios for cars and mobile phones	Covers more than 90% of audio components in China.
Type II	Company D	Computerized electronic components	Necessity to locate as a group company near its anchor company with whom shares important data.
	Company T	Logistic company	Offers milk-run way and cross dock strategy.
Type III	Company K	Car lamps	Cluster process accelerates when anchor company's car sales reaches to more than 300,000 cars.
	Company A	Crank shafts for engines and cone rods	Cluster process accelerates when anchor company's car sales reaches to more than 500,000 cars.
	Company S	Cold rolled steel sheets	Independent from the anchor company atits production size of more than 700,000.

In discussing whether the related firms of an anchor firm will invest in a cluster, we take into consideration economies of scale of the anchor firm.

Hypothesis: Development of an industrial cluster depends on market demand, or the quantity of production of an anchor firm. If an anchor firm expands its production size because of expected expansion of sales, then its related firms will establish new plants in the cluster.

Table 3. Industrial Cluster in Guangzhou

Relationship with the anchor company	Name of the cmpany	Product	Characteristics
Type I	Company T	Air-conditioner for autos and others	Not specialized only in auto-parts. The location of the plant is not required to be close to the automobile production site.
Type II	Company HL	Key sets for cars	Depends to Honda group.
	Company HA	Trading company of Honda's genuine auto-parts	No economies of scale. It is one of Honda's in-house departments.
Type III	Company M	Plastic parts (eg. Engine covers)	Attain economies of scale after 400,000 of car production.
	Company FT	Clutches, brakes and frames	Attain economies of scale after 100,000 of car production.

Independent variables of transportation costs are distance, cross dock logistics, and modularity in the following.

t = f (distance, cross dock logistics, modularity).

We assume that an increase in transportation costs caused by technological progress of modularity depends on management, technology, or

m = g (management, technology).

It is well known that external economies depend on a number of related firms in a cluster.

Notations are as follows:

t: transportation costs per unit,

m: increase in transportation costs per unit caused by technological progress of modularity,

e: external economies,

s: movement costs for a related firm to establish a new plant, and

q: quantities of production.

We assume that technology of modularity does not change, that movement costs are fixed, and that the number of related firms is fixed. Then, we can conclude that quantities of production decide whether related firms shift their plants to the place near its anchor firm locates. Related firms' decision depends on quantities of production of an anchor firm. That is, a related firm compares its total transport costs (tq) with its movement costs (s) as follows:

$$s < tq, \text{ or } s/t < q.$$

The difference between its transportation costs and movement costs reduces profits of the firm. An increase in the transportation costs caused by new modularity technology is crucial to deciding whether the related firm establishes a new plant at a cluster as follows:

$$s < mq, \text{ or } s/m < q.$$

Expected gains from external economies (e) can be deducted from movement costs (s) while total costs not to establish a new plant are the transportation costs (tq plus mq), so that the related firm compares the expected gains with the total costs,

$$s - e < tq + mq.$$

One of the sufficient conditions for the related firm to establish a new plant in its anchor firm's cluster is as follows:

$$(s - e) / (t + m) < q.$$

We illustrate the case in which quantities of production are crucial to determining whether related firms establish new plants in the following.

(1) Firms in Shanghai

Type I: Company P:

Company P established in 1995 in China produces four kinds of components such as speakers for car audios and mobile phones. Its research and development started in 2001 designs die-casting for its products in Shanghai. Company P has means to prevent its designs of die-casting from being stolen. It procures more than 90 % of components in China and sells about 8 % of its products to Toyota in Tianjin, Honda in Guangzhou, and GM in Shanghai in China. Kamigumi, a Japanese logistics company, collects Company P's products for Toyota in such a milk-run way as Japanese milk companies distribute milk bottles to homes in the morning. Company C is not inclined to outsource its components. Company C sells not only its car audios to car companies but also its speakers for mobile phones to Motorola in Tianjin. So it has no plan to invest in Guangzhou in near future.

Type II: Company D:

Company D produces computerized electronic components. Being an electronic component producer, the company D has a close relationship with its anchor company. The company D shares important confidential data with the anchor company including data of its customers since the company D joins in the development of the design of a new car with its anchor company from the early stage of the research and development. There are few large worldwide companies such as Denso of a Japanese company, Bosch of Germany, and Delphi of US. These companies have no other choice to locate near in their anchor companies.

Type II: Company T:

Company T is a logistics company of a Japanese automobile anchor company to adopt a milk-run way and a cross dock strategy. The milk-run way is a way that component companies prepare their products to be shipped by the time specified by their anchor company and company T goes round to collect them. The way is similar to the way Japanese milk companies distribute milk bottles to homes. The cross dock strategy is a method to package the collected components by just-in-time system to provide the components efficiently to the anchor assembly company. Company T has 5 routes of the milk-run way. One time of the collection covers components for 200 cars. The efficient way of logistics weakens incentives of component companies in Shanghai to invest in Guangzhou and Tianjin. But company T must locate its anchor company to provide components of the anchor company just in time as a Keiretsu company, a Japanese term for a set of companies with interlocking business relationships and shareholders. It is expected that sales of automobiles in China in 2010 will reach to more than 10 million.

Type III: Company K:

Company K produces lamps for automobiles. Its transportation costs from Shanghai to Guangzhou are more than 10 % of the total costs since the products of the lamps need a lot of space. The minimal optimal size of production is 300 thousand. The company cannot invest in Guangzhou if it is profitable for the company to transport the products to Guangzhou and Toyota in Guangzhou exceeds its products by 300 thousand. This is because the company cannot convince its shareholders to establish its plant in Guangzhou if the plant is in the red.

Type III: Company A:

Company A produces crank shafts for engines and cone rods. As these components are used mainly for the central part of the engines their material required to be easy to be processed and cut, and strong. Company A is so capital-intensive that the investment amount reaches to 10 million dollar. The optimal size of production of one line at a plant is 500 thousands. There are only three large Japanese companies in this industry. Company C has no plan to invest in Guangzhou since it locates in Shanghai and transports its products to all over China.

Type III: Company S:

Company S is a forging company. Cold rolled steel sheets used for automobile industry is not produced in China. This type of steel sheet requires high technology of “deep-drawing”.

Anshan Iron & Steel Group Corporation has formed a joint venture company with Tessen of Germany, and Benxi Iron & Steel Group formed a joint venture company with Posco (Pohang Iron & Steel) of Korea. Chinese companies will be able to adopt new technology through these joint ventures. Although the construction cost of Nippon Steel Corporation plant in Kitakyushu is estimated to reach approximately 2 trillion yen, the cost will be minimized to one quarter if the construction would be held in China. It can be interpreted that Nippon Steel Company has been forced to invest in China for the growing "demand capacity" of the Chinese market. Nippon Steel Company will begin to produce through joint venture with Shanghai Baosteel. The competition within Chinese steel industry has intensified since 1997 when Chinese government left its steel industrial policy and production increased out of control.

(2) Firms in Guangzhou

Type I: Company T:

Company T started its business in China from the production of air-conditioner parts, in an area not related to automobile production. In China, local companies have been catching up very closely the technological level of Japanese companies in a relatively short term by introducing CAD (Computer-aided Design) / CAM (Computer-aided Manufacturing) to the metal-molding production. Company T's products are required to achieve Japanese quality level and the Chinese price level at the same time. A large number of machines at the price level between 50 billion yen and 20 billion yen are needed for equipment investment. In 2003, the company T has started to produce auto-parts apart from the electronic equipment parts. As the company is not specialized only in auto-parts, the location of the plant is not required to be close to the automobile production site.

Type I: Company HL:

Company HL produces key sets for four-wheeled vehicles and two-wheeled vehicles. Magnesium and zinc are the key materials for their production. Plastic die-casting plays an important role in its process of production. HL intends to sell its products of auto-parts to Nissan and Toyota, even though the firm depends to Honda's group, or what is called Keiretsu. The minimum production level required to attain economies of scale is not clarified since HL they produce a variety of other auto-parts, apart from the key sets.

Type II: Company HA:

Company HA is one of the Honda's in-house departments that trade Honda's genuine auto-parts. For being trading company, HA does not possess fixed asset except for office installation. For this reason, the company can enter to the market where Honda invests. HA has no economies of scale.

Type III: Company M:

Company M produces plastic parts and components such as engine covers for Honda. Die-casting, painting and assembling are the processes of production. The company must increase its production for Honda's new investment in Wuhan City and start Honda's new plant operation in Guangzhou. Company M purchases plastic materials from two companies including Mitsui Chemical, to keep the price competitive. The company uses large-scale machines which enable the firm to attain economies of scale after approximately 400 thousands of Honda's automobile production.

Type III: Company FT:

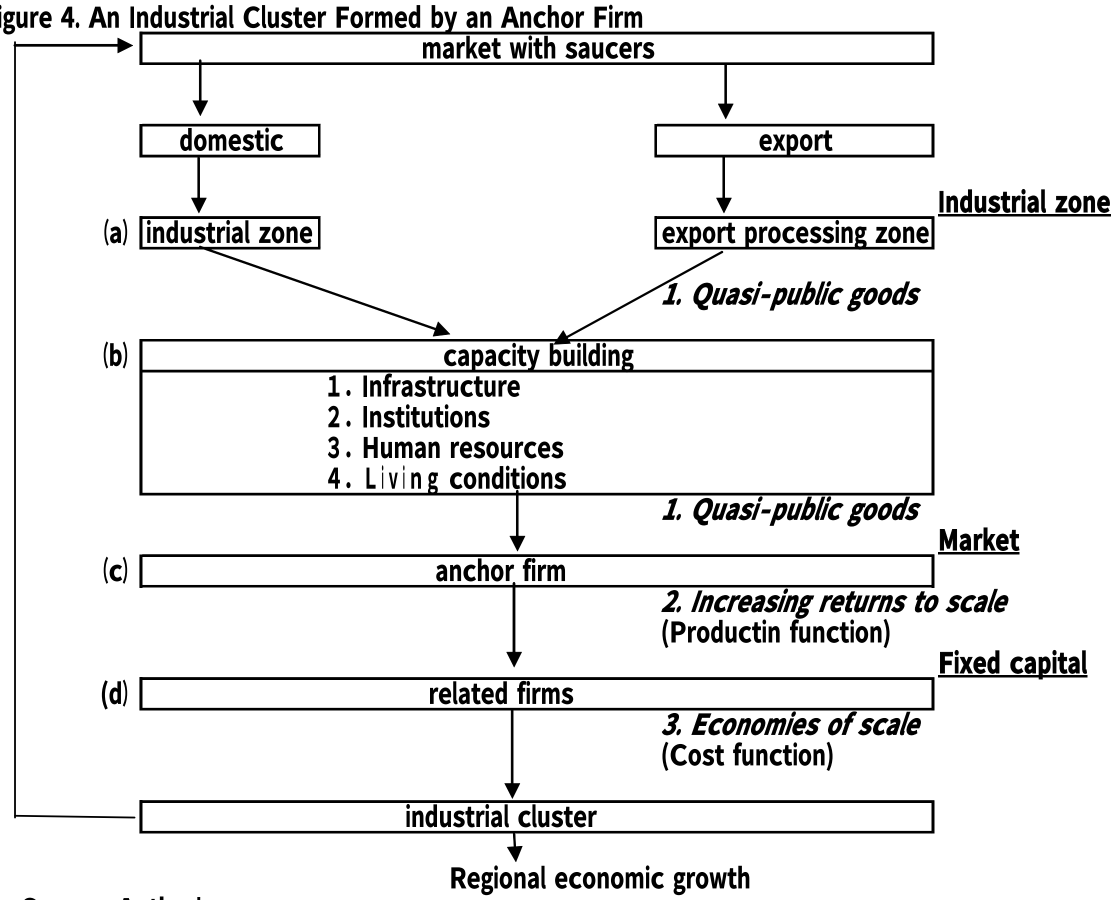
Company FT produces clutches, brakes and frames. Metal stamping, welding, painting and assembling are the processes of production. Maintenance of mold and three-dimensional measuring that guarantees the precision, are the key factors for their production. The minimum production level required to attain economies of scale is 100 thousands automobiles.

5. Conclusions and summary

This paper showed “a flowchart approach to industrial cluster policy” by proposing sufficient conditions of forming industrial clusters typical in the manufacturing industry in Asia and theoretically proving sufficiency of the conditions to enhance regional economic growth. We theorized the typical pattern of forming industrial clusters in East Asia by defining ‘quasi-public goods’, proved that the industrial cluster policy enhances economic growth under a production function of ‘increasing returns to scale’, and showed critical amounts of production of ‘scale economies’ for firms to decide to invest in clusters. Concepts of quasi-public goods, increasing returns to scale, and economies of scale are crucial to our proof. The sufficient conditions are to establish industrial zones, to build capacity, and to invite anchor firms together with their related firms. First, industrial zones and capacity such as physical infrastructure, institutions, and human resources as quasi-public goods are provided by both organizations in the quasi-public sector and firms in the private sector. Second, industrial cluster policy to provide industrial zones and capacity as quasi-public goods can enhance regional economic growth in cases that an anchor firm operates under increasing returns to scale. Markets for sales in China are at an early stage of development and large enough for anchor companies to attain increasing returns to scale. Third, the minimum optimal size of car production of economies of scale depends on the size of fixed capital of related companies of the anchor companies.

A flowchart approach to industrial cluster policy emphasizes the importance of ordering and timing of policy measures. The flow of policy implementation is to establish an industrial zone, to invite an anchor company, and to promote its related companies to invest in the industrial zone. Moreover, the recipient country’s government reduces its role to promote competition, thereby transferring greater authority to local governments and making more use of the quasi-public sector (public corporations and state enterprises). As a result, the quasi-public sector is likely to supply quasi-public goods (see Table 2). The improvement and expansion of network formation in Asia by both multinational corporations and the quasi-public sector are thus prerequisites to the upgrading of Asia's industrial structures.

Figure 4. An Industrial Cluster Formed by an Anchor Firm



Source: Author's.

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Appendix 1: Practical Considerations

There are some requests for decentralization. Some economists criticize the high degree of centralization on the governmental power. For example, let us show Friedman [4] and Sugioka (1976). Friedman (1962) indicates that national public goods often serve the benefit of a particular group, or result in an economic waste contrary to the intention of the central government. He says as follows:

"The preservation of freedom is the protective reason for limiting and decentralizing governmental power. But there is also a constructive reason. The great advances of civilization, whether in architecture or painting, in science or literature, or in industry or agriculture, have never come from centralized government." Sugioka (1976) advocates "Regionalism", which means that we should decentralize governmental power because it has centralized too much, is one of the most important topics in Japan.

However, it seems to have been seldom considered concretely what kinds of goods and services should be supplied by (1) local governmental units or (2) the sector which belongs to neither public nor private sector

We think that the importance of the sector has been increasing recently. In order to make clear the part of the sector, the concept of quasi-public optional goods will be useful. We define W, Y and T as quasi-public optional goods in terms of our above analysis. We will use the concept of quasi-public goods.

The sets M_b, which represent peoples' needs or the structures of their optionality, will be used below.

(1) The quasi-public goods which are locally demanded by most of the citizens in a city. That is, the sets M_b consist of the citizens (e.g. parks in the cities). From the point of equity, such goods had better be supplied by local governmental units.

(2)The cases: Organizations in the sector that belongs to neither public nor private sector supply quasi-public goods. The cases have recently become important, but do not seem to be analyzed sufficiently. Suppose that farmers in a country need many kinds of quasi-public goods. We cannot neglect the quasi-public optional goods. It is not appropriate for the local governmental unit to supply them because of inequality. In general private firms will not give priority to the quasi-public goods in terms of the profitability. For example, we can consider agricultural cooperatives as the economic units which supply quasi-public goods. The examples are as follows:

T: Establishment and management of water facilities

T: Wire broadcasting

T: Research on special products (e.g. flowers)

T: Information about markets

Y: Roads for agricultural use

The sector may well supply some kinds of quasi-public optional goods as "local private collective (production or consumption) goods”. Of course, further analysis on the sector will be needed to make clear roles of cooperatives.

Appendix 2

Individual Concern versus Collective Concern:

Millerton (1972) defined the characteristic. This is similar to Buchanan’s statement (1965): “The interesting cases are those goods and services, the consumption of which involves some “publicness”, where the optimal sharing group is more than one person or family but smaller than an infinitely large number. The range of “publicness” is finite.”

Appendix 3

Proof: Nonrivalness requires

$$0 \le t_f^i \le 1,$$

then

$$t_f^i T_f \le T_f.$$

We define

$$T_f^i = t_f^i T_f$$

The constraints of T will be

$$T_f^i \le T_f,$$

which are the same as those of W.

Appendix 4

Proof: When we interpret the constraints with respect to W and Y, we only consider the difference between w_b^i and y_d^i which are constant. If the possibilities are

$$\sum_i w_b^i > 1,$$

then the constraints correspond to W. If the following must hold

$$\sum_i w_b^i \le 1,$$

then to Y. Both of them are the same in process of calculation of the optimality conditions. We may only change the way of interpretation according to w_b^i. Similarly to the above statement, we can discuss the relationship between X and V. Therefore, attention is concentrated on V and W.

Applendix 5

Max U [$u^1(V;W^1;Z^1)$, ---, $u^s(V;W^s;Z^s)$] (1)

Subject to

F (V,W,Z)≤0 (2)

$W_b^i \leq w_b^i W_b$, b =1,---, k ,

i =1,----,s, (3)

$\sum_i Z_e^i \leq Z_e$, e=1, ---,n, (4)

V, W^i ,W, Z^i, Z ≥0 (5)

Let α, β_b^i , γ_e represent the multipliers associated with constraints (2), (3) and (4), respectively.

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