Location and Infrastructure Policies for Sustainable Economic Growth in Japan

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The International Centre for the Study of East Asian Development (ICSEAD)

Working Paper Series Vol. 2011-02
January 2011

The International Centre for the Study of East Asian Development, Kitakyushu

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Abstract

It is widely recognized in conventional location theory that regional development policies can be enhanced by localization or activity-complex economies. While such policies effectively work on the beginning of economic development, those are not sustainable in general. An attempt is made in this analysis to clarify missing elements of the long-run sustainable regional economic growth from the standpoint of central-place theory. An alternative model framework shows that a comprehensive policy adjustment needs to consider centripetal forces of populations in particular localities. This includes either well-organized accessibility to the core region or highly-advanced administrative and functional structures within the region. Furthermore, roles played by sustainable regional growth for the enhancement of the long-run national economy are also explored to reveal those linkages.

JEL Classification: D04; F23; L23; O18; R11; R58
Keywords: regional development; external economies; sustainability; social welfare

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* The preliminary version of this paper was presented at the 57th North American Meetings of Regional Science Association International at Denver in Colorado. The final version of the paper was completed under the ICSEAD research project 2010/2011.
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1 INTRODUCTION

A severe dependency on the central-place system can be observed in many developing and developed countries. Such concentration of economic activity in particular localities may cause various potential issues regarding the enhancement of regional income disparities at local regions as well as congestion and pollution at the core region. With respect to economic efficiency and equity, spatial dispersion policy has been considered in many developed countries including Japan. Since 1960s, the Japanese Government has launched several policy initiatives named the Comprehensive National Development Acts which aims to disperse spatial distribution of economic activity across the nation.

In location theory, these types of policy may work well together with localization or activity-complex economies. Localization economies were indicated by Marshall (1892) as the economy at particular localities, and further detailed by Parr (2002) as advantages to obtain opportunities for a pool of skilled labor, lower freight rates on input or output, specialized services, knowledge spillovers and closely limited information as well as sharing input acquisition, product marketing and research and development activity. While localization economies are internal to the firm and external to the industry, activity-complex economies are internal to the complexity and involve upstream or downstream linkages between different firms (Parr, 2002). Since these economies are spatially-constrained external economies, it is important to have opportunities for infrastructure development by local regions. Although regional infrastructural development has sufficiently been established in Japan, almost one third of population still locates in the core region which is called the capital region composed by Tokyo, Saitama, Chiba, Kanagawa, Ibaraki, Tochigi, Gunma and Yamanashi prefectures.

The main problem of the country is to face not only an expansion of regional income disparities but also an involvement of crucial international cost-reduction competition on a majority of industries. Since the accumulating higher price and cost structures are not possible to avoid in developed countries, a number of industries which have market areas within Japan are now shifting their plant locations abroad or changing supply areas from domestic to foreign intermediate producers.

In theoretical term, market-area analysis was systematically examined by Lösch (1944 [1954]) which how products are distributed to an economic plane. In addition, supply-area analysis was earlier explored by Lösch (1938) to investigate how inputs are collected to the processing plant. The recognition of a center was categorized into two types, namely, administrative and functional structures by Parr (2007;2008). The former structure is relevant to administrative services such as Edinburgh as the capital city of Scotland, whereas the latter structure is related to the financial center or the center of the market area represented as Glasgow. As will be shown in later sections of the paper, this framework becomes important to consider the spatial mechanism of regions as functions of a country. Within the framework of central-place theory, any empty space must be utilized and the presence of price allocates economic agent across the economic plane by hierarchical structures (Lösch, 1954[1944]:94-97). However, geographical attributes of Japan form irregular long and narrow spatial configurations, which generate insufficient network of transportation and communication. As a result, the hollowing-out problem for particular industries tends to be more serious and such disturbance for sustainable economic growth has to be readily solved in order to protect from further excessive international market competitions.

2 THE MODEL

The basic element of the model is composed in this section. For reasons of simplicity, assumptions are limited to the following conditions in this analysis. First, there is solely one final product q using a particular type of input x. Secondly, there are two countries, *H* and *L*, in the world. The country *H* has higher price and cost structures as a typical developed country, while the country *L* has lower advantageous on these elements. A producer in country *H* needs to set a unit production cost w_C, if the production is engaged at the core region, or w_R $\left(w_C > w_R\right)$ otherwise. If the production plant is located in country *L*, the unit production cost will be much lower level at w_L $\left(w_L < w_R\right)$. In addition, there is a technological losses during the production process by $1/k_L$ $(0 < k_L < 1)$ in country L and by $1/k_H$ $(0 < k_H < 1)$ in country H where $k_H > k_L$. This implies that the production is engaged more efficiently in country H. For instance, the former country can produce 200 high-performance vehicles per day, while the latter country can produce 200 standard vehicles per day. Thirdly, consumers need to pay the amount of product price which includes uniform shipping cost across the nation as σ $(\sigma > 0)$.

In addition, the producer has to bear certain amount of transportation costs t_D for interregional and t_I $(t_I < t_D)$ for international segments per unit between the plant location and the warehouse as well as between the warehouse and each retail store. Here, the former transportation is relevant to assembly transportation costs, while the latter type relates to distribution transportation costs. The warehouse is assumed to locate at the core region due to a given condition that the core region has high density of demand therefore high density of potential demand for selling the product can be expected. As a result, the domestic producer who locates processing plant at a local region needs to pay extra assembly transportation costs, given as $t_D(d_R - d_C)$ in comparison with the domestic producer who locates at the core region. These situations are illustrated in Fig. 1.

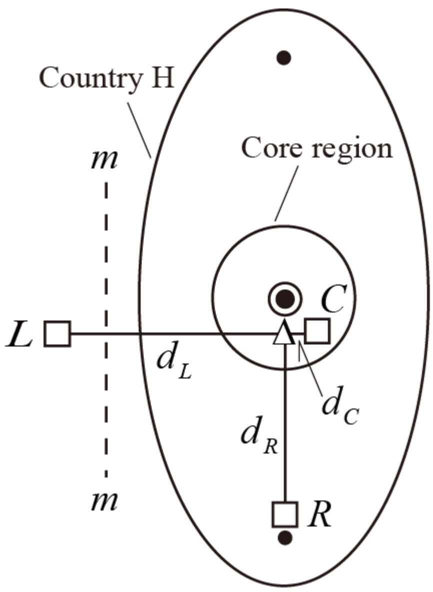

Fig. 1 The location decision-making under three different conditions

Factor costs for country *H* as C_H and for country *L* as C_L are shown as the following expressions.

$$C_H = [P \cdot (w_C + t_D d_C) + (1-P) \cdot (w_R + t_D d_R)] \cdot x \tag{1}$$

$$C_L = (w_L + m + t_I d_L) \cdot x \tag{2}$$

where an additional variable m = tariff for importing this product from the country *L* to *H*. Moreover, the country *H* has two types of location of production either at the core region or local region in equation (1).

$P = 1$ if the production is engages at the core region (Case 1)

$P = 0$ if the production is engaged at the local region (Case 2)

The total cost TC and the relevant marginal cost MC for each case can be expressed with the above stated technological losses k_i $(i = L, H)$ in addition to *Case 3* which the production is engaged in country *L*:

Case 1:

$$TC_C = (w_C + t_D d_C) \cdot k_H q \tag{3}$$

$$MC_C = \frac{\partial TC_H}{\partial q} = (w_C + t_D d_C) \cdot k_H \tag{4}$$

Case 2:

$$TC_R = (w_R + t_D d_R) \cdot k_H q \tag{5}$$

$$MC_R = \frac{\partial TC_R}{\partial q} = (w_R + t_D d_R) \cdot k_H \tag{6}$$

Case 3:

$$TC_L = (w_L + m + t_I d_L) \cdot k_L q \tag{7}$$

$$MC_L = \frac{\partial TC_L}{\partial q} = (w_L + m + t_I d_L) \cdot k_L . \tag{8}$$

As commonly assumed in conventional economic analysis, the revenue function is given with uniform shipping cost σ as:

$$AR = a - (b + \sigma) \cdot q . \tag{9}$$

where additional variables a and b are non-negative constant. In this analysis, a monopolistic market is considered which the optimal quantity of output is determined by a circumstance where marginal revenue equals marginal cost. From equation (9), the total revenue TR becomes:

$$TR = \left(a - [b + \sigma] \cdot q\right) \cdot q \ . \tag{10}$$

The marginal revenue MR can be derived from (10):

$$MR = \frac{\partial TR}{\partial q} = a - 2(b + \sigma) \cdot q \ . \tag{11}$$

The optimal quantity of output for each case will be:

(Case 1) $$q_C^* = \frac{a - k_H \left(w_C + t_D d_C\right)}{2(b + \sigma)} \tag{12}$$

(Case 2) $$q_R^* = \frac{a - k_H \left(w_R + t_D d_R\right)}{2(b + \sigma)} \tag{13}$$

(Case 3) $$q_L^* = \frac{a - k_L \left(w_L + m + t_I d_L\right)}{2(b + \sigma)} \tag{14}$$

where q_C^* q_R^* and q_L^* are the optimal quantity of output for the production at the core region, the local region in country *H* and at a location in country *L*.

3 A HYPOTHETICAL ANALYSIS

In this section, sustainable economic issues for a developed country will be considered. In addition to the assumptions given in the previous section, the following condition is provided.

$$t_D d_C < \left(t_I d_L + m\right) < t_D d_R \tag{15}$$

This condition describes that assembly transportation costs are the lowest among three different plant locations, if the producer locates at the core region (Case 1). Also, if he locates at the local region (Case 2), these costs are higher than the case 3 where the plant locates in country *L*. From the condition (15), the optimal quantity of output should be:

$$q_C^* > q_L^* > q_R^* \ . \tag{16}$$

This scenario implicates that a product is assembled at the core region of country *H* in order to achieve cost minimizing production.

Next, a consideration is given to consider the actual situation of typical developed countries. Here, the core region may have economically inefficient congestion in the long run due to a severe spatial concentration of the population and the economic activity. In other words, urbanization economies will increase the amount of w_C and the impact of a change in w_C on the optimal quantity of output at the core region can be expressed as:

$$\frac{\partial q_C^*}{\partial w_C} = -\frac{k_H}{2(b+\sigma)} < 0 . \qquad (17)$$

If the increasing level exceeds certain amount, the expression (16) is changed to the following order.

$$q_L^* > q_R^* > q_C^* \qquad (18)$$

The above result (18) shows that the production is alternatively engaged in country *L*. In this way, the combination of lower assembly transportation costs and tariff encourage more production to be held in foreign countries that may cause the hollowing-out problem with the domestic production for particular industries. As the above cost factors cannot be changed readily, it is necessary to examine alternative policy remedies.

From the standpoint of cost-minimization behavior by the producer, a reduction of either factor cost w_R or the interregional assembly transportation costs t_D can be altered to solve the hollowing-out issue for particular industries. These impacts of changes in the optimal output level at the local region will be shown as follows.

$$\frac{\partial q_R^*}{\partial w_R} = -\frac{k_H}{2(b+\sigma)} < 0 \qquad (19)$$

$$\frac{\partial q_R^*}{\partial t_D} = -\frac{k_H d_R}{2(b+\sigma)} < 0 \qquad (20)$$

Considering the above outcomes, it is clear that the impact is stronger by changes in interregional assembly transportation costs than the reduction in factor cost:

$$\left|\frac{\partial q_R^*}{\partial t_D}\right| > \left|\frac{\partial q_R^*}{\partial w_R}\right| . \qquad (21)$$

It is noted that the reduction of unit production cost can be occurred by the effects of pecuniary terms of external economies, and the reduction of interregional assembly transportation cost may be brought by the enhancement of the transportation network between the core and local regions. Finally, this policy objective is to achieve the following condition.

$$q_R^* > q_L^* > q_C^* \tag{22}$$

4 POLICY IMPLICATIONS

The previous sections clarify that the enhancement of local economy in a developed country may be provided either by a reduction of factor cost or by a reduction of interregional transportation costs together with centrifugal forces from the core region due to the expansion of urbanization diseconomies for the long-run perspective. Hitherto, there is a missing discussion regarding the warehouse location. If the density of demand in the core region disperses to local regions, the producer may establish warehouse branches at local regions. In such a case, product price for consumers can be reduced by declines of unit shipping cost as well as by the reduction of location cost of the warehouse at the core region in a single large scale. The reduction directly reflects a decline of the variable σ in the revenue function. As a result, the impact of its change on the optimal quantity of product which is processed at local region becomes:

$$\frac{\partial q_R^*}{\partial \sigma} = -\frac{a - k_H\left(w_R + t_D d_R\right)}{2(b+\sigma)^2} < 0\,. \tag{23}$$

In order to satisfy the above condition, the consumer market has to be dispersed from the core region. This also reduces the physical distance between the processing plant and warehouse location therefore the previous condition (22) can be attainable as shown in Fig. 2.

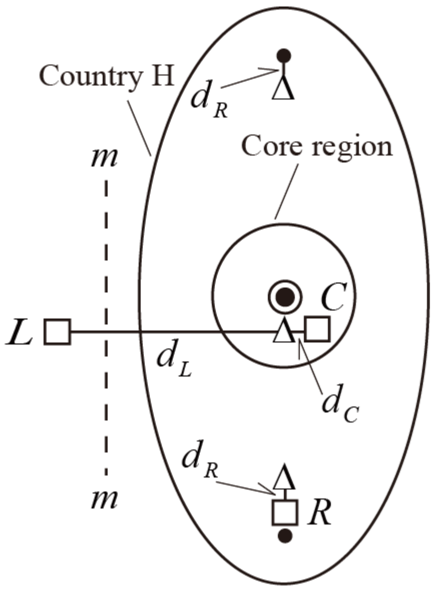

Fig. 2 The presence of branch warehouse in local regions

In other words, if the spatial concentration in the core region remains, the location dispersion of warehouse will cause higher price and cost structures. As a result, it is important for public policy to disperse the population distribution and the economic activity across the nation.

These positive effects would create more efficient localization and activity-complex economies, and those economies improve the technological losses during the production processes in addition to pecuniary cost-saving opportunities. The impact of change in technological losses on the optimal output level at the local region is:

$$\frac{\partial q_R^*}{\partial k_H} = -\frac{w_R + t_D d_R}{2b} < 0 . \qquad (24)$$

However, it should be noted that these cumulative causations are available only if the density of population in the local region is kept at a higher level. Even though location migration policy works properly in the short run, there is no guarantee to sustain a solid growth in the local region. The evidence is shown that the population ratio in the core region of Japan tends to increase at a constant rate as illustrated in Table 1, while urbanization diseconomies have certain impact of disutility both for producers and individuals.

Table 1. Population at the capital region in Japan (Source: The Official Statistics of Japan)

Year	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005
%	22.65	23.82	25.22	27.18	28.91	30.04	30.50	31.08	31.87	32.17	32.56	33.17

In order to disperse the density of demand in the core region, regional development in each local region may have important roles. For industrial activities, economic infrastructure such as localization and activity-complex economies would enhance these policies or the sufficient system of interregional transportation has to be developed. Also, the local region has to supply sufficient conditions of employment and infrastructure in social terms. The infrastructural development in social term includes highly-advanced medical, education, cultural and other household-related services. Since some certain services require much larger scale for operation than the scale of local population, it may have difficulty to provide entire services in each local region in general.

In such a case, the accessibility to the core region can be the effective policy remedy. However, as described earlier in this paper, the long and narrow geographical attributes may provide inefficient transportation system, in particular, the Northern and Southern parts of Japan. Besides this, the fundamental infrastructure development on transportation already established during the previous Comprehensive National Development Acts. As a result, additional interregional transportation development between the core and local regions would provide certain limited impacts for the national economy, and the development of local regions for self-sufficient systems can be more preferred strategy for the national policy in the long run.

5 AN EXTENSION

When social infrastructure development cannot be established in a local region due to insufficient density of demand, a cooperative behavior with neighbor regions may enable the policy to launch. This is relevant to the hierarchical system of economic space on the framework of central-place theory. For the urban system, there are two criteria, namely, the functional and administrative structures. Within this framework, Parr (2007;2008) found that market-area analysis in Lösch (1944 [1954]) directly refers to the functional structure. Another criterion, the administrative structure, can be related to urbanization economies where administrative accessibility, well-organized infrastructure, a variety of labor supply and highly-advanced system of transportation and communication are available. These advantages of urbanization economies should refer to Parr (2002). Since these economies are not available in a small scale of region, an integration of several neighboring regions may enable them to establish such particular structures. This may be closely related to the Administrative Reform Proposal in Japan.

Another perspective to consider the sustainability of the national economy in developed countries would be the strategy of product differentiation and entry deterrence. When cost and price competitions are not available due to structural problems, the value-added and intellectual production system can be the alternative economic behavior. For example, aero-space industries in Toulouse have spatial proximities to various upstream and downstream linked firms with highly qualified research laboratories and engineers in exclusively specialized environment as activity-complex economies. However, product differentiated products such as the German branded vehicles have location strategy to keep headquarter within the country, while assembly plants are dispersed across the world. These considerations should refer to Silva and Hewings (2007) which investigate the recent location decision-making of the American aero-space industry from the standpoint of principal-agent theory in Hart (1995).

While these advanced industrial location structure is useful for firms and establishments in many cases, it may not be suitable for Japanese economy with respect to sustainable economic growth and development. The main reason of this thought is that regional income disparities have never been declined due to the market access problem as demonstrated by López-Rodríguez and Nakamura (2010), although regional industrial infrastructure has developed enough in the past decades. This implies that the public policy should initially have a priority on the improvement of social welfare across the nation, while a question rises regarding the availability of financial sources to support the social-term development in local regions.

6 CONCLUDING COMMENTS

The main concern of this paper is to examine the method of sustainable regional development under the severe condition of core centripetal forces. It is revealed that the core concentration can be solved by the enhancement of regional economic development both in pecuniary and technological terms. Moreover, it is clarified that these incentives are not enough to sustain local populations. The solution of this sustainable issue is given to the sufficient supply of social infrastructure such as highly-advanced medical, educational and other household-related services and facilities. However, it is necessary to solve the question of financial availability for the social-welfare development in local regions until the level where they become self-sufficient regions.

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