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A Note on Location and Infrastructure Policies for Sustainable Economic Growth

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It is commonly recognized that rural economic development policies can be enhanced by localization or activity-complex economies. While such policies effectively work on the beginning, those are not sustainable as the national economic growth reaches at a mature stage. An attempt is made in this analysis to clarify missing elements of the long-run sustainable regional economic growth from the standpoint of industrial location analysis. An alternative model framework shows that a spatial policy adjustment needs to consider centripetal forces of populations in rural areas. This includes an establishment of either well-organized accessibility to the core area or self-sufficient regional economic system. Furthermore, roles played by sustainable rural economic growth for the enhancement of the long-run national economy are also explored to reveal these linkages.

1. Introduction

The economic space is generally not homogeneous across the plane. For instance, an area has severe population concentration, while another area does not engage any economic activity. In terms of economic activity, a severe dependency on the central-place system tends to be observed in many developed and developing countries. Here, the central place of the economic activity may be exemplified in Chicago, London and Tokyo as representative financial centers. Although there are various advantages to situate these locations for the entire economic agent, the severe spatial concentration may cause several potential problematic issues regarding the enhancement of interregional income disparities at rural areas as well as congestion and pollution within the core area. Under these circumstances, spatial dispersion policies have been considered in many countries. For the case of Japan, the central government has launched spatial policy initiatives named the Comprehensive National Development Acts since 1960s which aims to disperse spatial distribution of economic activity across the nation. The policy was successful and several rural areas achieved remarkable economic growth during that period.

In location theory, these types of policy may work well together with agglomeration economies. According to the categorization of Parr (2002), agglomeration economies in external terms can be divided into three parts; namely, localization economies, urbanization economies and activity-complex economies. Localization economies were initially indicated by Marshall (1892) as the economy at particular localities, and detailed further by Weber (1909 [1928]) in terms of the trade-off relationship between localization economies and transportation costs. Other elements of these economies are such as advantages to obtain opportunities for a pool of skilled labor, lower freight rates on input or output, specialized services, knowledge spillovers and information exchanges as well as sharing input acquisition, product marketing and research and development activity (Isard, 1956).

Urbanization economies were formally introduced by Hoover (1937), which have advantages of administrative accessibility, well-organized infrastructure, a variety of labor supply and highly-advanced system of transportation and communication network. Also, there are negative economies such as congestion, pollution and highly price of land when the area has a severe spatial concentration and are called urbanization diseconomies. Finally, Parr (2002) introduced the notion of activity-complex economies, which are internal to the complexity but external to the firm and involve upstream or downstream linkages between different firms. There, two types of complexity can be observed that the first relies on specialized firms at particular processing stages and the second relies on several specialized providers for the supply inputs for the final assembly. For instance, aero-space industries in Toulouse and the Ford Campus in Chicago are representative examples of activity-complex economies.

Since these economies are spatially-constrained external economies, it is important to have sufficient opportunities of infrastructure coordinated by public sectors. This can be exemplified in Japan and a minimum infrastructure element has already been well-established across the nation. However, almost one third of the total population still locates within the core area which is called the Capital Region composed by Tokyo, Saitama, Chiba, Kanagawa, Ibaraki, Tochigi, Gunma and Yamanashi prefectures. In many developed countries including Japan, one of biggest problems of the country is to face not only an expansion of interregional income disparities but also an involvement of severe international cost-reduction competition on various industries. Since structures of higher prices and costs are not avoidable 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 processes.

In theoretical terms, market-area analysis examines how final goods and services are distributed across the plane, while supply-area analysis explores how inputs are collected to the processing plant from the economic plane. The former analysis was systematically investigated by Lösch (1944 [1954]) and the latter was studied earlier by Lösch (1938). 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 and the latter structure is related to the financial center or the center of the market area. An example may be given to the case of Scotland where both centers are not identical. The capital city of Scotland is Edinburgh, the east-coast of the country, where the administrative structure is historically present. However, the financial structure may be more available in Glasgow, the west-coast of Scotland, where the city used to be the center of heavy industries and international trade in previous centuries. As will be shown in later sections of the paper, this framework becomes important to consider the spatial mechanism of regions.

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, the geographical configuration in many countries such as Japan form irregular long and narrow spatial attributes, which generate insufficient network of transportation and communication. Hence, the hollowing-out problem for particular industries tends to be more serious in these countries, and such disturbance for sustainable economic growth has to be solved in order to protect from further excessive international market competitions against rapidly growing developing countries.

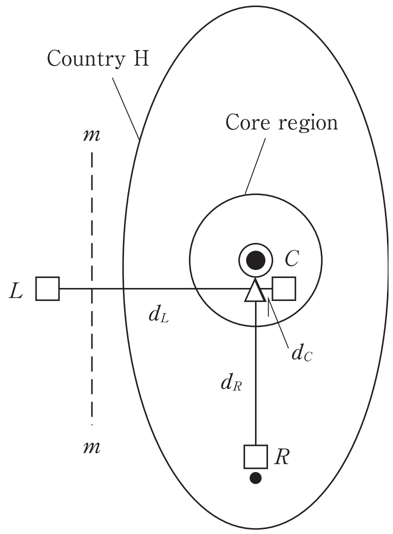
2. A location model

A 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 a producer processing solely one final product using a particular input. Here, the quantity of final product is represented by q ($q>0$) and the amount of input is expressed by x ($x>0$). The relationship between q and x can be stated by $q=f(x)$ as a typical production function which will be detailed later. Secondly, there are two countries, H and L, in the world. The country H has structures of higher prices and costs as a common developed country, while the country L is a developing country which has sufficient labor supply with lower wages than country H. The producer in country H needs to set a unit production cost c_C ($c_C>0$), if the production is engaged at the core area, or c_R ($c_R>0$) at rural areas ($c_C>c_R$). If the production plant is located in country L, the unit production cost will be much lower level at c_L ($c_L>0$) than the cost in country H ($c_L<c_R$).

In addition, there are technological efficiencies during the production processes which is related to the structure of production function and represented 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 units of high-performance vehicles per day, while the latter country can produce 200 units of standard vehicles per day. It is also assumed that consumers need to pay the amount of product price which includes unit shipping cost across the nation, represented by σ ($\sigma>0$).

There is another element of transportation costs. The producer has to bear certain amount of transportation costs t_D for interregional and t_I ($t_I<t_D$) for the cross-border segments per unit between the plant location and the facility location as well as between the facility location and each distribution center of the final good. Here, the former type is relevant to assembly transportation costs, while the latter type relates to distribution transportation costs. The facility location is assumed to situate at the core area under a given condition that the core area has a high density of demand, which brings more sales revenue than other areas. As a result, the domestic producer who locates processing plant at the rural area needs to pay extra assembly transportation costs, given by $t_D\cdot(d_R-d_C)$ as an absolute comparison with the domestic producer who locates at the core area. These situations are illustrated in Figure 2-1 where the square point represents the processing plant, the triangular point shows the facility location and d_i ($i=C,R,L$) is the distance to the facility location from each processing plant C, R or L.

Figure 2-1 The location decision-making of the firm



Factor costs for country H represented by C_H and for country L stated by C_L are formally descripted as the following expressions.

$$C_H=[\delta\cdot(c_C+t_Dd_C)+(1-\delta)\cdot(c_R+t_Dd_R)]\cdot x \tag{2.1}$$

$$C_L=(c_L+m+t_Id_L)\cdot x \tag{2.2}$$

where an additional variable m ($m>0$)=tariff for importing this particular product from country L to H. Moreover, country H has two types of location of production either at the core area or rural area in equation (2.1).

$\delta=1$ if the production is engaged at the core area (Case 1)

$\delta=0$ if the production is engaged at the rural area (Case 2)

The total cost TC and the relevant marginal cost MC for each case can be expressed with the above stated technological efficiencies $1/k_i$ ($i=L,H$) in addition to Case 3 which the production is engaged in country L:

Case 1:

$$TC_C=(c_C+t_Dd_C)\cdot k_Hq \tag{2.3}$$

$$MC_C=\frac{\partial TC_H}{\partial q}=(c_C+t_Dd_C)\cdot k_H \tag{2.4}$$

Case 2:

$$TC_R=(c_R+t_Dd_R)\cdot k_Hq \tag{2.5}$$

$$MC_R=\frac{\partial TC_R}{\partial q}=(c_R+t_Dd_R)\cdot k_H \tag{2.6}$$

Case 3:

$$TC_L=(c_L+m+t_Id_L)\cdot k_Lq \tag{2.7}$$

$$MC_L=\frac{\partial TC_L}{\partial q}=(c_L+m+t_Id_L)\cdot k_L. \tag{2.8}$$

As commonly assumed in conventional economic analysis, the revenue function is given as follows in terms of price p ($p>0$) with uniform shipping cost σ in this case.

$$p=a-(b+\sigma)\cdot q \tag{2.9}$$

where additional variables a and b are non-negative constant, which partly specify the shape of the demand curve. 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 (2.9), the total revenue TR becomes:

$$TR=(a-[b+\sigma]\cdot q)\cdot q. \tag{2.10}$$

The marginal revenue MR can be derived from (2.10).

$$MR=\frac{\partial TR}{\partial q}=a-2(b+\sigma)\cdot q \tag{2.11}$$

The optimal quantity of output for each case will be given as follows.

(Case 1) $$q_C^*=\frac{a-k_H(c_C+t_Dd_C)}{2(b+\sigma)} \tag{2.12}$$

(Case 2) $$q_R^*=\frac{a-k_H(c_R+t_Dd_R)}{2(b+\sigma)} \tag{2.13}$$

(Case 3) $$q_L^*=\frac{a-k_L(c_L+m+t_Id_L)}{2(b+\sigma)} \tag{2.14}$$

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

3. Hypothetical analysis

In this section, an issue on the sustainable economic growth for a developed country will be considered by hypothetical scenarios. In addition to assumptions given in the previous section, the following condition is provided.

$$t_Dd_C<(t_Id_L+m)<t_Dd_R \tag{3.1}$$

The above condition describes that assembly transportation costs are the lowest among three different plant locations, if the producer locates at the core area (Case 1). Also, if he locates at the rural area (Case 2), these costs are higher than the Case 3 where the plant locates in country L. From the condition (3.1), the optimal quantity of output should be:

$$q_C^*>q_L^*>q_R^*. \tag{3.2}$$

This scenario implies that a product is assembled at the core area of country H in order to achieve cost minimizing production. It is also assumed that country L locates nearby country H so that the condition $q_L^*>q_R^*$ sustains.

Next, a concern is given to the actual situation of typical developed countries in the long run. Here, the core area may have economically inefficient congestion due to a severe spatial concentration of population as well as economic activities. This can be referred to urbanization diseconomies on negative terms of agglomeration economies. Urbanization diseconomies will increase the amount of c_C and the impact of a change in c_C on the optimal quantity of output at the core area can be expressed as:

$$\frac{\partial q_C^*}{\partial c_C}=-\frac{k_H}{2(b+\sigma)}<0. \tag{3.3}$$

If the increasing level exceeds certain amount, the expression (3.2) is changed to the following order in the long run.

$$q_L^* > q_R^* > q_C^* \tag{3.4}$$

The above representation (3.4) shows that the production is alternatively engaged in country L.

In this way, the combination of low levels of cross-border assembly transportation costs t_I, distance d_I and tariff m encourage more production to be held in foreign countries that cause the hollowing-out problem for the domestic production on particular industries. While such strategy may enable the firm to minimize their total costs for processes, the situation may not be ideal from the standpoint of disappearance of domestic industrial activities. Since the above cost structures cannot be changed readily, it is necessary to examine an alternative policy remedy for domestic industries. Regarding the cost-minimization behavior by the producer, a reduction of either factor cost c_R at the rural area or the interregional assembly transportation costs t_D can be altered to solve the problem. These impacts of changes in the optimal output level at the rural area may be shown as follows.

$$\frac{\partial q_R^*}{\partial c_R} = -\frac{k_H}{2(b+\sigma)} < 0 \tag{3.5}$$

$$\frac{\partial q_R^*}{\partial t_D} = -\frac{k_H d_R}{2(b+\sigma)} < 0 \tag{3.6}$$

Considering the above observations, it is clear that the impact is stronger by changes in interregional assembly transportation costs than the reduction in factor cost c_R. Due to presence of d_R in (3.6),

$$\left|\frac{\partial q_R^*}{\partial t_D}\right| > \left|\frac{\partial q_R^*}{\partial c_R}\right| \tag{3.7}$$

There, the reduction of unit production cost c_R can occur as a result of pecuniary terms of external economies. In addition, the reduction of interregional assembly transportation cost t_D may be brought by an enhancement of the transportation network between the core and rural areas. Finally, this specific policy objective should be to achieve at least the following condition.

$$q_R^* > q_L^* > q_C^* \tag{3.8}$$

4. Policy implications

In previous sections, it has been clarified that an enhancement of local economy in the developed country may be provided either by a reduction of factor cost or by a reduction of interregional transportation costs together with the centrifugal force of the economic activity