Footloose Capital and Locational Advantage of a Hub

Kikuchi, Toru

Kobe University

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of a Hub

Toru Kikuchi[*][†]

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Abstract

The purpose of this study is to illustrate, with a simple three-region (located on a line), two-good (homogeneous good/differentiated high-tech products), two-factor (labor/"footloose" capital) model, how falling transport costs can affect firms' location decisions and trade structure.

It is shown that the locational advantage of a central hub is magnified via firms' location decisions.

1   Introduction

In recent decades competing new economic geography theories have suggested that deeper economic integration might serve to change industry structure among regions (or countries).[1] For the sake of mathematical tractability, however, geographical space in these studies is symmetric (e.g, two-symmetric regions or many symmetric regions located on a circle). Contrary to that, the role of an "entrepôt," which is a hub area that imports a good from a neighbor and re-exports at least part of the same good to another, gained the attention of economists (e.g., Feenstra and Hanson, 2004; and Endoh, Hamada and Shimomura, 2008). Also, it is increasingly recognized that some locational advantages of a hub due to the *asymmetric* location of regions or countries play a crucial role in such trade flows. This seems to suggest that the traditional focus on symmetric locational settings should be accompanied by a focus on asymmetric settings.

In a recent influential contribution involving the asymmetric location of regions, Ago, Isono and Tabuchi (2006) analyzed the impacts of falling transport costs on the spatial distribution of economic activities by comparing two representative models of economic geography (i.e., Krugman, 1991, 1993; and Ottaviano, Tabuchi and Thisse, 2002). By considering a network economy

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[1]See, for example, Fujita, Krugman and Venbles (1999) and Baldwin *et al.* (2003).

consisting of three regions on a line, they show that firms in an increasing returns sector will tend to locate in the central region in the Krugman model, while firms tend to move away from the center in the Ottaviano-Tabuchi-Thisse model.[2] Note that some of their results depend on the manufacturing workers' mobility among regions: since immigrant workers spend their income locally, demand-linked circular causality emerges.

However, in a global environment, it is often observed that higher transaction costs hinder workers from cross-border movement. Instead, "footloose capital" often moves from one country to other. According to these observations, the present study focuses on the role of footloose capital (hereafter FC) in determining the spatial distribution of economic activities in asymmetric locations. The purpose of this study is to illustrate, with a simple three-region (located on a line), two-good (homogeneous good/differentiated high-tech products), two-factor (labor/"footloose" capital) model, how falling transport costs can affect firms' location decisions and the nature of the trading equilibrium.

There are two major advantages for this formulation of FC. First, since the FC model does not rely on worker migration, it is plausible to interpret the three regions as separate nations, which is more suitable for the analysis

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[2]They concluded that the sharp contrats between the two models are ascribed to the difference in the degree of price competition.

of international trade and capital flows. The second reason is a technical one: the Krugman model is not analytically solvable due to its high nonlinearity (simulations are needed to obtain satisfactory results).[3] In contrast, by using the FC model, one can obtain the closed forms of variables.

Section 2 presents the model. Section 3 analyzes the impacts of falling transport costs on industrial location.

2 The Model

Let us consider a network economy consisting of three regions (or countries) $r = 1, 2, 3$, each with two factors (capital, K, and labor, L) and two types of goods (a homogeneous good and a large variety of differentiated high-tech products). Each region is endowed with K units of capital and L units of labor. Assume that the regions are identical in regard to tastes, size, and technology, but differ with respect to location. They are evenly distributed along a line such that Region 2 is the central region and the distance between Region 1 and Region 2 is equal to that between Region 2 and Region 3.

Consumers have Cobb-Douglas preferences over both categories and spend fraction μ of their income on high-tech products. The "iceberg" type of transport technology is assumed: if t $(t > 1)$ units of high-tech product are shipped

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[3]See Krugman (1991, 1993) and Ago, Isono, and Tabuchi (2006).

from one region to the next region, only one unit arrives. Therefore, if it is shipped from Region 3 to Region 1, t^2 units must be shipped in order for one unit to be received. Region 1's price index for high-tech products is represented by the Dixit-Stiglitz form:

$$P_1 = \left[n_1(p_1)^{1-\sigma} + n_2(tp_2)^{1-\sigma} + n_3(t^2p_3)^{1-\sigma} \right]^{1/(1-\sigma)}, \quad \sigma > 1 \qquad (1)$$

where σ is the degree of substitution between every products, p_r is the producer price for high-tech products produced in Region r, and n_r is the number of varieties produced in Region r, respectively.[4]

The demands of consumers in Region 1 for a Region 1 (c_{11}) variety, a Region 2 (c_{12}) variety, and a Region 3 (c_{13}) variety are respectively

$$c_{11} = p_1^{-\sigma} P_1^{\sigma-1} \mu E_1, \qquad (2)$$

$$c_{12} = (tp_2)^{-\sigma} P_1^{\sigma-1} \mu E_1, \qquad (3)$$

$$c_{13} = (t^2p_3)^{-\sigma} P_1^{\sigma-1} \mu E_1, \qquad (4)$$

where E_1 is the total income of Region 1.

The homogeneous good is produced under Walrasian conditions (constant returns and perfect competition) using only labor as an input. Units are chosen so that one unit of labor produces one unit of output. As usual in new geography models, no transport costs exist for the homogeneous good,

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[4]Price indices in other regions (P_2 and P_3) are defined in a similar way.

which serves to tie down the wage rate. Also assume that the parameters of the model are such that all countries produce the homogeneous good; thus, constant, identical wages for labor hold (hereafter set to unity).

The production of each variety of high-tech product requires one unit of capital and β units of labor per unit of output. As in Martin and Rogers (1995) and Martin and Ottaviano (1999), one of the central assumptions is that the capital is "footloose": although it is firm-specific, it moves freely between regions. Then, if a variety developed by Region 1 capital is produced in Region 2 (or Region 3), the operating profits are repatriated to Region-1. Given a Dixit-Stiglitz specification with constant elasticity σ, each firm sets its price as $p_1 = p_2 = p_3 = (\beta\sigma)/(\sigma - 1)$. By choice of units, one can set $\beta = (\sigma - 1)/\sigma$ to have

$$p_1 = p_2 = p_3 = 1. \tag{5}$$

Given that one unit of capital is required to develop a variety, the payment for each unit of capital employed in Region i, π_i, must satisfy,

$$\pi_i = p_i x_i - \beta x_i = x_i/\sigma, \tag{6}$$

where x_i is the output of a representative firm in Region i. When capital mobility is unrestricted, the payment for capital will be equalized between regions, which implies that $\pi_1 = \pi_2 = \pi_3$ and thus

$$x_1 = x_2 = x_3. \tag{7}$$

3 Trade Liberalization and the Locational Advantage of a Hub

Now consider the firms' location decisions. The product market equilibrium in Region 1 requires that supply equal demand for each variety: $x_1 = c_{11} + tc_{12} + t^2 c_{13}$. Similarly, product market equilibrium conditions for Region 2 and Region 3 are $x_2 = tc_{21} + c_{22} + tc_{23}$ and $x_3 = t^2 c_{31} + tc_{32} + c_{33}$, respectively. Substituting (2), (3), (4), and corresponding conditions into these conditions and setting $\mu E_i = \mu(rK + L) = 1$ yields the following equilibrium conditions:

$$x_1 = \frac{1}{n_1 + \tau n_2 + \tau^2 n_3} + \frac{\tau}{\tau n_1 + n_2 + \tau n_3} + \frac{\tau^2}{\tau^2 n_1 + \tau n_2 + n_3}, \quad (8)$$

$$x_2 = \frac{\tau}{n_1 + \tau n_2 + \tau^2 n_3} + \frac{1}{\tau n_1 + n_2 + \tau n_3} + \frac{\tau}{\tau^2 n_1 + \tau n_2 + n_3}, \quad (9)$$

$$x_3 = \frac{\tau^2}{n_1 + \tau n_2 + \tau^2 n_3} + \frac{\tau}{\tau n_1 + n_2 + \tau n_3} + \frac{1}{\tau^2 n_1 + \tau n_2 + n_3}, \quad (10)$$

where $\tau \equiv t^{1-\sigma}$ ($\tau \leq 1$) measures the freeness of trade. Falling transport costs are represed by an increase in τ.

Using (7), (8), (9) and (10), the equilibrium number of Region 1 firms can be obtained:[5]

$$n_1 = \frac{(1 - 2\tau)}{3(1 - \tau)^2}(n_1 + n_2 + n_3), \quad (11)$$

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[5]Note that n_3 can be obtained in a similar way. Since the total number of varieties in the world is fixed, n_2 can also be obtained.

$$\begin{aligned}
\frac{dn_1}{d\tau} &= -\frac{2\tau}{3(1-\tau)^3}(n_1 + n_2 + n_3) < 0, \\
\frac{d^2 n_1}{d\tau^2} &= -\frac{2(1+2\tau)}{3(1-\tau)^4}(n_1 + n_2 + n_3) < 0.
\end{aligned}$$

I would like to emphasize that the major advantage of FC modeling is to obtain a closed form solution, which makes the role of a hub much easier to understand. Equation (11) conveys the important impact of trade liberalization in a setting with asymmetric location.

Proposition 1: *As trade in goods is liberalized, the center attracts capital from the periphery.*

Figure 1 illustrates the implications of this proposition. The horizontal axis shows the level of freeness of trade (τ) and the vertical axis shows the equilibrium number of varieties in each region (n_r). The central region's share in the production of high-tech products increases continuously from full dispersion to full agglomeration.[6] As each region is endowed with an equal amount of capital, the bold arrows show the capital outflow from the periphery $(K - n_1, K - n_3)$: capital outflows from the periphery increase as goods trade is liberalized.

Now let us turn to the welfare aspect of trade liberalization. In the present model, only price changes affect utility is the one with the price

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[6]Note that full agglomeration occurs when $\tau = 1/2$.

index: a larger reduction in the price index implies larger gains from trade. By simple calculations, the following condition can be obtained:

$$\frac{dP_2}{d\tau} < \frac{dP_1}{d\tau} = \frac{dP_3}{d\tau} < 0. \tag{12}$$

While each region gains from trade liberalization, gains in the center are amplified the most in an asymmetric setting, which is the source of the locational advantage of a hub.

Proposition 2: *Capital outflow from the periphery to the center becomes a source of unequal trade gains among regions.*

In a world with footloose capital, the center region attracts capital from the periphery due to lower transport costs, which becomes a source of an unequal distribution of trade gains. Although trade liberalization reduces import transaction costs, it also induces capital outflow from the peripheral regions and may raise total transaction costs in such regions. The possibility of capital outflow provides some theoretical grounds for unequal incentives for regional economic integration. Further research should focus on these policy implications.

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