Transport Market Structure Effect on Economic Geography

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1 Introduction

Majority of the world's population and economic activities are distinctly concentrated in a limited number of areas. Among numerous studies devoted to explaining this phenomenon, the simple model developed by Krugman (1991) is the first and most successful attempt to clarify the microeconomic underpinning of the spatial economic agglomeration in a fullfledged general equilibrium approach. This study paved the way for development of "new economic geography" (NEG), that has become a fast-growing field. During the last two decades, various extensions of the NEG model have been performed, and notably, the NEG framework has been applied to various policy issues, such as trade policy, taxation, or regional redistribution (Baldwin et al., 2003).

These studies showed that the changes in transport costs have a critical impact on the distribution of industry. However, most of the theoretical research in NEG creates restrictive assumptions about transportation: the level of unit transport costs is exogenously given, which means that the market for transport services is assumed to be either perfectly competitive or fully regulated by fixed freight rates. Neither of these two extreme interpretations provides reasonable approximations of real-world transportation.

In addition, the empirical evidence provided by Combes and Lafourcade (2005) suggests that market structure in the transport sector is an important factor in determining freight rates. In the same vein, the deregulation of the transport sector has abolished many entry barriers, which led to an increase in the number of carriers. These changes in market structure are bound to affect freight rates and carriers' costs for providing transport services (Behrens et al., 2009).

Behrens et al. (2009) provide the NEG model that can describe the market structure of the transport sector; examine how the number of carriers operating in the market changes the spatial distribution of industry; and show how deregulation in an imperfectly competitive transport sector maps into welfare changes. They assume, however, that freight rates are symmetric irrespective of the shipping direction, while it is frequently observed that they depend on the direction of the shipments.

In this paper, we extend an economic geography model developed by Thisse (2010) in order to incorporate the transport sector and to represent asymmetric freight rates. We then investigate the impact of the transport market structure on the distribution of industry.

2 The Model

2.1 Basic Assumptions

The economy is composed of two regions (labeled by $0, 1$), two factors of production (skilled and unskilled labor), and three sectors (agriculture A, manufacture M, and transport T). There is a continuum of individuals with mass $H + L$, comprising H skilled and L unskilled workers. Each individual (worker) consumes A- and M-sector goods, and supplies one unit of this type of labor inelastically. The skilled workers are assumed to be able to move freely between the two regions, and we let h_i be the number of skilled workers living in region i. On the other hand, the unskilled workers are immobile and equally distributed across regions (i.e., the number of unskilled workers in each region is $L/2$).[1]

Preferences U over the A- and M-sector goods are identical across individuals.

[1] In this study, we do not focus on asymmetric locations, since the symmetric assumption allows us to reveal essential properties of the model. Note that this concept has been recognized as a powerful tool that helps to clarify the intrinsic properties of many phenomena in a variety of fields such as physics, engineering, and applied mathematics.

The utility of every individual in region i is given by

$$U(M_i, A_i) = \left(1 - \frac{M_i}{2}\right) M_i + A_i, \tag{2.1}$$

where M_i and A_i are the consumption of the A- and M-sector products, respectively, in region i. Each individual maximizes the utility under the budget constraint:

$$p_i M_i + p_i^{\mathrm{A}} A_i = Y_i, \tag{2.2}$$

where p_i is the price of the M-sector goods in region i, p_i^{A} is the price of the A-sector goods, and Y_i is the wage of the workers.

The A-sector is perfectly competitive and it produces homogeneous goods under constant returns to scale technology that requires one unit of unskilled labor in order to produce one unit of output. For simplicity, we assume that A-sector goods are transported freely between the two regions and are chosen as the numéraire.[2] In consequence of these assumptions, the wage of unskilled workers and the price of the A-sector goods in all regions are equal to one.

The M-sector consists of m_i firms in region i producing homogeneous goods under imperfect (Cournot) competition and increasing returns. A firm incurs a fixed input requirement of one unit of skilled labor in order to enter the market and produce the output. Market clearing for the skilled labor implies that $h_i = m_i$. We assume that shipping the output is costly. Particularly, firms have to pay a freight rate t_{ij} per unit of the output shipped from region i to $j(\neq i)$. An M-sector firm located in region i chooses quantities $\{q_{ii}, q_{ij}\}$ to be sold in region i and j to maximize profit

$$\pi_i = p_i(q_{ii}, q_{ji})q_{ii} + \{p_j(q_{jj}, q_{ij}) - t_{ij}\}\, q_{ij} - w_i, \quad (i \neq j) \tag{2.3}$$

where $p_i(q_{ii}, q_{ji})$ is the inverse demand for the M-sector goods and w_i is the wage of the skilled workers.

The T-sector is described by a number c of carriers that engage in Cournot competition, and non-cooperatively supply homogeneous transport services from region i to j. We consider both the case where c is fixed (i.e., carriers' entry is regulated) and where c is determined by the carriers' zero-profit conditions (i.e., carriers' entry is free). All carriers have access to the same technology which requires $f \geq 0$ units of unskilled labor to enter the market and $\tau > 0$ units of unskilled labor

[2]For the case that shipping the A-sector goods is costly, see, e.g., Fujita et al. (1999) and Picard and Zeng (2005).

to ship one unit of the M-sector goods between the two regions. Letting Q_{ij}^k be the volume of the M-sector goods shipped from i to j by carrier $k = 1, 2, \cdots, c$ and $Q_{ij} = \sum_k Q_{ij}^k$, the profit function of carrier k is given by

$$\Pi_{ij}^k = \{t_{ij}(Q_{ij}) - \tau\} Q_{ij}^k - f \tag{2.4}$$

where $t_{ij}(Q_{ij})$ is the inverse demand for the transport service. The equilibrium market freight rate $t_{ij}(Q_{ij})$ is determined, as in standard Cournot oligopoly, by the Nash equilibrium among the carriers.

3 Short-run Equilibrium and Long-run Equilibrium

In the short run, skilled workers cannot move between the two regions, individuals maximize their utility, firms and carriers maximize their profits, and all markets clear. Therefore, short-run equilibrium conditions consist of M-sector goods, T-sector services, and the skilled labor market clearing conditions and the zero-profit conditions for the M-sector firms and the T-sector carriers. These conditions lead to the indirect utility $v_i(\boldsymbol{h})$ of the skilled worker in region i and the freight rate $t_{ij}(\boldsymbol{h})$ as the function of spatial distribution $\boldsymbol{h} \equiv [h_0, h_1]^\top$ of skilled workers. From this, it is shown that the freight rate t_{ij} is a decreasing (resp., increasing) function of Q_{ij} in the case that carriers' entry is free (resp., regulated). and represented as an explicit function of $\boldsymbol{h}$:

In the long run, the skilled workers are inter-regionally mobile and choose the region that provides the highest indirect utility $v_i(\boldsymbol{h})$. Long-run equilibrium arises when no worker may get a higher utility level by moving to another region. It is well known that the NEG model usually predicts the existence of multiple equilibria: "dispersion" ($h_0 = h_1$) and "agglomeration" ($h_0 < h_1$ or $h_0 < h_1$). Therefore, we assess the local stability of long-run equilibria by assuming the following dynamics of the migration of skilled workers:

$$\dot{h}_i = h_i(v_i(\boldsymbol{h}) - \bar{v}(\boldsymbol{h})), \tag{3.1}$$

$$\bar{v}(\boldsymbol{h}) = \frac{1}{H} \sum_k h_k v_k(\boldsymbol{h}) \tag{3.2}$$

This adjustment dynamics is the replicator dynamics, which are routinely used in

NEG models.

4 The Transport Sector and Spatial Agglomeration

We investigate the equilibrium distribution of skilled workers and its stability condition on the parameters c, f and τ. The result is shown in Fig.1 in which the slashed area indicates that the agglomeration is stable while the white area indicates that dispersion is stable.

Provided that carriers' entry is free, the relationship between the stable equilibrium and the parameters f and τ is illustrated in Fig.1-a. As shown in this figure, falling fixed f and/or marginal costs τ lead to agglomeration, since the falling these costs intensify price competition among carriers and decrease the freight rates. This result is consistent with that of the conventional NEG literature.

If the entry regulation in the T-sector exists, an increasing number c of carriers (i.e., price competition) also leads to agglomeration as illustrated in Fig.1-b. By contrast, the falling marginal cost τ do not necessarily lead to agglomeration. Specifically, when $c = 2$, the agglomeration collapses in the course of decreasing τ. Because the agglomeration in region i and/or increases in the demand for the transport service from region i to j increase market power of carriers shipping from region i to j and allows them to charge higher rates. It is worth pointing out that such a result never arises in the NEG literature.

These results suggest that the effect of transport improvements (e.g., infrastructure improvements) on the spatial distribution of economic activities deeply depends on the transport market structure. Specifically, the entry deregulation of the transport sector fosters industrial agglomeration, thereby exacerbating spatial inequality. In contrast, the entry regulation can inhibit agglomeration of industries.

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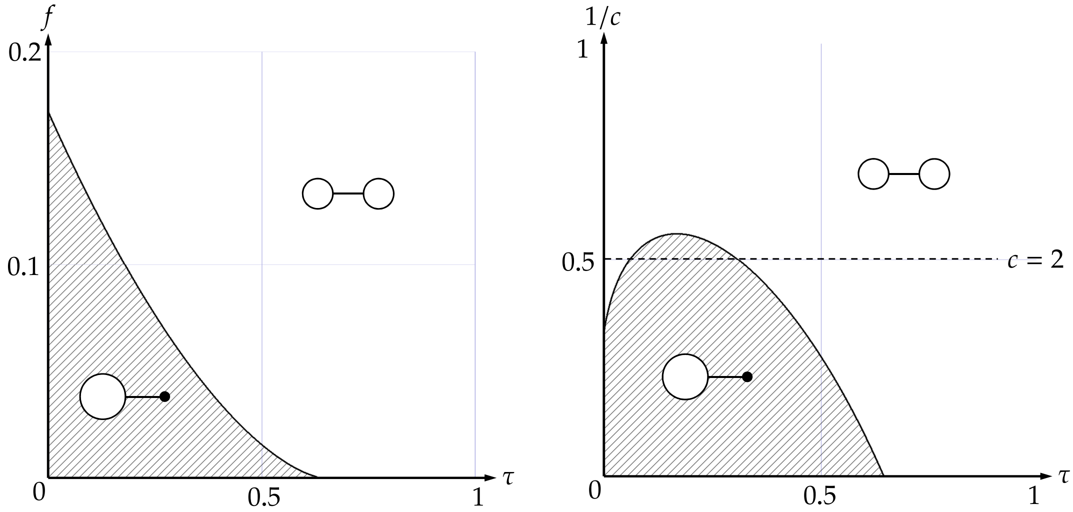

Figure 1-a: free entry

Figure 1-b: entry regulation

Figure 1: Spatial configurations of the skilled workers

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