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The role of country size in spatial economics: A survey of the home market effects*

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Abstract

This paper surveys the growing literature on the home market effects (HMEs) in spatial economics. The HMEs are utilized to disclose the role of country size in the configuration of economic activity. Various HMEs display distinctive features of size advantage and they are originally obtained from different models. Recent studies find that these features are closely related to each other. The following questions are answered. Are these HMEs equivalent under some conditions? Are some of the properties more general than others? Why do the theoretical studies and empirical studies obtain inconsistent results?

Key words: *agglomeration, home market effects, new trade theory, trade pattern, trade integration*

JEL classification: *F12, F63, R12*

1. Introduction

Trade integration is promoted by numerous high-level Economic Partnership Agreements, Free Trade Agreement networks, and the modern transport and telecommunications technology. In this new era, policy makers have intense and persistent interest in finding efficient policies for enhancing local economies. Spatial economics has been developed to clarify the geographic location of economic activity and disclose trade patterns that occur when economies are integrated. It has become an increasingly useful tool for policy makers of governments. Some of them are presented in Baldwin et al. (2003).

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The manufacturing sector is a major concern of spatial economics. This sector refers to industries engaged in the chemical, mechanical, or physical transformation of materials, substances, etc. All are important ingredients of a modern economy. Firm location evidently depends on natural advantages such as resources, local amenities, and geographical convenience. These are known as *the first nature*, and have been thoroughly explored in the neoclassical world with homogeneous goods and perfectly competitive product markets. They are major topics of traditional regional/international economics and trade theory.[2] Except for the first nature, New Economic Geography (NEG) and New Trade Theory (NTT) find that firms may locate according to an advantage stemming from the presence of other firms, which is called *the second nature*. Three important features of the modern economy—monopolistic competition, increasing returns to scale (IRS), and transport/trade costs–form an economic mechanism that leads to economic agglomeration and results in intra-industry trade.

While NEG mainly illustrates how small temporary shocks can have large permanent effects on the location of economic activity (Krugman, 1991; Fujita et al., 1999), a great concern of NTT is to clarify the effect of size on economic agglomeration and trade patterns. Consider an economic space of two countries, which are homogeneous except for their sizes. In a case of perfect competition and constant returns to scale (CRS), economic activity is distributed evenly in the two countries: firm shares are proportional to their sizes, wage rates in the two countries are equal, and the net export of each country is zero. However, Krugman (1980) shows that the location of economic activity becomes uneven with the appearance of the second-nature force. A strong demand at home results in a disproportionate share of firms. It also raises local wages and domestic production for export. Specifically, the firm share in the larger country is more than proportionate, the wage rate in the larger country is higher, and the larger country is a net exporter of manufactured goods. Krugman's results demonstrate that size matters in spatial economics. This is dubbed *the Home Market Effect* (HME) in the literature.

Economic activity in the real world is determined by both the first nature and the second nature. To clarify the role of the second nature, we need some special assumptions to remove the effect of the first nature when we establish models. To analogize, we need to peel an orange to taste the flesh; otherwise, we will not know whether the taste is from the peel or the flesh. Three different models developed by Krugman (1980) and Helpman and Krugman (1985) are useful for rigorously deriving three aspects of the HME. Since these HMEs are obtained from different models, some questions are naturally raised. Are they equivalent under some

[2] In history, economic geography and trade theory are developed separately as two subfields of economics. However, as suggested in the title, Ohlin (1933) says that "international trade theory cannot be understood except in relation to and as part of the general location theory, to which the lack of mobility of goods and factors has equal relevance." These two subfields have converged recently.

conditions? Which HME is more general than the others? Recent studies answer some of these questions.

The theoretical results of the HME activate empirical studies. Surprisingly, while the result of the wage advantage in the larger country is supported by much research, the result of the firm-share advantage is not. These empirical results inspire more theoretical studies of the HME to understand the essence of agglomeration.

The remaining part of this paper is organized as follows. Section 2 introduces three aspects of the HME revealed by the one-factor models of Krugman (1980) and Helpman and Krugman (1985). Section 3 displays their equivalence relationship using the two-factor model of Takahashi et al. (2013). Empirical studies are summarized in Section 4. Finally, Section 5 presents some recent results that scrutinize the inconsistencies between the theoretical and empirical results.

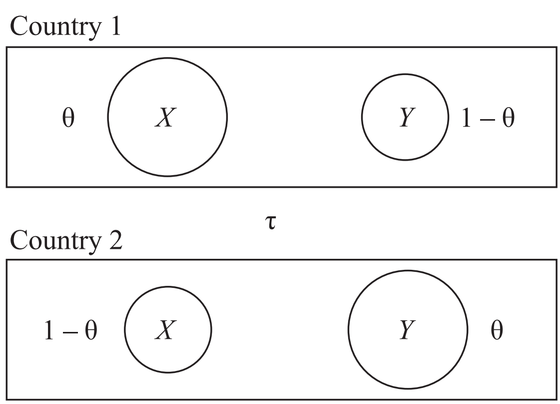
2. Three HMEs

There are several approaches to "removing the orange peel" which show how the interaction of transport costs and IRS at the firm level could lead to a size advantage. Here we introduce three typical models.

2.1. Two symmetric industries

We start with the two-industry model of Krugman (1980, Section III).

Figure 1: A two-industry model



Source: Author

As illustrated in Figure 1, there are two industries and two kinds of residents. Notations X and Y denote their classes. The population of each country is L.

In Country 1, residents are of type θ*L*, and (1–θ)*L* residents are of type *Y*, where θ ∈ (1/2,1). Thus, there are more *X*-people than *Y*-people in Country 1. A "mirror image" is in Country 2: θ*L* residents are of type *Y* and (1–θ)*L* residents are of type *X*.

Within each industry, there is a continuum of potential products (also called goods or varieties). The two classes of consumers have different preferences for products, which are represented by the following utility functions:

$$U^X = \int_0^{n^X} q^\rho\,(i^X)di^X, \quad U^Y = \int_0^{n^Y} q^\rho\,(i^Y)di^Y,$$

where n^X and n^Y are the numbers of the varieties in industries *X* and *Y*, respectively, and ρ ∈ (0,1) represents the degree of "love of variety". In the literature, σ = 1/(1 – ρ) ∈ (1,∞) is also widely used, which represents the elasticity of substitution between any two varieties.

All individuals can work in either industry, and they have the same productivity. Therefore, their wage rates are identical, *w*.

The national demand for an *X*-good, i^X, produced in Country 1 and the demand for a good, j^X, produced in Country 2 are:

$$d_{11}^X(i^X) = \frac{[p_{11}^X(i^X)]^{-\sigma} w\theta L}{(P_1^X)^{1-\sigma}}, \quad d_{21}^X(j^X) = \frac{[p_{21}^X(j^X)]^{-\sigma} w\theta L}{(P_1^X)^{1-\sigma}}, \tag{1}$$

where $p_{k_1 k_2}^X(i)$ is the consumer price of variety i produced in Country k_1 and consumed in Country k_2, while P_1^X is the price index of industry *X* in Country 1 defined by

$$P_1^X = \left\{\int_0^{n_1^X} [p_{11}^X(i^X)]^{1-\sigma}\, di^X + \int_0^{n_2^X} [p_{21}^X(j^X)]^{1-\sigma}\, dj^X\right\}^{\frac{1}{1-\sigma}}.$$

Similar expressions $d_{12}^X(i^X)$ and $d_{22}^X(j^X)$ can be derived for Country 2, and for industry *Y*.

The production in each country and each industry is under the same IRS technology. We simply assume that *F* workers are fixed inputs and ρ workers are marginal inputs for an additional unit of product. The IRS technology implies that each variety is produced by only one firm.

Iceberg transport costs are assumed here. Specifically, τ units of a variety need to be transported in order for one unit of the variety to arrive. We also use $\phi = \tau^{(1-\sigma)}$ to denote trade freeness. A larger ϕ corresponds to a smaller τ, since σ > 1.

A firm that produces variety i^X chooses prices $p_{11}^X(i^X)$ and $p_{12}^X(i^X)$ to maximize profit

$$\pi = p_{11}^X(i^X)d_{11}^X(i^X) + p_{12}^X(i^X)\tau d_{12}^X(i^X) - w\{F + \rho[d_{11}^X(i^X) + \tau d_{12}^X(i^X)]\}.$$

Under monopolistic competition, prices $p_{11}^X(i^X)$ and $p_{12}^X(i^X)$ do not impact price indices P_1^X and P_2^X directly. Therefore, optimal prices are derived as

$$p_{11}^X(i^X) = w, \quad p_{12}^X(i^X) = w\tau, \tag{2}$$

respectively. Note that they are independent of the variety names. Therefore, we use notation p_{ij}^k for any variety in industry k produced in Country i and consumed in Country j. Combining (1) and (2), we obtain optimal production of this firm, $q_1^X = \sigma F$. Similarly, the optimal production of a firm in Country 2 is $q_2^X = \sigma F$.

By using (2), the price indices of industry X are given by

$$P_1^X = w(n_1^X + \phi n_2^X)^{\frac{1}{1-\sigma}}, \quad P_2^X = w(\phi n_1^X + n_2^X)^{\frac{1}{1-\sigma}}.$$

If both countries accommodate firms of industry X, then the market-clearing condition for varieties produced in two countries is

$$\frac{\theta L}{n_1^X + \phi n_2^X} + \phi \frac{(1-\theta)L}{\phi n_1^X + n_2^X} = \sigma F, \;\; \phi \frac{\theta L}{n_1^X + \phi n_2^X} + \frac{(1-\theta)L}{\phi n_1^X + n_2^X} = \sigma F \tag{3}$$

from (1). The two equations above derive the result of X-firm share in Country 1:

$$k^X \equiv \frac{n_1^X}{n_1^X + n_2^X} = \theta + (2\theta - 1)\frac{\phi}{1-\phi} > \theta, \tag{4}$$

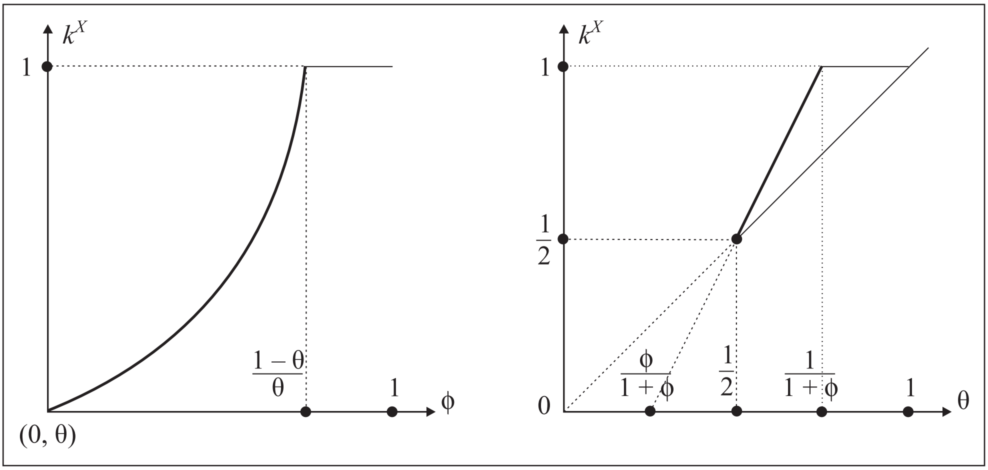
where the inequality comes from the assumption of $\theta \in (1/2,1)$. This equality demonstrates that the firm share of X-industry in the country with a larger X-market is more than the proportion θ. Similarly, the share of Y-industry in Country 2 is also more than θ.

The agglomeration of X-firms in Country 1 and Y-firms in Country 2 is an important aspect of the HME. In IRS industries, the location with the larger local demand succeeds in attracting a more-than-proportionate share of firms. Takahashi et al. (2013) call it *the HME in terms of firm share*. Since the location of economic activity is an important concern of researchers in regional science, this property of firm share is taken as the HME definition by most authors in the field of regional science. Indeed, it has become "the basic ingredient that lies at the heart of most models of agglomeration" (Ottaviano and Thisse, 2004: 2566).

A further examination of corner equilibria tells us that it is impossible for all X-firms to agglomerate in Country 2. However, all these firms agglomerate in

Country 1 when $\phi \geq (1-\theta)/\theta$ (or, equivalently, $\theta \geq 1/(1+\phi)$). The relationships between the firm share of *X*-industry, trade freeness, and the *X*-population share, θ, in Country 1 are depicted in Figure 2. Both (thick) curves are monotonically increasing. In particular, the right panel exhibits a linear relationship between the production share and the demand share.

Figure 2: The relationships between k^X, ϕ, and θ



Source: Author

We are now ready to examine the trade pattern. The trade surplus of *X*-industry in Country 1 is

$$B^X \equiv n_1^X \phi \frac{w(1-\theta)L}{\phi n_1^X + n_2^X} - n_2^X \phi \frac{w\theta L}{n_1^X + \phi n_2^X} = \frac{\phi w \sigma F}{1+\phi}(n_1^X - n_2^X) > 0,$$

where the equality is from (3) and the inequality is from (4). Similarly, the net export of *Y*-industry in Country 1 is $B^Y = -B^X < 0$.

We obtain another facet of the HME: the country with the larger number of consumers of an industry's varieties runs a trade surplus in that industry. Takahashi et al. (2013) call it *the HME in terms of trade pattern*. The trade pattern has been an important concern of new trade theory since the pioneering work of Burenstam Linder (1961) who long ago recognized the crucial role of home demand. Therefore, the net-exporter property is taken as the definition of HME by most trade theory authors.

Two facets of the HME are considered equivalent by many authors. For example, Ottaviano and Thisse (2004: 2566) use "stated differently" when describing these two properties. However, as we will see in Section 3.2, these are different definitions.

In summary, the different preferences of two kinds of consumers produce "idiosyncratic demands" (Davis and Weinstein, 1999) in this model. The demand-share difference is magnified by the second-nature force in the production shares. This idea is further generalized by Trionfetti (2001) and Brülhart and Trionfetti (2009), who assume that consumers' preferences are home biased.

2.2. Agricultural sector

In the previous two-industry model, the symmetry between *X*- and *Y*-industries results in identical wage rates in the two economies, making the model fully tractable. Helpman and Krugman (1985) propose another approach to equalizing the wage rates by introducing an agricultural good, which is freely traded across two countries.

In this model, workers are completely homogeneous, and the population share in Country 1 is θ again. With one manufacturing sector and one agricultural sector, the utility function is written as

$$U = M^{\mu} A^{1-\mu}, \tag{5}$$

where *A* denotes the homogeneous agricultural good. The agricultural market is characterized by perfect competition and each worker produces one unit of *A* (CRS). Since *A* is costlessly tradable across the countries, we choose *A* as the numeraire so that wage rates in the two countries are $w = 1$.

The production technology of the manufacturing sector is exactly the same as in Section 2.1. Therefore, the optimal price of any variety in the manufacturing sector is 1, and the optimal production of a firm in either country is $q_1^* = q_2^* = F\sigma$.

The price indices are simply

$$P_1 = (n_1 + \phi n_2)^{\frac{1}{1-\sigma}}, \quad P_2 = (\phi n_1 + n_2)^{\frac{1}{1-\sigma}}.$$

Therefore, the demands d_{ij} in the two countries are calculated as

$$d_{11} = \frac{\mu\theta L}{n_1 + \phi n_2}, \quad d_{12} = \frac{\phi}{\tau}\frac{\mu(1-\theta)L}{\phi n_1 + n_2},$$

$$d_{22} = \frac{\mu(1-\theta)L}{\phi n_1 + n_2}, \quad d_{21} = \frac{\phi}{\tau}\frac{\mu\theta L}{n_1 + \phi n_2}.$$

Then the market clearing condition is

$$\frac{\mu\theta L}{n_1 + \phi n_2} + \frac{\phi\mu(1-\theta)L}{\phi n_1 + n_2} = F\sigma, \quad \frac{\phi\mu\theta L}{n_1 + \phi n_2} + \frac{\mu(1-\theta)L}{\phi n_1 + n_2} = F\sigma.$$

The two equations above lead to the firm location result

$$k \equiv \frac{n_1}{n_1 + n_2} = \theta + (2\theta - 1)\frac{\phi}{1-\phi} > \theta, \tag{6}$$

which is exactly the same as in (4). Namely, the larger country's share of firms in the IRS industry exceeds its share of consumers.

The equality of (6) has two more implications. Taking the partial derivative of (6) with respect to θ, we obtain the *primary magnification effect* (Head and Mayer, 2004):

$$\frac{\partial k}{\partial \theta} = \frac{1+\phi}{1-\phi} > 1. \tag{7}$$

The inequality of (7) indicates that the equilibrium firm share increases disproportionately with the share of consumers. In the right panel of Figure 2, it means that the thick curve increases faster than the thin 45-degree line. Since (7) is closely related to the inequality $k > \theta$, this primary magnification effect is used as a definition of the HME by Head et al. (2002), Crozet and Trionfetti (2008), and many other authors in empirical studies. However, their equivalence is limited to some specific models. In general, (7) is neither a necessary nor a sufficient condition for $k > \theta$ to hold. We will see this in Section 3.1.

Further taking the partial derivative of (7) with respect to ϕ, we obtain the *secondary magnification effect* (Head and Mayer, 2004):

$$\frac{\partial^2 k}{\partial \theta \partial \phi} = \frac{2}{(1-\phi)^2} > 0. \tag{8}$$

The inequality above exhibits that the magnification is larger when trade is more integrated. As depicted in the left panel of Figure 2, the thick curve is convex, having a U-shape.

It is easy to examine the trade pattern in this model. The larger country is a net exporter of the manufactured goods and a net importer of the agricultural good. In other words, the larger country runs a trade surplus in the IRS sector, and the agricultural good offsets the industrial trade imbalance. The HME in terms of trade pattern is observed again in this model.

The assumption of a free-traded homogeneous A is a smart modeling trick to derive $w = 1$. This A is referred to as an "outside good," and the convenient assumption regarding A is widely imposed in the literature of both NEG and NTT to focus on exploring the IRS sector.

This assumption may not be innocuous because Davis (1998) reports that when the transport costs in two sectors are the same. Furthermore, Yu (2005) finds that the reverse inequality of (6) may hold (the reverse HME) when the Cobb-Douglas function form of (5) is replaced by a general CES utility function and the iceberg transport cost τ^a is high.

Needless to say, the assumption of cheaply A transported does not reflect the fact that many agricultural goods are even heavier than manufactured goods. Furthermore, the derived result of equal wages is not supported by empirical data, since we observe spatial income inequality all over the world. Therefore, some papers consider the firm location with a more realistic agricultural sector. On the one hand, general agricultural transport costs are considered by Takatsuka and Zeng (2012a, 2012b). Keeping the one-factor assumption, Takatsuka and Zeng (2012a) provide the exact threshold value of the agricultural transport cost for the inequality in (4). In contrast, Takatsuka and Zeng (2012b) include mobile capital as the second production factor and find that the inequality of (4) is always satisfied for any agricultural transport costs. On the other hand, Crozet and Trionfetti (2008), Zeng and Kikuchi (2009) also find that the HME in terms of firm share exists if the agricultural sector has heterogeneous agricultural goods.

Helpman and Krugman (1985) recognize that their setup relies on specific assumptions. These issues notwithstanding, they argue that the result is quite pervasive (p. 209). Indeed, keeping the assumption of the free-traded agricultural good, Head et al. (2002) find that the HMEs in terms of firm share and in term of trade pattern appear in other two models of imperfect competition. One of them replaces the CES utility function by a quasi-linear quadratic function, and the iceberg transport cost by linear transport cost (Ottaviano et al., 2002). Interestingly, Head et al. (2002) also provide a model of CRS and perfect competition in which the reverse HME is observed. Although the HME arguments of Head et al. (2002) are based on (7) rather than (6), their results are robust.

2.3. One-sector model

Krugman (1980, Sections I and II) gives one more model to display the size effect. This model removes the agricultural sector of Helpman and Krugman (1985) (Section 2.2). Accordingly, there is only one sector that produces manufacturing varieties. The utility is simplified as

$$U = \int_0^n q\,(i)^\rho di. \tag{9}$$

Without the free-traded agricultural good, the wage rates in the two countries are not necessarily equalized. Let the wage rate in Country i be w_i.

The populations in two countries are $L_1 = \theta L$ and $L_2 = (1 - \theta)L$, respectively. The demands for the varieties in country i are

$$d_{ii} = \frac{p_i^{-\sigma}}{P_i^{1-\sigma}} w_i L_i, \quad d_{ji} = \frac{\phi}{\tau} \frac{p_j^{-\sigma}}{P_i^{1-\sigma}} w_i L_i, \quad i.j = 1.2, i \neq j,$$

in which the price index in Country *i* is

$$P_i = p_i[n_i + \phi(\frac{w_j}{w_i})n_j]^{\frac{1}{1-\sigma}}.$$

The optimal price of a firm in Country *i* is $p_i = w_i$ and its optimal production amount is $q_i = F\sigma$. Therefore, the equilibrium firm number in Country *i* is $q_i = F\sigma$.

Since there is only one sector, trade is balanced at equilibrium. Namely, the net export in Country 1 should be zero. Choose the labor in Country 2 as the numeraire. Then $w_2 = 1$ and we have

$$0 = p_1 \tau n_1 d_{12} - p_2 \tau n_2 d_{21} = L_1 L_2 \phi B(w_1),$$

where

$$B(w_1) \equiv \frac{w_1^{1-\sigma}}{L_2 + \phi w_1^{1-\sigma} L_1} - \frac{w_1}{w_1^{1-\sigma} L_1 + \phi L_2}.$$

The relationship above establishes an equation for the equilibrium wage, w_1^*: $B(w_1^*) = 0$. Function $B(w_1)$ is decreasing, and

$$\lim_{w_1 \to \infty} B(w_1) < 0, \quad \lim_{w_1 \to 0} B(w_1) > 0,$$

$$B(1) = \frac{(1-\phi)(L_1 - L_2)}{(L_1 + \phi L_2)(L_2 + \phi L_1)} \begin{cases} < 0 & \text{if } L_1 < L_2 \\ = 0 & \text{if } L_1 = L_2 \\ > 0 & \text{if } L_1 > L_2 \end{cases}$$

hold. Therefore, the unique equilibrium wage rate is

$$w_1^* \begin{cases} < 1 = w_2^* & \text{if } L_1 < L_2 \\ = 1 = w_2^* & \text{if } L_1 = L_2 \\ > 1 = w_2^* & \text{if } L_1 > L_2 \end{cases}.$$

The above result exhibits the wage advantage in the larger country: The larger country provides a higher wage rate. This is called *the HME in terms of wages* in Takahashi et al. (2013).

In country *i* the firm number, $n_i = L_i/(F\sigma)$, is proportional to the population size L_i. Therefore, neither the HME in terms of firm share nor the HME in terms of trade pattern appears in this model.

3. The relationship between the HMEs

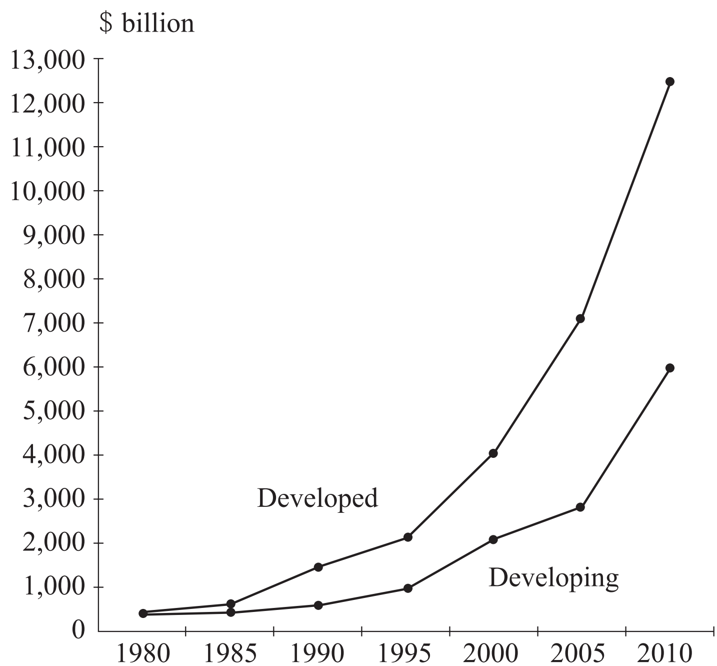
Three models in the previous section display different facets of the size advantage. Each model can only observe a part of them. Some questions are natural. Are these properties equivalent in some situations? Is any one of them more general than the others? Here, we introduce a footloose capital model of two countries to show their equivalence. The model is then extended to a space including multiple countries to show their differences.

3.1. Equivalence

Takahashi et al. (2013) answer the first question by reformulating the footloose capital model of Martin and Rogers (1995). The three models of Section 2 assume labor as the only production factor. There are at least three reasons to incorporate capital as the second production factor.

First, the role of capital in economic activity has recently increased significantly. Figure 3 illustrates the FDI inward stock of developed and developing economies for the period of 1980-2010. Both curves have increased rapidly in recent decades.

Figure 3: FDI inward stock of developed and developing economies, 1980–2010



Source: UNCTAD (2003, p. 257; 2006, p. 303; 2011, p. 191)

Second, as represented by the Heckscher–Ohlin model, capital is treated as an immobile production factor in traditional trade theory. However, the mobility of capital is a representative issue in the globalizing world. It is becoming more acceptable to model capital as a mobile factor.

Third, Arkolakis et al. (2012) show that the gains from trade in a number of existing models, including Eaton and Kortum (2002), Melitz (2003), and the one-sector model of Krugman (1980) can be summarized by changes in the share of domestic consumption and the elasticity of trade volume with respect to variable trade costs. These quantitative trade models, however, rest on the trade balance condition, which is automatically met in one-factor and one-sector general equilibrium models. To gain deeper insight, a simple idea is to employ either a two-factor-one-sector model or a one-factor-two-sector model. While two-sector-one-factor models are widely explored in the literature (e.g., Section 2.2), a two-factor-one-sector model is relatively fresh.[3]

The reformulated capital footloose model of Takahashi et al. (2013) is simple. There are homogeneous people, θ of them are in Country 1, and $1-\theta$ of them are in Country 2. There are K units of capital equally owned by L individuals. The even distribution of capital assumption is to rule out the Heckscher-Ohlin comparative advantage (to peel an orange).

There is only one sector, as in Section 2.3. The utility function is the same as in (9). In production, footloose capital models assume mobile capital as the fixed inputs and immobile labor as the marginal inputs. Units of capital and manufactured goods are chosen in a way that a fixed input of one unit of capital and a marginal input of $(\sigma-1)/\sigma$ units of workers are required to produce a variety.

As in Section 2.3, we let the labor in Country 2 be the numeraire, and w be the endogenous wage rate in Country 1. The optimal prices of firms are

$$p_{11} = w, \quad p_{12} = \tau w, \quad p_{22} = 1, \quad p_{21} = \tau$$

and the optimal production amounts of firms in two countries are σr_1 and σr_2. The price indices are

$$P_1 = \{[kw^{1-\sigma} + \phi(1-k)]K\}^{\frac{1}{1-\sigma}}, \quad P_2 = [(\phi k w^{1-\sigma} + 1 - k)K\}^{\frac{1}{1-\sigma}}$$

in the two countries, where k is the firm share in Country 1. Note that the total number of firms is equal to the total amount of capital, since one firm employs one unit of capital.

[3] There are more two-factor-two-sector models in the literature, including Ottaviano and Thisse (2004), Zeng and Kikuchi (2009), and Takatsuka and Zeng (2012b).

Let the returns of each unit of capital in Country i be r_i. Then national incomes in the two countries are

$$\begin{aligned} Y_1 &= \theta K[kr_1 + (1-k)r_2] + \theta L w, \\ Y_2 &= (1-\theta)K[kr_1 + (1-k)r_2] + (1-\theta)L, \end{aligned} \tag{10}$$

and the demands are

$$\begin{aligned} d_{11} &= \frac{w^{-\sigma}Y_1}{K[kw^{1-\sigma} + \phi(1-k)]}, \\ d_{12} &= \frac{(\tau w)^{-\sigma}Y_2}{K(\phi k w^{1-\sigma} + 1 - k)}, \\ d_{21} &= \frac{\tau^{-\sigma}Y_1}{K[kw^{1-\sigma} + \phi(1-k)]}, \\ d_{22} &= \frac{Y_2}{K(\phi k w^{1-\sigma} + 1 - k)}. \end{aligned} \tag{11}$$

The market-clearing condition is

$$\sigma r_1 = \frac{1}{K}\left[\frac{w^{1-\sigma}Y_1}{kw^{1-\sigma} + \phi(1-k)} + \phi \frac{w^{1-\sigma}Y_2}{\phi k w^{1-\sigma} + 1 - k}\right], \tag{12}$$

$$\sigma r_2 = \frac{1}{K}\left[\phi \frac{Y_1}{kw^{1-\sigma} + \phi(1-k)} + \frac{Y_2}{\phi k w^{1-\sigma} + 1 - k}\right]. \tag{13}$$

In a long-term equilibrium, $r_1 = r_2$ holds. Let it be r. Then $r = (Y_1+Y_2)/(\sigma K)$ holds from (12) and (13). Together with (10), we obtain

$$\begin{aligned} Y_1 &= \frac{\theta L[\sigma w + (1-\theta)(1-w)]}{\sigma - 1}, \\ Y_2 &= \frac{(1-\theta)L[\sigma - \theta(1-w)]}{\sigma - 1}, \\ r &= \frac{L(\theta w + 1 - \theta)}{K(\sigma - 1)}. \end{aligned} \tag{14}$$

The labor demand in Country 1 is

$$k\frac{\sigma - 1}{\sigma}(Y_1 + Y_2) = k(\theta w + 1 - \theta)L,$$

where the equality is from (14). Since the labor supply in Country 1 is θL, the labor-market clearing condition implies

$$k = \frac{\theta w}{\theta w + 1 - \theta}, \tag{15}$$

which can be rewritten as

$$k - \theta = \frac{\theta(1-\theta)(w-1)}{\theta w + 1 - \theta}. \tag{16}$$

The equation above has a meaningful implication: $k > \theta$ holds if and only if $w > 1$. This indicates that the HME in terms of firm share is equivalent to the HME in terms of wages. Although Krugman (1980) derive the wage property in a one-sector model from the balanced trade and the firm share property in another model by letting one country have mirror-image differences in preferences, these two properties are indeed equivalent in this simple two-factor model without the trade balance requirement and the idiosyncratic demands.

Furthermore, (16) tells us that k increases with w, so the two facets of the HME have the same evolving shape when ϕ rises. Intuitively, a high wage rate increases the local production cost. More precisely, local firms reduce their output because labor is the marginal input. This results in less labor input in each firm. On the other hand, workers are fully employed. Therefore, the number of firms increases with the wage rate.

To exhibit the HME, we need to show $w > 1$ holds in this model. The labor clearing-condition in Country 1 is useful to attain this objective:

$$\theta L = \frac{\sigma - 1}{\sigma} kK(d_{11} + \tau d_{12}).$$

According to (11), the equality above gives a wage equation

$$F(w) = Q_0(w) + Q_1(w)\phi + Q_2(w)\phi^2 = 0, \tag{17}$$

where

$$Q_0(w) = (w-1)\theta(1-\theta),$$

$$Q_1(w) = w^{2-\sigma}[(1-\theta)w^{2\sigma-3} - \theta]\sigma,$$

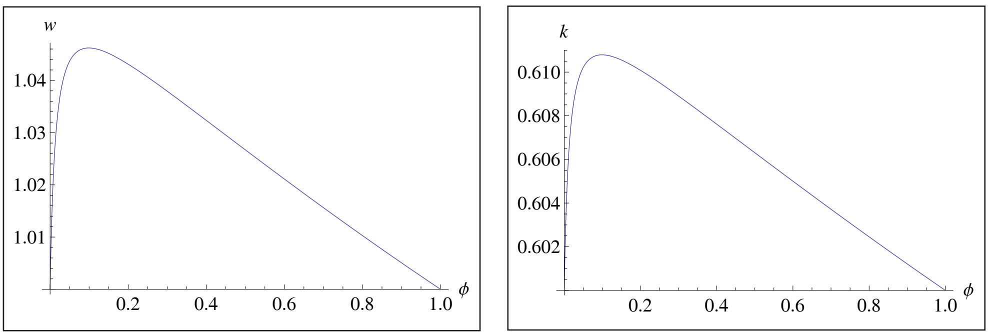
$$Q_2(w) = \theta(\sigma - 1 + \theta)w - (1-\theta)(\sigma - \theta).$$

Although (17) is not explicitly solvable, it contains much useful information. First, the (implicit) function $w(\cdot)$ is well defined by (16), revealing how the wage rate depends on trade integration. Consequently, $k(\phi)$ can be obtained from (15). By using the implicit function theorem, we know that

$$w(0) = w(1) = 1, \quad w'(0) = \frac{2\theta - 1}{\theta(1-\theta)}\sigma > 0, \quad w(1) = -\frac{2\theta - 1}{\sigma - 1} < 0.$$

Furthermore, (17) is a quadratic function of ϕ. Therefore, for a given w, there are, at most, two roots of ϕ that satisfy the wage equation. Those properties imply that both $w(\phi)$ and $k(\phi)$ have bell shapes when ϕ rises from 0 to 1. Furthermore, $w(\phi) > 1$ and $k(\phi) > \theta$ hold for all $\phi \in (0,1)$. Those useful properties are applied to examine endogenous offshoring by Zhou and Zeng (2015). A simulation example is given in Figure 4 with $\sigma = 5$ and $\theta = 0.6$.

Figure 4: Bell-shaped wage rate and firm share



Source: Author

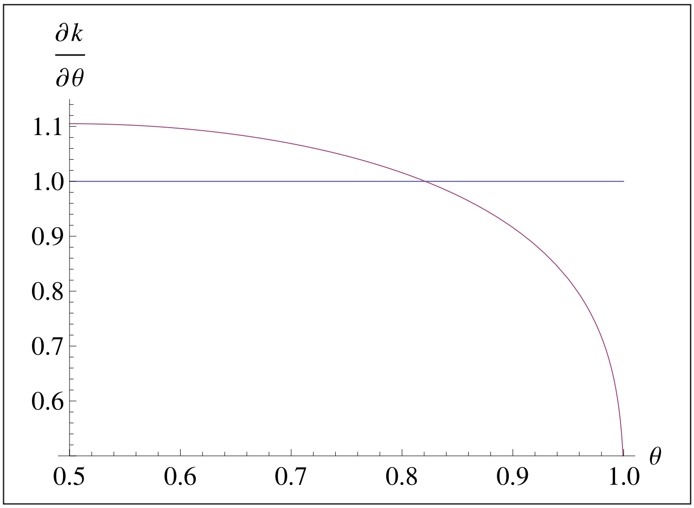
The intuition provided by Fujita and Thisse (2013: 371) and Zeng and Uchikawa (2014: 230) is helpful for understanding the bell shape. Because workers are immobile, a higher concentration of firms in a country increases wages there, resulting in two opposing forces. One is a backward linkage: final demand increases because of consumers' higher incomes, which is a centripetal force that encourages agglomeration; The other is a forward linkage: a higher wage rate increases the labor costs of firms, which is a centrifugal force that discourages agglomeration. When ϕ is small, the centripetal force is weaker because serving the local market is important, which results in a dispersion stage of firms. When ϕ is large, the centrifugal force is stronger, forming another dispersion stage of firms.

The bell shape of Figure 4 contrasts with the U shape in the left panel of Figure 2. The linear relationship observed in the right panel of Figure 2 is replaced by a concave curve in this two-factor model. More specifically, the relationship between and is given by (15), which implies

$$\frac{\partial k}{\partial \theta} = \frac{w}{(\theta w + 1 - \theta)^2} + \frac{\theta(1-\theta)}{(\theta w + 1 - \theta)^2}\frac{\partial w}{\partial \theta}. \tag{18}$$

Equation (18) has an importantly implication: although $k > \theta$ holds for any $\phi \in (0,1)$, inequality $\partial k/\partial\theta > 1$ may fail. This is confirmed in a numerical example of Figure 5 with parameters $\sigma = 5$, $\phi = 0.05$, in which $\partial k/\partial\theta > 1$ fails if θ is large. Thus, the definition of the HME based on the primary magnification effect (i.e., (7)) does not apply here.

Figure 5: No primary magnification effect



Source: Author

Moreover, the secondary magnification effect of (8), obtained in the models of Sections 2.1 and 2.2, predicts a more-intensive agglomeration when trade is more integrated. On the contrary, the bell shape observed in Figure 4 indicates that the agglomeration would be followed by a phase of convergence.

The bell-shaped prediction of Takahashi et al. (2013) is not new, since it is obtained in several NEG models through including different realistic features such as urban costs (Tabuchi, 1998; Helpman, 1998), impediments to interregional workers' mobility (Krugman and Venables, 1995; Puga, 1999), heterogeneity in the tastes of workers (Tabuchi and Thisse, 2002), and heterogeneity in agricultural goods (Picard and Zeng, 2005).

Note that the setup of Takahashi et al. (2013) purposely removed the Ricardian advantage of technology and the Heckscher–Ohlin advantage of resources. Tan and Zeng (2014) incorporate these first-nature differences between the two countries in the footloose capital model and find that three more evolving patterns are possible when trade freeness rises: increasing, decreasing, and U-shaped.

Now we turn to the trade surplus. The balance of payment consists of the trade surplus and the net capital returns. Therefore, Country 1 is a net exporter of the manufactured goods if and only if it is a net importer of capital. Since each firm employs exactly one unit of capital, the latter holds if and only if Country 1 accommodates firms that are more than proportionate. The larger country runs a trade surplus in the IRS sector again because the capital returns now offset the industrial trade imbalance.

In conclusion, all three definitions of the HME in Section 2 are equivalent in this footloose capital model.

3.2. A space of multiple countries

Zeng and Uchikawa (2014) generalize the footloose model of Section 3.1 to a space of $n \geq 2$ countries. Let w_i be the wage rate, θ_i be the population share, and k_i be the firm share in Country $i = 1, \dots, n$. We name the countries by population sizes so that $\theta_1 \geq \theta_2 \geq \dots \geq \theta_n$. In this space of multiple countries, three definitions are generalized as follows.

- The HME in terms of firm share:[4]

$$\frac{k_1}{\theta_1} \geq \frac{k_2}{\theta_2} \geq \cdots \geq \frac{k_n}{\theta_n}.$$

- The HME in terms of trade pattern:
$$B_1 \geq B_2 \geq \dots \geq B_n, \tag{19}$$
- where B_i is the trade surplus of manufactured goods in Country i.
- The HME in terms of wages: $w_1 \geq w_2 \geq \dots \geq w_n$.

Since the geographical features of countries might produce a hub effect that have a significant impact on trade patterns, we rule out this first-nature advantage among countries by assuming that the transport costs are the same for all pairs of countries (peeling the orange, again). Specifically, $\tau \geq 1$ units of a manufactured good must be shipped for one unit to arrive between any two countries. Then, we have $p_{ij} = \tau_{ij}\, p_{ii}$ for any $i,j = 1, \dots, n$, where

$$\tau_{ij} = \begin{cases} \tau & \text{if } i \neq j, \\ 1 & \text{if } i = j. \end{cases}$$

Zeng and Uchikawa (2014) find that

$$k_i = \frac{\theta_i w_i}{\sum_{l=1}^{n} \theta_l\, w_l}, \tag{20}$$

[4] This definition is first given by Behrens et al. (2009).

which generalizes (15). Equation (20) also displays the equivalence between the HME in terms of firm share and in terms of wages.

Choose the labor in Country 1 as the numeraire. Then $w_1 = 1$. Zeng and Uchikawa (2014) show that all wage rates $\boldsymbol{w} = (w_1, w_2, \ldots, w_n)$ are endogenously given by the following equations

$$\sum_{j=1}^{n} H_j(\boldsymbol{w}, \phi)\phi_{ij} = w_i^{\sigma-1}, \qquad i = 1, \cdots, n,$$

where

$$H_j(\boldsymbol{w}, \phi) = \frac{\frac{\sigma-1}{\sigma} w_j + \frac{1}{\sigma} \sum_{l=1}^{n} \theta_l w_l}{(1-\phi) w_j^{2-\sigma} + \phi \sum_{l=1}^{n} \frac{\theta_l}{\theta_j} w_l^{2-\sigma}}, \quad \text{for } j = 1, \cdots, n.$$

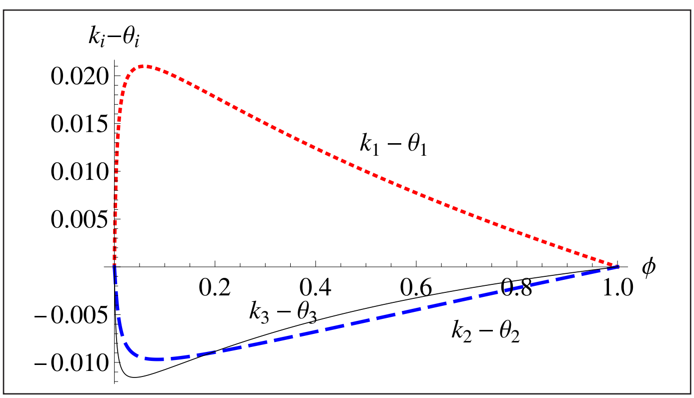
Although the equations above are not explicitly solvable, it is shown that inequalities $w_1 \geq w_2 \geq \ldots \geq w_n$ hold for all $\phi \in (0,1)$ so the HME in terms of wages is observed again.

Now we examine the HME in terms of trade pattern. Generalizing the case of two countries, inequalities of (19) hold if and only if

$$k_1 - \theta_1 \geq k_2 - \theta_2 \geq \cdots \geq k_n - \theta_n \tag{21}$$

from the balance of payment. Unfortunately, inequalities of (21) are not necessarily true, even when $n = 3$. Figure 6 plots $k_i - \theta_i$ by a simulation with parameters $\theta_1 = 0.62$, $\theta_2 = 0.3$, $\theta_3 = 0.08$ and $\sigma = 6$. In this numerical example, $k_2 - \theta_2 \geq k_3 - \theta_3$ holds only when ϕ is small.

Figure 6: Net flow of capital



Source: Author

Summarizing the results in a space of multiple countries, it is found that the three HMEs are not equivalent. Specifically, the HME in terms of trade pattern becomes ambiguous for middle-sized countries, while the other two are equivalent and observable. Since there are so many countries in the world, the above theoretical result does not support the trade pattern description of the HME.

4. Empirical insights

Empirical studies mainly focus on the HME in terms of firm share and the HME in terms of wages. They are called *the quantity* (of production) and *the price* (of labor) aspects of the HME in Head and Mayer (2004).

The price aspect is examined by the idea of real market potential (Head and Mayer, 2004) or market access (Redding and Venables, 2004), which is a distance-weighted sum of the market capacities of all countries:

$$\mathrm{RMP}_i = \sum_{j=1}^{n} \phi_{ij}\, Y_i P_i^{\sigma-1},$$

where Y_i is the national income, P_i is the price index in Country i, and $\phi_{ij} = \tau_{ij}^{(1-\sigma)}$ is the trade freeness between Countries i and j. Redding and Venables (2004) and Hanson (2005) link factor prices to RMP. They provide strong empirical evidence that market potential raises factor prices, which is the price aspect of the HME. Head and Mayer (2011: 288) also conclude that "larger and/or more centrally located countries are much richer than countries characterized by a small local market and few or small neighbors." A recent survey paper of Redding (2011) documents evidence clarifying that the close relationship between market access and wages is causal.

Regarding the quantity aspect, Davis and Weinstein (1999, 2003) use the primary magnification effect of (7) and the following inequality derived from (4):

$$\frac{d\left(\frac{n_1^X}{n_2^X}\right)}{d\left(\frac{\theta}{1-\theta}\right)} = \frac{1-\phi^2}{\left[1-\left(\frac{\theta}{1-\theta}\right)\phi\right]^2} > 1. \tag{22}$$

The inequality of (22) results from idiosyncratic demand.

Unlike the price aspect, Head and Mayer (2004: 2636) conclude that "the evidence on HMEs accumulated by these papers is highly mixed," after surveying many empirical studies. The industry level estimates are too noisy to provide sufficient support. Indeed, Davis and Weinstein (1999) find positive support in 8 of 19 manufacturing sectors. Davis and Weinstein (2003) find this HME in a majority of industries, with significantly positive support in 4 industries and significantly negative support in 2.

The empirical study of Head and Ries (2001) is based on (6) from the model with a free-traded agricultural good. Equation (6) can be rewritten as

$$\frac{n_1}{n_1 + n_2} = \frac{1}{2} + (\theta - \frac{1}{2})\frac{1 + \phi}{1 - \phi},$$

which leads to a simple regression equation. In this way, Head and Ries (2001) provide some "on average" support for the existence of the HME in the context of trade liberalization between Canada and the United States.

Meanwhile, Brülhart and Trionfetti (2009) examine their HME model with home-biased preferences. Their pooled estimate results paint an inconsistent picture because only 7 of 17 manufacturing industries exhibit a supportive response to home-biased demand in their industry-by-industry estimates. Therefore, Head and Mayer (2004: 2642) conclude that HMEs "generally take the form of higher factor incomes in large demand areas rather than magnified production shares of IRS industries."

While most empirical studies focus on the price and quantity aspects, some authors have investigated trade patterns. As revealed in Section 3.2, the HME in terms of trade pattern is fragile when multiple countries are involved. This is verified by Lundbäck and Torstensson (1998), who provide mixed results after examining trade patterns of 49 industries in 17 OECD countries. They obtain significantly positive support in 6 countries, significantly negative results in 3 countries, and insignificant results for the 8 remaining countries. In contrast, Head and Ries (2001) and Hanson and Xiang (2004) examine bilateral trade patterns. While Hanson and Xiang (2004) find strong evidence of the HME in terms of trade pattern, Head and Ries (2001) obtain negative evidence in the manufacturing industries of Canada and the United States.

5. Conclusion

Krugman (1980) reveals the impacts of country size on economic activity by the so-called home market effects. Three important advantages of a larger country are exhibited by different models. Specifically, a large country accommodates a more-than-proportionate share of firms and provides a higher wage rate. Moreover, it is a net exporter of the manufactured goods.

Since Helpman and Krugman (1985), a lot of papers assume a free-traded homogeneous (agricultural) good to facilitate their analysis. However, such an assumption does not match the fact that most agricultural goods are more costly to be transported than manufactured goods. Furthermore, as wages rates are identical across countries, nominal wage inequality is not observable under this assumption.

Recent studies of Takatsuka and Zeng (2012a, 2012b) find that we can explicitly incorporate positive transport costs of the agricultural good to derive the HMEs if the agricultural transport costs are not too high, or mobile capital is included as the second production factor. Furthermore, Takahashi et al. (2013) show that the agricultural good is not necessary in the appearance of mobile capital. Their new footloose capital model is able to display three advantages of a larger country in terms of firm share, wages, and trade pattern altogether. Thus, an important message of these theoretical results is the crucial role mobile capital.

Although many theoretical studies claim the existence of various HMEs, empirical studies do not fully support them. The inconsistencies encourage deeper research on this issue. Several explanations seem plausible.

First, many empirically studies take the primary magnification effect as the definition of the HME. As shown in Section 3.1, this is not equivalent to the HME in terms of firm share when some peculiar assumptions are removed.

Second, all of the theoretical models in previous sections have only one IRS industry. The theoretical results are not generally true in cases with multiple IRS industries. In fact, Hanson and Xiang (2004) find that industries with high transport costs and low substitution elasticities tend to concentrate in the larger country, while industries with low transport costs and high substitution elasticities tend to concentrate in the smaller country. They also show that the HME in terms of wages exists when there is a continuum of monopolistic competitive industries.

The third reason might be the CES utility function, which plays a crucial role in HME analysis. It successfully captures the income effect. However, it results in some unrealistic conclusions. For example, prices are a fixed markup over marginal costs, failing to reflect the pro-competitive effect. On the contrary, the quasi-linear quadratic function of Ottaviano et al. (2002) allows for variable markup but it fails to capture the income effect. A recent paper of Chen and Zeng (2014) use an additively separable utility function of Zhelobodko et al. (2012) that captures both the pro-competitive effect and the income effect. As a result, they find that the HME in terms of wages is still observable but the HME in terms of firm share becomes ambiguous. More specifically, the latter is observable only when trade costs are sufficiently small, if the utility function takes the CARA form of Behrens and Murata (2007).

Finally, Yang and Zeng (2014) find that the wage rate and the firm share in the larger country may display different evolutionary patterns when trade is more integrated if the heterogeneous productivity is incorporated into the two-factor model of Takahashi et al. (2013).

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Uloga veličine zemlje u prostornoj ekonomiji: Istraživanje učinaka domaćeg tržišta

Dao-Zhi Zeng[1]

Abstract

U radu se istražuje rastuća literatura o učincima domaćeg tržišta (HMEs) u prostornoj ekonomiji. HME-ovi se koriste da bi se utvrdila uloga veličine zemlje u konfiguraciji ekonomske aktivnosti. Različiti HME-ovi prikazuju distinktivne osobine prednosti veličine i izvorno su dobiveni iz različitih modela. Najnovija istraživanja potvrđuju da su te osobine usko povezane jedna s drugom. Ovim istraživanjem dobiveni su odgovori na slijedeća pitanja. Jesu li ovi HME-ovi pod nekim uvjetima ekvivalentni? Jesu li neke od osobina općenitije od drugih? Zašto se teorijskim i empirijskim istraživanjima dobivaju nedosljedni rezultati?

Ključne riječi: *aglomeracija, učinci domaćeg tržišta, nove teorije trgovine, trgovinske strukture, trgovinska integracija*

JEL klasifikacija: *F12, F63, R12*

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