

Home Market Effect and the Agricultural Sector*

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Abstract

The “home market effect” (HME) is an essential topic of the new trade theory. Assuming the transport costs only for the manufacturing goods, Krugman (1980) shows that the country with bigger market size is a net exporter. The assumption of free transport of the agricultural good was shown mattering a great deal rather than being innocuous by Davis (1998). Particularly, when manufacturing and agricultural goods have identical transport costs, the HME disappears. However, we find that the homogeneous-agricultural-good assumption in Davis’ model derives the discontinuity of inverse demand functions, which causes the disappearance of the HME. After establishing an analytical solvable model and assuming two differentiated agricultural goods in two countries, we find that the HME does exist even if the transport cost of the agricultural goods is positive.

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1 Introduction

Based on a model of increasing returns to scale, Krugman (1980) first finds that the country with larger local demand succeeds in attracting a more-than-proportionate share of firms in monopolistically competitive industry. This “home market effect” (HME) implies a link between a country’s market size and its exports that does not exist in trade models that are based solely on comparative advantage. This topic is extremely important and now has become standard knowledge and an important element in a field named “new trade theory.”

Helpman and Krugman (1985) reformulated the model of Krugman (1980) and confirmed the existence of HME. In their model, there are two countries and each country has two sectors: one produces a differentiated product (called the manufacturing sector), and the other produces a homogeneous product (called the agricultural sector). To make the model tractable, they assume that the homogeneous product is costlessly tradable and both countries produce it after trade. However, Davis (1998) finds that the assumption of zero transport costs of the homogeneous good is not innocuous. Specifically, if the transport costs of the homogeneous good is the same as the transport costs of the manufacturing goods, then the HME disappears. In Davis’s framework, the transport costs of the homogeneous good is large enough to blockade the trade of the homogeneous good. Recently, Davis’ model is further extended by Yu (2005), assuming there is no trade of the homogeneous good. Yu uses a CES function to replace the Cobb-Douglas function in Krugman’s model, and find that the HME for production structure can arise, disappear, or even reverse in sign, depending on the relative expenditure share on differentiated goods in the larger country.

Despite Davis’ negative result, several recent papers find that the HME has greater generality. For example, Head, Mayer and Ries (2002) find that HME is pervasive in two other models. By use of a framework of multiple manufacturing industries, Hanson and Xiang (2004) show that HME takes the form of industries with higher transport costs and more differentiated products being more concentrated in large countries than industries with lower transport costs and less differentiated products. They also find strong empirical

evidence of HME. Meanwhile, Holmes and Stevens (2005) establish another model with a continuum of industries including both models of Krugman (1980) and Davis (1998) as special cases. They conjecture that a high-fixed-cost industry would be produced in the larger country, and the structure of production and trade would generally depend in systematic ways upon the size of the home market. Unfortunately, two models of multiple industries are not completely analytically solvable, and the role of the industry under constant returns to scale remains unclear.

Both Davis (1998) and Yu (2005) show that the agricultural sector is worthy of more attention, but their artificial assumption of no trade of agricultural good is essential in their model. The purpose of this paper is to clarify the relation between the agricultural sector and the existence of HME when the agricultural goods are traded between countries. This relation is partially hidden by the tradition of treating the agricultural goods as the numéraire in the literature. To avoid such kind of confusion, we separate the agricultural goods from the numéraire. More precisely, the transport cost is zero for the numéraire but positive in the agricultural sector. In the real world, transporting gold is much cheaper than transporting rice. On the other hand, the agricultural good of two countries in the model of Davis (1998) and Yu (2005) is homogeneous. This makes the price of the agricultural good in a country jump when it imports (even a little of) the agricultural good from the other country if the transport cost is positive. Such thing is evidently not consistent with the economic situation of real life. To avoid this discontinuity of prices, we treat the agricultural goods of two countries as differentiated. In other words, two agricultural goods are two varieties produced in the agricultural sector. In the real world, the wool in New Zealand is different from the rice in Japan, and furthermore, Japanese rice is different from Thai rice. In empirical study, the “homogeneous good” of Rauch (1999) (also named organized exchange category) also consists of more than one variety.

A sister version of the new trade theory is the new economic geography (see Fujita, Krugman and Venables 1999), in which some workers are mobile. Similar to new trade theory, the framework of Cobb-Douglas preference and iceberg transport costs is traditional in the literature, but this generally causes analytical intractability. To overcome this difficulty, Ottaviano, Tabuchi and Thisse (2002) reconstruct the core-periphery

model by a framework of quadratic utility and linear transport costs, which turns out to be completely solvable. Their framework is applied to analyze the HME in Section 3.2.2 of Ottaviano and Thisse (2004). Meanwhile, their framework is also extended to include the agricultural sector by Picard and Zeng (2005), and it is found that the transport cost of the agricultural good is very important. Fortunately, the framework of Picard and Zeng (2005) can be extended to examine the HME in an analytically solvable way and can tell us how the trade pattern changes when both the manufacturing and agricultural goods are subjected to transport costs. This framework be considered as complementary to Davis (1998) but we will see that the results are completely different.

The paper is organized as follows. Section 2 develops the basic model modified from Ottaviano *et al* (2002) and Picard and Zeng (2005). Section 3 examines the HME when the transport costs of agricultural goods are positive. Surprisingly, the results of this paper show that HME does exist even when the transport costs of agricultural goods are positive but small enough to allow trade. Finally, section 4 summarizes the results and suggests some conclusions.

2 The Model

Our model simply extends that of Ottaviano and Thisse (2004, Section 3.2.2) by reconstructing its agricultural sector. Specifically, assume that the world consists of two countries: North (n) and South (s). There are H capitalists and L workers in the world, which are endowed to countries n and s with the same fractions θ and $1 - \theta$, respectively.¹ Each capitalist holds a unit of capital and each worker has a unit of labor. Capital services, but not capital-owners, are perfectly mobile between country whereas labor is immobile. Without loss of generality, we let $\theta \in (1/2, 1)$.

There are 3 kinds of goods in the economy: manufacturing goods, agricultural goods and the numéraire. The manufacturing sector produces a continuum of varieties indexed by interval $[0, N]$, whose production requires both capital and labor under increasing returns to scale. In contrast, there are only two agricultural goods, each of which is pro-

¹In this way, we rule out comparative advantage à la Heckscher-Ohlin.

duced in a country by labor only under constant returns to scale and perfect competition. The reader can think of the agricultural goods as the rice in Japan and the wool in New Zealand. Finally, the numéraire good is homogeneous, which is produced by nature. The reader can think of it as gold. The numéraire is initially allocated to L workers and H capitalists averagely, and let the quantity of endowment to each individual be \bar{q}_0 . The numéraire can be used to buy manufacturing goods and agricultural goods, or consumed directly.²

In the same way as in Picard and Zeng (2005), the preferences of a representative worker in both countries are given by utility function

$$U^r(q_0, q_m, q_a) = \alpha_m \int_0^N q_m^r(x) dx - \frac{\beta_m - \gamma_m}{2} \int_0^N [q_m^r(x)]^2 dx - \frac{\gamma_m}{2} \left[\int_0^N q_m^r(x) dx \right]^2 + \alpha_a (q_a^{nr} + q_a^{sr}) - \frac{\beta_a - \gamma_a}{2} [(q_a^{nr})^2 + (q_a^{sr})^2] - \frac{\gamma_a}{2} [q_a^{nr} + q_a^{sr}]^2 + q_0. \quad (1)$$

where $q_m^r(x)$ is the quantity of industrial variety $x \in [0, N]$ in country r , q_a^{nr} (resp. q_a^{sr}) is the quantity of agricultural product of country n (resp. country s) in country r , and q_0 is the quantity of the numéraire. In this expression, α_m (resp. α_a) expresses the intensity of preferences for the industrial (resp. agricultural) differentiated product, whereas $\beta_m > \gamma_m$ (resp. $\beta_a > \gamma_a$) means that consumers are biased toward a dispersed consumption of varieties. Particularly, $\beta_a = \gamma_a$ represents the situation that consumers do not distinguish two agricultural goods, which is the model base of Davis (1998).

Transporting one unit of any variety good in the manufacturing sector costs τ_m , and one unit of any variety good in the agricultural sector costs τ_a . Both τ_m and τ_a are positive but they are supposed to be small enough so that foreign goods in both sectors are consumed. Specifically, the following inequalities are assumed:

$$\tau_m < \frac{2a_m}{2b_m + c_m N} \quad (2)$$

$$\tau_a < \frac{(1 - \theta)L - N\phi}{(b_a + 2c_a)(H + L)(1 - \theta)}, \quad (3)$$

where parameters a_m , b_m , c_m , b_a and c_a are defined in (4), (5) and (6) later. The numéraire is assumed to be transported free.

²We do not include the saving function of gold in our model, and individuals consume gold for decoration only.

3 Home Market Effect

3.1 Consumer

Each consumer maximizes his/her utility given budget constraint

$$\int_0^N p_m(j)q_m(j)dj + p_a(n)q_a(n) + p_a(s)q_a(s) + q_0 = y + \bar{q}_0,$$

where y is the wage income, $p_a(\cdot)$ and $p_m(\cdot)$ are the consumer prices and where y is the consumer's income. The initial endowment \bar{q}_0 is supposed to be sufficiently large for the equilibrium consumption q_0 of the numéraire to be positive for each individual. This implies that each individual consumes all varieties (provided that prices are small enough, which is assumed below). Because marginal utility for the numéraire is equal in each country, its price can be normalized to one without losing generality.

We denote by $p^{kl}(\cdot)$ and $q^{kl}(\cdot)$ the price and the quantity of a variety produced in country $k \in \{n, s\}$ and sold in country $l \in \{n, s\}$. Obviously, since country n (resp. s) does not produce the agricultural variety s (resp. n), we have that $q_a^{nn}(s) = q_a^{ns}(s) = q_a^{sn}(n) = q_a^{ss}(n) = 0$. We can therefore drop the reference to the varieties of agricultural goods and denote the quantities of variety r by q_a^{nn} and q_a^{ns} , and the quantities of variety s by q_a^{ss} and q_a^{sn} . First order conditions of the consumer program yield the demands for agricultural goods in country n . These are given by

$$\begin{aligned} q_a^{nn} &= a_a - (b_a + 2c_a)p_a^{nn} + c_a(p_a^{nn} + p_a^{sn}) \quad \text{for variety } n \\ q_a^{sn} &= a_a - (b_a + 2c_a)p_a^{sn} + c_a(p_a^{nn} + p_a^{sn}) \quad \text{for variety } s \end{aligned}$$

where the parameters

$$a_a = \frac{\alpha_a}{\beta_a + \gamma_a}, \quad b_a = \frac{1}{\beta_a + \gamma_a}, \quad c_a = \frac{\gamma_a}{(\beta_a - \gamma_a)(\beta_a + \gamma_a)} \quad (4)$$

measure the size of the demand for agricultural goods, its price sensitivity and the degree of product substitutability between agricultural varieties. For $c_a = 0$, varieties n and s are independent, while they are perfect substitutes for $c_a \rightarrow \infty$. Demands for agricultural products in country s are given by symmetric formulae.

Symmetry between varieties imposes that $q_m^{kl}(i) \equiv q_m^{kl}$ for all variety i produced in country k and sold in country l . Similarly to the derivation of expression (3) of Ottaviano

et al (2002), we take the first order condition of the consumer's program with respect to the consumption of each manufactured variety, q_m^{kn} with $k \in \{n, l\}$ and we get the following demands for manufactured varieties in country n :

$$\begin{aligned} q_m^{nn} &= a_m - (b_m + Nc_m)p_m^{nn} + c_m P_m^n \\ q_m^{sn} &= a_m - (b_m + Nc_m)p_m^{sn} + c_m P_m^n \end{aligned}$$

where the size of the demand for manufactured goods, the price sensitivity and the degree of product substitutability between manufactured varieties are measured by

$$a_m = \frac{\alpha_m}{\beta_m + (N-1)\gamma_m}, \quad b_m = \frac{1}{\beta_m + (N-1)\gamma_m}, \quad (5)$$

$$c_m = \frac{\gamma_m}{(\beta_m - \gamma_m)[\beta_m + (N-1)\gamma_m]}. \quad (6)$$

These demand functions include the price index of manufactured products in country n

$$P_m^n = \lambda N p_m^{nn} + (1 - \lambda) N p_m^{sn},$$

where λ is the share of firms that locate in country n . Demands in countries s are given by symmetric formulae.

3.2 Equilibrium

Recall that the economy is endowed with H capitalists and L workers each supplying one unit of their corresponding factor. Capital services, but not capital-owners, are perfectly mobile between country whereas labor is immobile.

The manufacturing sector produces a continuum of horizontally differentiated varieties under increasing returns to scale. For convenience, the production of a firm in the manufacturing sector needs only fixed costs of 1 unit of capital and ϕ unit of labor³ Therefore, the total number of firms is $N = H$.

³The assumption of increasing returns to scale does not necessarily imply the zero marginal cost. However, the assumption of no marginal cost catches the essence of increasing return and makes the analysis much more convenient. Furthermore, although Ottaviano and Thisse (2004) include the marginal cost m into their model, their results do not substantially depend on m . Therefore, as in Ottaviano *et al.* (2002), Picard and Zeng (2005), we keep this assumption to gain more tractability here.

The agricultural sector of each country produces one original product under constant returns to scale and perfect competition. For convenience, take units so that a unit of labor produces a unit of agricultural good in each country.

Let λ be the ratio of manufacturing sector located in country n . Then the manufacturing labor is $\lambda N\phi$ in country n , and $(1 - \lambda)N\phi$ in country s . The agricultural population is $\theta L - \lambda N\phi$ in country n and $(1 - \theta)L - (1 - \lambda)N\phi$ in country s .

Taking units so that a unit of labor produces a unit of agricultural good in each country. Therefore, the prices of agricultural goods become the wages w_n and w_s in their countries, respectively. Then

$$\begin{aligned}\theta L - \lambda N\phi &= \theta(L + H)[a_a - (b_a + 2c_a)w_n + c_a(w_n + w_s + \tau_a)] \\ &\quad + (1 - \theta)(L + H)[a_a - (b_a + 2c_a)(w_n + \tau_a) + c_a(w_n + w_s + \tau_a)] \\ (1 - \theta)L - (1 - \lambda)N\phi &= \theta(L + H)[a_a - (b_a + 2c_a)(w_s + \tau_a) + c_a(w_n + w_s + \tau_a)], \\ &\quad + (1 - \theta)(L + H)[a_a - (b_a + 2c_a)w_s + c_a(w_n + w_s + \tau_a)].\end{aligned}$$

Solving them obtains

$$\begin{aligned}w_n &= \frac{a_a}{b_a} - \frac{b_a(\theta L - \lambda N\phi) + c_a(L - N\phi)}{b_a(b_a + 2c_a)(H + L)} - (1 - \theta)\tau_a, \\ w_s &= \frac{a_a}{b_a} - \frac{b_a[(1 - \theta)L - (1 - \lambda)N\phi] + c_a(L - N\phi)}{b_a(b_a + 2c_a)(H + L)} - \theta\tau_a.\end{aligned}$$

Let r be the profit of one unit of capital. Then the profit of a firm in country n is

$$\pi_m^n = p_m^{nn}q_m^{nn}\theta(L + H) + (p_m^{ns} - \tau_m)q_m^{ns}(1 - \theta)(L + H) - r - w_n\phi.$$

By the FOC of maximizing this profit, the prices should satisfy

$$\begin{aligned}a_m - 2(b_m + Nc_m)p_m^{nn} + c_m[\lambda Np_m^{nn} + (1 - \lambda)Np_m^{sn}] &= 0, \\ a_m - 2(b_m + Nc_m)(p_m^{ns} - \frac{\tau_m}{2}) + c_m[\lambda Np_m^{ns} + (1 - \lambda)Np_m^{ss}] &= 0.\end{aligned}$$

Similarly, for a firm in country s , it holds that

$$\begin{aligned}a_m - 2(b_m + Nc_m)p_m^{ss} + c_m[\lambda Np_m^{ss} + (1 - \lambda)Np_m^{ns}] &= 0, \\ a_m - 2(b_m + Nc_m)(p_m^{sn} - \frac{\tau_m}{2}) + c_m[\lambda Np_m^{sn} + (1 - \lambda)Np_m^{sn}] &= 0.\end{aligned}$$

Solving the above four equations, we have

$$p_m^{nn} = \frac{2a_m + c_m N(1 - \lambda)\tau_m}{2(2b_m + c_m N)}, \quad p_m^{sn} = p_m^{nn} + \frac{\tau_m}{2},$$

$$p_m^{ss} = \frac{2a_m + c_m N\lambda\tau_m}{2(2b_m + c_m N)}, \quad p_m^{ns} = p_m^{ss} + \frac{\tau_m}{2}.$$

Then

$$q_m^{nn} = \frac{b_m + c_m N}{4b_m + 2c_m N} [2a_m - (1 - \lambda)c_m N\tau_m],$$

$$q_m^{ns} = \frac{b_m + c_m N}{4b_m + 2c_m N} \{2a_m - [2b_m + c_m N(1 - \lambda)]\tau_m\},$$

$$q_m^{ss} = \frac{b_m + c_m N}{4b_m + 2c_m N} [2a_m + c_m N\lambda\tau_m],$$

$$q_m^{sn} = \frac{b_m + c_m N}{4b_m + 2c_m N} [2a_m - (2b_m + c_m N\lambda)\tau_m].$$

For costs τ_m and τ_a satisfying (2) and (3), q_a^{ns} , q_a^{sn} , q_m^{ns} and q_m^{sn} are all positive. In other words, the goods in both sectors are traded.

Due to the free-entry of firms, it should hold that $\pi_m^n = \pi_m^s = 0$, which are simplified as

$$\frac{(b_m + c_m N)(L + H)}{4(2b_m + c_m N)^2} \left(\theta [2a_m + (1 - \lambda)c_m N\tau_m]^2 + (1 - \theta) \{2a_m - [2b_m + c_m N(1 - \lambda)]\tau_m\}^2 \right)$$

$$= r + \phi \left(\frac{a_a}{b_a} - \frac{b_a(\theta L - \lambda N\phi) + c_a(L - N\phi)}{b_a(b_a + 2c_a)(H + L)} - (1 - \theta)\tau_a \right),$$

$$\frac{(b_m + c_m N)(L + H)}{4(2b_m + c_m N)^2} \left(\theta [2a_m - (2b_m + c_m N\lambda)\tau_m]^2 + (1 - \theta)(2a_m + c_m N\lambda\tau_m)^2 \right)$$

$$= r + \phi \left(\frac{a_a}{b_a} - \frac{b_a[(1 - \theta)L - (1 - \lambda)N\phi] + c_a(L - N\phi)}{b_a(b_a + 2c_a)(H + L)} - \theta\tau_a \right).$$

Subtracting the second from the first, we obtain

$$\frac{(b_m + c_m N)(L + H)\tau_m}{4(2b_m + c_m N)} [2(2\theta - 1)(2a_m - b_m\tau_m) + (1 - 2\lambda)c_m N\tau_m]$$

$$= \phi \left((2\theta - 1)\tau_a + \frac{(1 - 2\theta)L - (1 - 2\lambda)N\phi}{(b_a + 2c_a)(H + L)} \right).$$

The above expression can be rewritten as

$$(2\lambda - 1) \left[\frac{c_m N(b_m + c_m N)(L + H)\tau_m^2}{4(2b_m + c_m N)} + \frac{N\phi^2}{(b_a + 2c_a)(H + L)} \right]$$

$$= (2\theta - 1) \left\{ \frac{(b_m + c_m N)(L + H)(2a_m - b_m\tau_m)\tau_m}{2(2b_m + c_m N)} + \phi \left[\frac{L}{(b_a + 2c_a)(H + L)} - \tau_a \right] \right\}$$

and hence

$$\lambda - \theta = \Delta \times \left(\theta - \frac{1}{2} \right), \quad (7)$$

where

$$\Delta = \frac{\frac{(b_m + c_m N)(L + H)\tau_m[2a_m - (b_m + c_m N)\tau_m]}{4(2b_m + c_m N)} + \phi \left[\frac{L - N\phi}{(b_a + 2c_a)(H + L)} - \tau_a \right]}{\frac{c_m N(b_m + c_m N)(L + H)\tau_m^2}{4(2b_m + c_m N)} + \frac{N\phi^2}{(b_a + 2c_a)(H + L)}}. \quad (8)$$

Because of (2) and (3), the numerator of (8) is positive. Therefore, $\Delta > 0$ and $\lambda > \theta$ holds at equilibrium from (7), which shows the existence of home market effect. The above is summarized as follows.

Theorem 1 *The HME exists if τ_m and τ_a are small so that goods in both sectors are traded.*

In the framework of Davis (1998) and Yu (2005), there is only one agricultural good. This corresponds to the case of $\beta_a = \gamma_a$ in our framework, which implies $c_a \rightarrow \infty$ and (3) is violated for any positive τ_a . This explains that why they fail to observe the existence of HME, which is observed in our model.

On the other hand, if we exclude the parameters in the agricultural sector, (7) degenerates to

$$\lambda^m - \theta = \frac{2[2a_m - (b_m + c_m N)\tau_m]}{c_m N\tau_m} \left(\theta - \frac{1}{2} \right) > 0, \quad (9)$$

which is consistent with (25) of Ottaviano and Thisse (2004).⁴ Comparing (7) with (9), we find that including the agricultural sector does not decrease the HME at all.

4 Summary and conclusions

The results of Davis (1989) show that the over simplification on the agricultural sector in traditional new-economic-geography models is not innocuous. Recently, Yu (2005) extended the result of Davis (1989) and find that, the home market effect may either disappear, be reversed, or be kept when the transport costs of the agricultural good is positive. However, their models treat the agricultural good as the numéraire, and over

⁴Note that our model further assumes $f = 1$ and $m = 0$ for simplicity.

simplifies the agricultural sector again. This paper reconstructs the agricultural sector in two respects. First, we separate the agricultural goods from the numéraire, which allows us to distinguish their impact on the home market effect. Second, we differentiate two agricultural goods produced in two countries so that importing a bit of agricultural good from the foreign country does not change the price of its own agricultural good catastrophically. In this way, we surprisingly find that the home market effect does not disappear because of positive transport costs of agricultural goods. Therefore, we can conclude that, the results of Davis (1998) and Yu (2005) essentially depend on the fact of no trade in the agricultural sector between countries.

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