E C O N O M I C S B U L L E T I N

Reconsideration of trade patterns in a Chamberlinian−Ricardian model

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Abstract

This paper reexamines the patterns of trade in a Chamberlinian−Ricardian model by introducing a simple dynamic process of labor reallocation. Our analysis shows the following results. First, the patterns of inter−industry trade are determined by technical differences among countries. Second, whether intra−industry trade emerges depends not only on the cross−country technical heterogeneity but also on the size of a country and the expenditure share for differentiated products. Our main finding is that intra−industry trade can emerge in the trading equilibrium even if there is technical heterogeneity among countries.

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1. Introduction

Since the seminal work of Krugman (1979), Chamberlinian monopolistic competition models of trade have been extensively studied, and have proved very successful in explaining the emergence of intra-industry trade. To emphasize the role of increasing returns to scale and imperfect competition, the standard monopolistic competition model assumes cross-country technical homogeneity: all firms in the monopolistically competitive sector in the economy share the same marginal cost and fixed cost. As a result, there has been little investigation of the role of technological differences among countries. However, Ricardian comparative advantage is worthy of more attention. To deal with this point, Kikuchi (2004) investigated cross-country heterogeneity in both marginal and fixed costs as a determinant of trade patterns.[1] In a two-country model with two (one differentiated-product and one homogeneous good) industries, he showed that the differentiated-product industry is concentrated in a single country and the intra-industry trade is very unlikely in the trading equilibrium.

The purpose of this paper is to reexamine the patterns of trade in a two-country model of monopolistic competition with cross-country technical heterogeneity. We assume a dynamic process of labor reallocation in which labor moves sluggishly between industries in response to cross-industry wage differences. Our analysis uncovers the following results. First, the patterns of inter-industry trade are determined by the technology index that represents the degree of technical heterogeneity among countries. Second, whether intra-industry trade emerges depends not only on the technology index but also on the size of a country and the expenditure share for differentiated products. We find that Kikuchi's (2004) argument is valid only when the homogeneous good is produced in both countries: if the homogeneous good is produced by only one country under free trade, there is a strong likelihood of intra-industry trade emerging in the presence of cross-country technical heterogeneity.

The remainder of this paper is organized as follows. Sections 2 and 3 develop a Chamberlinian–Ricardian model and provide an explanation with regard to the autarkic equilibrium, respectively. Section 4 explores the patterns of specialization in the trading equilibrium. Section 5 is devoted to concluding remarks.

2. The Model

Suppose that the economy comprises two countries, the home country and the foreign country, and that they are identical in regard to consumers' preferences but not in regard to size and production technologies. There are two sectors: the monopolistically competitive sector which produces a large variety of differentiated products, and the competitive sector which produces a homogeneous good. The homogeneous good, which will be taken as the numeraire, is produced under constant returns to scale.

We assume that all consumers share the same Cobb–Douglas preferences. Then, the social utility function is given by[2]

$$U = C_M^{\gamma} C_A^{1-\gamma}, \quad 0 < \gamma < 1,$$

where C_M is the quantity index of the differentiated products and C_A is the consumption level of the homogeneous good. The quantity index takes the form

$$C_M = \left[\sum_{i=1}^{n} d_i^{(\sigma-1)/\sigma} + \sum_{i^*=1}^{n^*} d_{i^*}^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}, \quad \sigma > 1,$$

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[1] By developing a two-country model with transport costs and asymmetric preferences, Venables (1987) also explores the influence of technological differences in the monopolistically competitive sector on trade patterns.

[2] Kikuchi (2004) assumes the quasi-linear utility function.

where n (n^*) is the number of products produced in the home (foreign) country, d_i (d_{i^*}) is the quantity of product i (i^*), and σ is the elasticity of substitution between every pair of products.

Solving the consumer's utility maximization problem yields the following demand functions for products i and i^*:

$$d_i = \gamma p_i^{-\sigma} G^{\sigma-1}(I + I^*), \tag{1}$$

$$d_{i^*} = \gamma p_{i^*}^{-\sigma} G^{\sigma-1}(I + I^*), \tag{2}$$

where p_i (p_{i^*}) is the price of the i-th variety of differentiated product produced in the home (foreign) country, G is the aggregate price index for the differentiated product, and I (I^*) is the home (foreign) country's national income. The price index takes the form

$$G = \left[\sum_{i=1}^{n} p_i^{1-\sigma} + \sum_{i^*=1}^{n^*} p_{i^*}^{1-\sigma}\right]^{1/(1-\sigma)}.$$

In both countries, the production technology in the competitive sector is such that one unit of output requires one unit of labor. Following Kikuchi (2004), we assume that there is cross-country technical heterogeneity in the monopolistically competitive sector. The amount of labor required to produce the quantity x_i (x_{i^*}) of product i (i^*) is given by

$$l_i = Bx_i + F \quad (l_{i^*} = B^* x_{i^*} + F^*),$$

where B (B^*) is the marginal labor requirement and F (F^*) the fixed labor requirement. Without loss of generality, we can choose units such that the marginal cost and the fixed cost in the home (foreign) country satisfy

$$B = (1 - 1/\sigma)b \quad (B^* = (1 - 1/\sigma)b^*)$$

and

$$F = f/\sigma \quad (F^* = f^*/\sigma),$$

respectively. With the number of firms being very large, we can assume that all firms take the price index G as given. Then, profit maximization implies that the price of product i (i^*) is

$$p_i = bw \quad (p_{i^*} = b^* w^*), \tag{3}$$

where w (w^*) is the wage rate in the monopolistically competitive sector in the home (foreign) country. Thus, the profit functions for monopolistically competitive firms in both countries are given by

$$\pi_i = w(bx_i - f)/\sigma,$$

$$\pi_{i^*} = w^*(b^* x_{i^*} - f^*)/\sigma.$$

We suppose that there is no barrier to entry or exit. The zero-profit condition implies that the equilibrium output of any active firm in the home (foreign) country is

$$x_i = f/b \quad (x_{i^*} = f^*/b^*), \tag{4}$$

and the associated equilibrium labor input in the home (foreign) country is

$$l_i = f \quad (l_{i^*} = f^*).$$

Now let L_M ($L_M{}^*$) denote the number of workers in the monopolistically competitive sector in the home (foreign) country. Then, the number of monopolistically competitive firms in the home (foreign) country is given by

$$n = L_M / f \quad (n^* = L_M{}^* / f^*). \tag{5}$$

Finally, we assume a dynamic process of labor reallocation in which, within each country, labor moves sluggishly from the sector with a lower wage rate to the sector with a higher wage rate.[3] Because the homogeneous good is the numeraire, the wage rate in the competitive

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[3] This adjustment process was developed by Tawada (1989), which explored the influence of

sector is unity. Thus, the dynamic adjustment process can be described as

$$\dot{L}_M = g(w-1), \quad dg(z)/dz > 0, \quad g(0) = 0, \tag{6}$$

$$\dot{L}_M^* = g^*(w^*-1), \quad dg^*(z)/dz > 0, \quad g^*(0) = 0, \tag{7}$$

where dot denotes a time derivative.

3. Autarky Equilibrium

Before turning to the trading equilibrium, let us direct our attention to the equilibrium allocation of the home country in autarky (i.e., $n^* = 0$). By the use of the full employment condition, the output of the homogeneous good in the home country is expressed as $Q_A = L - L_M$, where L is the home country's labor endowment. The national income of the home country is given by $I = (L - L_M) + wL_M$. Then, the market-clearing condition for the homogeneous good is

$$L - L_M = (1-\gamma)[(L - L_M) + wL_M],$$

which can be rewritten as

$$w = \gamma(L - L_M)/(1-\gamma)L_M. \tag{8}$$

This is the short-run equilibrium wage rate in the monopolistically competitive sector, which clears all goods markets for a given L_M. This schedule is drawn in Figure 1 as the downward sloping curve AA'. The wage rate in the monopolistically competitive sector falls in response to an increase in the number of firms in the sector.

(Figure 1)

By setting $w = 1$ in (8), we can obtain the level of L_M in the autarky equilibrium. If L_M^a is the number of monopolistically competitive firms in the autarky equilibrium, then

$$L_M^a = \gamma L. \tag{9}$$

Under the above-mentioned process of labor reallocation, the declining property of w with respect to L_M ensures that the autarky equilibrium is unique and globally stable in the home country, as shown in Figure 1. Similarly, we can show that the autarky equilibrium is unique and globally stable in the foreign country, and that its equilibrium number of firms under autarky is

$$L_M^a{}^* = \gamma L^*, \tag{10}$$

where L^* is the foreign country's labor endowment.

4. Trading Equilibrium

Suppose that the two countries open their goods markets. Then, if both countries continue to produce differentiated products, the output level at which each firm makes no profit is equal to the firm's total sales in both countries. By (1), (2) and (4), the equilibrium conditions are given by

$$f/b = \gamma p_i^{-\sigma} G^{\sigma-1}(I + I^*), \tag{11}$$

$$f^*/b^* = \gamma p_{i^*}^{-\sigma} G^{\sigma-1}(I + I^*). \tag{12}$$

Dividing (11) by (12) and the use of (3) yield

$$w^*/w = (f/f^*)^{1/\sigma}(b/b^*)^{(\sigma-1)/\sigma}. \tag{13}$$

Accordingly, the relative wage rate in the monopolistically competitive sector w^*/w is determined by the technology index $\Phi \equiv (f/f^*)^{1/\sigma}(b/b^*)^{(\sigma-1)/\sigma}$.[4] In what follows, we

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increasing returns to scale on the patterns of trade and the gains from trade.

[4] The term "technology index" was put forward by Kikuchi (2004).

impose the following assumption:

Assumption 1: $\Phi > 1$.

This assumption implies that after trade opens, the wage rate in the monopolistically competitive sector in the foreign country is always higher than that in the home country.

Under free trade, the wage rates in the monopolistically competitive sectors in both countries are determined so as to clear all goods markets for given L_M and L_M*. After the opening of trade, the condition that clears the homogenous good market is

$$(L - L_M) + (L* - L_M*) = (1-\gamma)[(L - L_M) + (L* - L_M*) + wL_M + w*L_M*].$$

This can be rewritten as

$$w = \frac{\gamma(L + L* - L_M - L_M*)}{(1-\gamma)[L_M + (w*/w)L_M*]}. \qquad (14)$$

Inserting (13) into the RHS of (14), we have the short-run equilibrium wage rate in the monopolistically competitive sector in the home country

$$w = \frac{\gamma(L + L* - L_M - L_M*)}{(1-\gamma)[L_M + \Phi L_M*]}. \qquad (15)$$

Similarly, the wage rate in the foreign country can be obtained as

$$w* = \frac{\gamma(L + L* - L_M - L_M*)}{(1-\gamma)[\Phi^{-1}L_M + L_M*]}. \qquad (16)$$

From (15) and (16), it is obvious that the wage rates in the monopolistically competitive sectors in both countries are decreasing in L_M and L_M*.

Let us turn to the determination of trade patterns. By substituting (15) and (16) into (6) and (7), respectively, we have the simultaneous differential equations that describe the dynamic adjustment process under free trade. Under Assumption 1 (i.e., $\Phi > 1$), the phase diagram can be depicted as Figure 2. The line HH' (FF') illustrates the locus of pairs of L_M and L_M* for which $\dot{L}_M = 0$ ($\dot{L}_M* = 0$). As drawn in the figure, the line HH' must lie in the lower region of the line FF'. Therefore, the foreign country is driven to increase its production of differentiated products by the opening of trade. Suppose that the labor endowments in both countries are as indicated by point E. Then, the autarky equilibrium is located at point A, the intersection of OE and FH'.[5] According to the dynamic behaviors of L_M and L_M* illustrated by arrows, the point that represents the trading equilibrium will be point T at which the home (foreign) country completely specializes in the homogeneous good (differentiated products).[6]

(Figure 2)

Given Figure 2, we can state the following proposition with respect to the patterns of specialization in the trading equilibrium:

Proposition 1

Under Assumption 1, the following statements are applicable in the trading equilibrium:

(i) Both countries produce the homogeneous good and only the foreign country produces differentiated products if $L*/L > \gamma/(1-\gamma)$.

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[5] The dotted line WW' in Figure 2 represents the locus of pairs $(L, L*)$ that satisfy $L + L* = \bar{L}$. From (9) and (10), it is shown that the input pair (L_M, L_M*) in the autarky equilibrium is located on the dotted line FH' in the figure.

[6] This diagrammatical technique for determining the trading equilibrium is essentially the same as Ethier's (1982) allocation curve technique.

(ii) Only the foreign (home) country produces differentiated products (the homogeneous good) if $\gamma/(1-\gamma) \geq L^*/L \geq \gamma/(1-\gamma)\Phi$.

(iii) Both countries produce differentiated products and only the home country produces the homogeneous good if $\gamma/(1-\gamma)\Phi > L^*/L$.

Proof. By allowing L^*/L to vary while keeping $L+L^*$ constant at $\bar{L}$, we can explore all possible situations under free trade without shifting the lines FF' and HH' in Figure 2 (see (15) and (16)). Suppose that L^* exceeds $\gamma\bar{L}$, the level implied by point F in the figure. Then, it is easy to verify that the condition

$$L^*/L > \gamma/(1-\gamma) \tag{17}$$

holds. In view of the dynamic behaviors indicated by arrows, we find that the trading equilibrium is given by point F. Therefore, if condition (17) holds, both countries produce the homogeneous good and only the foreign country produces differentiated products in the trading equilibrium. Next, suppose that L^* falls short of the level implied by point H, the intercept of the line HH' on the vertical axis. Then, since the level of L_M at the intercept is obtained as $L_M = \gamma\bar{L}/[\gamma+(1-\gamma)\Phi]$, the condition

$$\gamma/(1-\gamma)\Phi > L^*/L \tag{18}$$

holds. In this case, it can be observed that the trading equilibrium is represented by a point on the line HH'. Hence, if condition (18) holds, both countries produce differentiated goods and only the home country produces the homogeneous good in the trading equilibrium. In the case where neither (17) nor (18) holds, the labor endowments in both countries are as indicated by point E, so only the foreign (home) country produces differentiated products (the homogeneous good) in the trading equilibrium. Hence, the proposition is proved. **Q.E.D.**

Two points are worth noting here. First, the patterns of inter-industry trade are determined by the technology index Φ. As shown in Proposition 1, if Φ is greater than unity, the foreign country necessarily produces differentiated products in the trading equilibrium and becomes a net exporter of them. By developing parallel arguments, we can demonstrate that if Φ is less than unity, the home country becomes a net exporter of differentiated products in the trading equilibrium. Second, whether intra-industry trade emerges depends not only on the technology index but also on the relative country size L^*/L and the share of income spent on differentiated products γ. Proposition 1 states that under Assumption 1, intra-industry trade is more likely to occur if L^*/L is smaller, γ is larger, and $\Phi(>1)$ is closer to unity.

Kikuchi (2004) pointed out that in the presence of cross-country technical heterogeneity (i.e., $\Phi \neq 1$), intra-industry trade never emerges without complete standardization of production technologies (i.e., $\Phi = 1$). However, our analysis reveals that this argument is not valid except when the homogeneous good is produced in both countries.[7] From (ii) and (iii) in Proposition 1, we find that if the homogeneous good is produced by only one country, production technologies need not be completely standardized to generate intra-industry trade: both marginal cost and fixed cost can differ between countries even after intra-industry trade is generated by technical standardization.[8]

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[7] Kikuchi (2004) focused on the case where both countries produce the homogeneous good in the trading equilibrium, so Proposition 1 never contradicts the result obtained in his analysis.

[8] Kikuchi and Zeng (2004) also show that intra-industry trade emerges in the presence of cross-country technical heterogeneity. However, their results are dependent on a multi-industry framework with only monopolistically competitive sectors.

5. Concluding Remarks

In this paper, we develop a two-country model of monopolistic competition with cross-country technical heterogeneity and investigate trade patterns by introducing a simple dynamic process of labor reallocation. Our analysis establishes the following two results: first, the patterns of inter-industry trade are determined by technical differences between countries. Second, whether intra-industry trade emerges is dependent not only on cross-country technical heterogeneity but also on the relative country size and the expenditure share for differentiated products. It should be emphasized that intra-industry trade can emerge in the trading equilibrium even if there is technical heterogeneity among countries.

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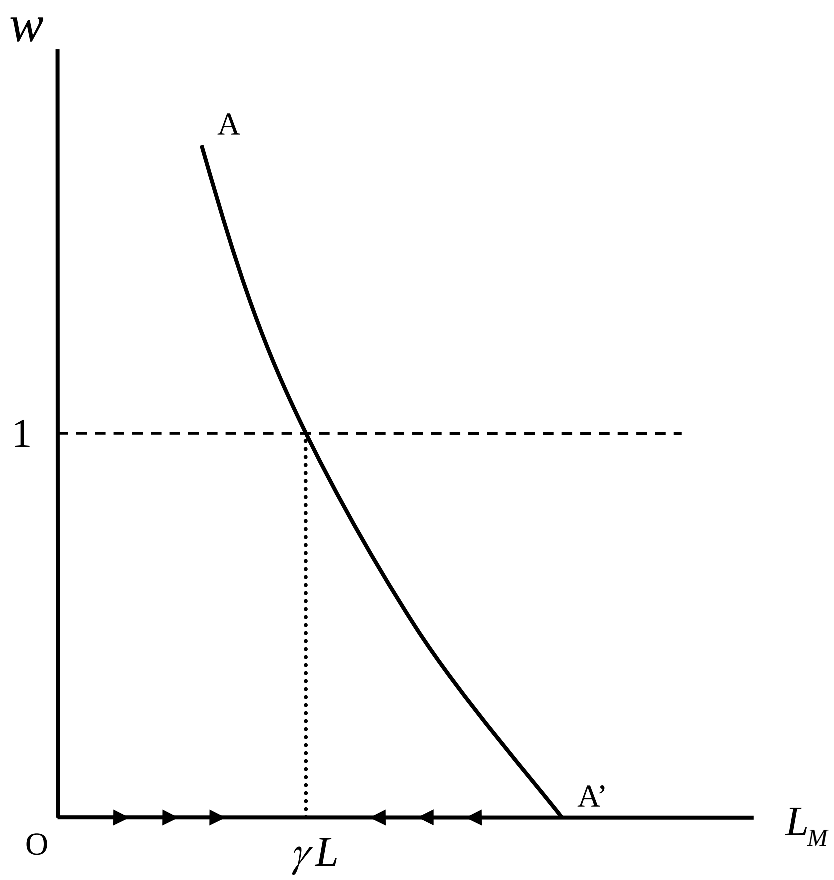

Figure 1

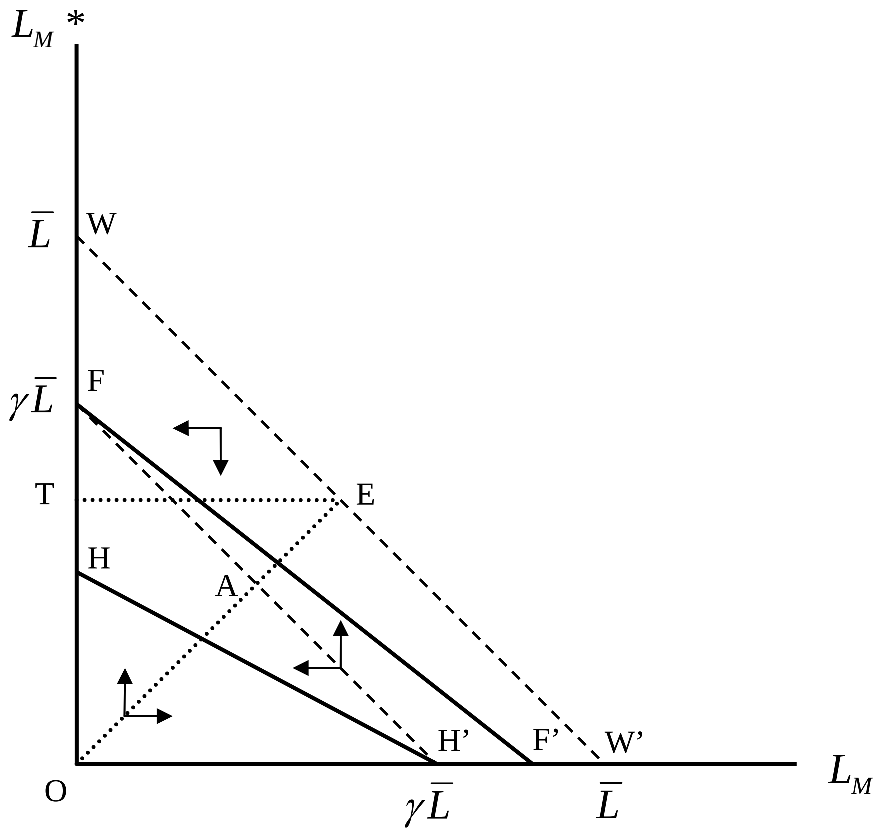

Figure 2