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

A note on Chamberlinian−Ricardian trade patterns

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Abstract

Using a two−country model of monopolistic competition with cross−country technical heterogeneity, this note explores the determinants of comparative advantage. It is shown that trade patterns are determined by a technology index, and that autarky relative prices do not serve as reliable predictors of trade patterns.

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1 Introduction

Ever since the seminal work of Krugman (1979), Chamberlinian monopolistic competition models of trade have been proliferated. One of the major phenomena evident from these models is the emergence of intra-industry trade (i.e., two-way trade of differentiated products). The standard monopolistic competition models are based on the assumption of cross-country technical homogeneity: each firm in the monopolistically competitive sector incurs an identical fixed cost (α) and a constant marginal cost (β). To emphasize the role of increasing returns and imperfect competition, the Ricardian aspect (cross-country technical heterogeneity) is downplayed in the standard models. This treatment is justified as a modeling strategy. On the other hand, there has been little investigation of the role of technical heterogeneity among countries.[1]

The main purpose of this note is to explore cross-country technical heterogeneity as a determinant of trade patterns. The analysis is carried out within a two-country framework. The countries are identical in every respect except for the technology of the monopolistically competitive sector. Both fixed costs and marginal costs can differ between the countries. It will be shown that, with cross-country technical heterogeneity in the monopolistically competitive sector, intra-industry trade is very unlikely in a trading equilibrium. It will also be shown that trade patterns are determined by a technology index and that the autarky prices do not reflect the structure of comparative advantage.

The next section develops a one-factor Chamberlinian-Ricardian model. Section 3 deals with the determinants of trade patterns. Section 4 discusses some directions in which the model could be extended.

2 The model

Suppose there are two countries in the world, Home and Foreign, and that they are similar in regard to consumers' preferences and size but not necessarily in regard to production technologies. There is only one primary factor of production: labor. There are two sectors: the competitive sector which produces a homogeneous good, and the monopolistically competitive sector

[1] Venables (1987) explores the influence of technological differences in the monopolistically competitive sector on trade patterns. However, his results are dependent on both the existence of transport costs and asymmetric preferences.

which produces a large variety of differentiated products. The homogeneous good, which will be taken as the numeraire, is produced under constant returns to scale technology.

Demands are derived from the utility function of a single representative consumer in each country. Each consumer maximizes the quasi-utility function[2]

$$U = \epsilon^{-1} D^{\epsilon} + Y, \quad 0 < \epsilon < 1, \tag{1}$$

where Y is the consumption level of the homogeneous good and D is the quantity index of the differentiated products. The quantity index takes the well-known form

$$D = \left(\sum_{i=1}^{n} (d_i)^{\theta} + \sum_{i*=1}^{n*} (d_{i*})^{\theta} \right)^{1/\theta}, \quad 0 < \theta < 1, \tag{2}$$

where n (n^*) is the number of products produced in Home (Foreign), d_i (d_{i*}) is the quantity of product i ($i*$), and $1/(1-\theta) > 1$ is the elasticity of substitution between every pair of products. The aggregate price index for the differentiated product can be obtained as:

$$P = \left(\sum_{i=1}^{n} (p_i)^{\theta/(\theta-1)} + \sum_{i*=1}^{n^*} (p_{i*})^{\theta/(\theta-1)} \right)^{(\theta-1)/\theta}, \tag{3}$$

where p_i (p_{i*}) is the price of the i ($i*$)-th differentiated product produced in Home (Foreign).

The consumer's utility maximization problem can be solved in two steps.[3] Let us take the case of Home. First, whatever the value of the quantity index, D, each d_i (d_{i*}) needs to be chosen so as to minimize the cost of attaining D. By solving the cost minimization problem, we obtain

$$\begin{aligned} d_i &= (p_i/P)^{1/(\theta-1)} D, \quad i = 1, ..., n, \\ d_{i*} &= (p_{i*}/P)^{1/(\theta-1)} D, \quad i* = 1, ..., n^*. \end{aligned}$$

The upper-level step of the consumer's problem is to divide total income between the differentiated products in aggregate and the homogeneous good, which yields

$$D = P^{1/(\epsilon-1)}.$$

[2] See Helpman and Krugman (1989, chap. 7).
[3] See, for example, Helpman and Krugman (1985, chap. 6).

Pulling these two stages together yields the following demand functions:

$$d_i = (p_i)^{1/(\theta-1)} \left(\sum_{j=1}^{n} (p_j)^{\theta/(\theta-1)} + \sum_{j*=1}^{n*} (p_{j*})^{\theta/(\theta-1)} \right)^{(\theta-\epsilon)/[\theta(\epsilon-1)]}, \quad (4)$$

$$d_{i*} = (p_{i*})^{1/(\theta-1)} \left(\sum_{j=1}^{n} (p_i)^{\theta/(\theta-1)} + \sum_{j*=1}^{n*} (p_{j*})^{\theta/(\theta-1)} \right)^{(\theta-\epsilon)/[\theta(\epsilon-1)]}. \quad (5)$$

Differentiated products are supplied by monopolistically competitive firms. There is cross-country technical heterogeneity: each Home (Foreign) firm has both a fixed cost α (α^*) and a constant marginal cost β (β^*). With the number of firms being very large, the elasticity of demand for each product becomes $1/(1-\theta)$. Thus, each product is priced at a markup over marginal cost:

$$p_i = \beta/\theta, \;\; p_{i*} = \beta^*/\theta. \quad (6)$$

It must be noted that the relative autarky prices reflect the relative marginal costs: $(p_i/p_{i*}) = (\beta/\beta^*)$.

Before turning to the trading equilibrium, we must draw attention to the autarky equilibrium of Home (i.e., $n^* = 0$). Assuming that n^A firms with marginal cost β are active in Home, the summation in equation (4) takes the form

$$\sum_{i=1}^{n^A} (p_i)^{\theta/(\theta-1)} = n^A(\beta/\theta)^{\theta/(\theta-1)} \quad (7)$$

Substituting this into the demand function yields the profit function for each firm[4] [5]

$$\begin{aligned} \pi &= (p-\beta)x - \alpha \\ &= [(1-\theta)/\theta]\beta x - \alpha \\ &= (1-\theta)(\theta/\beta)^{\theta/(1-\theta)}[n^A(\beta/\theta)^{\theta/(\theta-1)}]^{(\theta-\epsilon)/[\theta(\epsilon-1)]} - \alpha. \end{aligned} \quad (8)$$

It is important to note that profits are increasing in the number of firms if $\epsilon > \theta$. In this case the differentiated products would be complements rather than substitutes. To exclude this case, we assume $\epsilon < \theta$. Solving the zero-profit condition ($\pi = 0$) yields

$$n^A = (\theta/\beta)^{\theta\epsilon/(\theta-\epsilon)}[(1-\theta)/\alpha]^{[\theta(1-\epsilon)]/(\theta-\epsilon)}. \quad (9)$$

[4] Hereafter, the subscript i is dropped for simplicity.

[5] The profit function is derived from the demand function (5) and the pricing rule (6).

3 Trading equilibrium

Suppose that the two countries open their goods markets. Given that both countries continue to produce the homogeneous good, Home (Foreign) products are sold at price $p = \beta/\theta$ ($p^* = \beta^*/\theta$). In what follows, the analysis is restricted to this case.

In the trading equilibrium, we need non-positive profits in each country, with profits being equal to zero if production takes place. Thus, by setting profits equal to zero for both countries ($\pi = \pi^* = 0$), we would like to test whether the co-existence of both countries' firms is consistent with equilibrium.

Firstly, let us draw attention to a condition that, if both countries' firms co-exist, profits must be identical for each country's firms, i.e.,

$$\pi = \pi^*. \tag{10}$$

This is the condition that must be satisfied if $\pi = \pi^* = 0$ has to hold. Substituting the demand functions (4) and (5) and the pricing rule (6) into (10) and simplifying leads to

$$\begin{aligned} 2(1-\theta)\theta^{\theta/(1-\theta)}\left[n(\beta/\theta)^{\theta/(\theta-1)} + n^*(\beta^*/\theta)^{\theta/(\theta-1)}\right]^{(\theta-\epsilon)/[\theta(\epsilon-1)]} \\ = (\alpha-\alpha^*)/[\beta^{\theta/(\theta-1)} - \beta^{*\theta/(\theta-1)}]. \end{aligned} \tag{11}$$

Inserting the RHS of (11) into the profit function yields

$$\begin{aligned} \pi &= [\beta^{\theta/(\theta-1)}(\alpha-\alpha^*)]/[\beta^{\theta(\theta-1)} - \beta^{*\theta/(\theta-1)}] - \alpha, \\ \pi^* &= [\beta^{*\theta/(\theta-1)}(\alpha-\alpha^*)]/[\beta^{\theta/(\theta-1)} - \beta^{*\theta/(\theta-1)}] - \alpha^*. \end{aligned}$$

It is important to note that profits are independent of both the total number of firms and market size.

Before turning to the case of co-existence, note that the equilibrium number of firms for the case in which only one country's firms exist is

$$n^T_{\{n*=0\}} = (\theta/\beta)^{\theta\epsilon/(\theta-\epsilon)}[2(1-\theta)/\alpha]^{[\theta(1-\epsilon)]/(\theta-\epsilon)}, \tag{12}$$

$$n^{*T}_{\{n=0\}} = (\theta/\beta^*)^{\theta\epsilon/(\theta-\epsilon)}[2(1-\theta)/\alpha^*]^{[\theta(1-\epsilon)]/(\theta-\epsilon)}, \tag{13}$$

where T refers to the value in trading equilibrium.

Using these results, one can obtain the necessary condition for the co-existence of firms. Let us define a technology index:

$$\Phi \equiv [(\beta/\beta^*)^{\theta/(1-\theta)}/(\alpha/\alpha^*)]. \tag{14}$$

In free trade equilibrium with the co-existence of firms, the profit must be zero: $\pi = \pi^* = 0$. Simple calculations show that the equations are satisfied only if the technology index, Φ, is equal to 1. This implies that, given technical heterogeneity in the monopolistically competitive sector, the co-existence of both countries' firms is very unlikely in a trading equilibrium. Now the surprising feature of Chamberlinian-Ricardian trade patterns becomes evident.

Proposition: *If $\Phi > (<) 1$, only Foreign (Home) firms produce differentiated products and Foreign (Home) becomes an exporter of differentiated products. Intra-industry trade (i.e., the co-existence of both countries' firms) occurs only if $\Phi = 1$.*

[Proof] Suppose that $\Phi < 1$. In this case, both countries' firms cannot co-exist. To see that the case where only Home firms are active cannot be an equilibrium note that

$$\pi^*_{\{n=n^T,\, n^*=0\}} = (\beta/\beta^*)^{\theta/(1-\theta)}\alpha - \alpha^*. \tag{15}$$

This becomes positive if $\Phi < 1$. Therefore, Foreign firms have an incentive to enter the world market. Also, the case in which only Home firms are active cannot support a free trading equilibrium. Since

$$\pi_{\{n=0,\, n^*=n^{*T}\}} = (\beta^*/\beta)^{\theta/(1-\theta)}\alpha^* - \alpha$$

is negative, Home firms have no incentive to enter given that n^{*T} Foreign firms are active. Therefore, only Foreign firms produce differentiated products in the free trade equilibrium. The case of $\Phi > 1$ can be proven analogously. [Q.E.D.]

Two points are worth noting here. First, in a free trade equilibrium with cross-country technical heterogeneity, it is rare for more than one country to specialize in the production of differentiated products. In other words, with slight technical heterogeneity, intra-industry trade never occurs. Second, trade patterns are determined by the technology index Φ, which is composed of (a) relative fixed costs, (b) relative marginal costs, and (c) the substitution parameter θ.[6] On the other hand, autarky relative prices (which only reflect the relative marginal costs) do not reflect true comparative advantages. Hence, even if a country has a higher autarky price for differentiated

[6] See (14).

products in autarky equilibrium, the country may become an exporter of those products. We would like to stress the failure of autarky prices to reveal comparative advantage: the point is that prices reflect marginal costs, but efficiency depends on both the magnitude of the marginal and the fixed cost components.

Paramount is the interaction between cross-country technical heterogeneity and trade patterns in the model of monopolistic competition: if an arbitrarily small amount of cross-country technical heterogeneity is introduced, intra-industry trade will cease.

4 Discussion

Finally, it is important to note that the above argument depends on the assumption that both countries continue to produce the homogeneous good in the trading equilibrium (i. e., the case of incomplete specialization). Because of this assumption, wage rates are equalized between countries, which makes the analysis tractable. While this assumption is justified for the case where the differentiated products sector is small compared to the entire economy, it is also important to explore what happens if one country completely specializes in the differentiated products.[7]

As space is limited, let us take the case where $\Phi < 1$ holds and only Home firms produce the differentiated products while only Foreign firms produce the homogeneous good. If Home completely specializes in the differentiated products, the equilibrium number of firms $\bar{n}^T$ will be obtained by solving the labor market condition

$$\bar{n}^T = L/[\alpha + \beta(2d)], \tag{16}$$

where L is the Home labor endowment. Since the demand for each differentiated product in one country (d) does not depend on the income level, the total supply of each product becomes $2d$.[8] Since each country consumes the equal amount of the differentiated products and only Home exports the differentiated products, the balance-of-payments condition becomes

$$\bar{n}^T(\beta w/\theta)d = wL - \bar{n}^T(\beta w/\theta)d, \tag{17}$$

[7] This case occurs when the share of the differentiated products sector is large in the economy. In this regard, Ethier (1982) explores the influence of both the expenditure share for the increasing returns good and the size of a country on trade patterns.

[8] See (4).

where w is the Home wage rate.[9] The LHS is the Home export value of the differentiated products, while the RHS is the Home import value of the homogeneous good.[10] In this case, wage rates diverge between countries in order to attain balance-of-payments equilibrium. By using (4), (16) and (17), one can obtain the equilibrium number of firms ($\bar{n}^T$), the demand for each product (d), and the Home wage rate (w). The same as the case of incomplete specialization, this case also implies that, in the presence of technical heterogeneity, intra-industry trade hardly ever occurs. In order to fully analyze the interaction of technical heterogeneity and intra-industry trade patterns, this kind of extension needs further consideration.

References

[1] Ethier, W. J. (1982) 'Decreasing Costs in International Trade and Frank Graham's Argument for Protection,' *Econometrica,* Vol. 50, pp. 1243–1268.

[2] Krugman, P. (1979) 'Increasing Returns, Monopolistic Competition, and International Trade,' *Journal of International Economics,* Vol. 9, pp. 469-479.

[3] Helpman, E., and P. Krugman (1985) *Market Structure and Foreign Trade,* MIT Press, Cambridge, MA.

[4] Helpman, E., and P. Krugman (1989) *Trade Policy and Market Structure,* MIT Press, Cambridge, MA.

[5] Venables, A. (1987) 'Trade and Trade Policy with Differentiated Products: A Chamberlinian-Ricardian Model,' *Economic Journal,* Vol. 97, pp. 700-717.

[9] Note that Foreign wage rate remains at 1.

[10] The latter is also equal to the Home consumption value of the homogeneous good.