Comparative Advantage and Intra-Industry Trade: A Cournot-Ricardo Approach

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This paper attempts to provide an alternative conceptual framework for understanding the prevalence of trade and intra-industry trade among similar countries. This paper builds on the idea of Brander(1980) that international Cournot competition in segmented markets can generate intra-industry trade. I merge his partial equilibrium model with the Ricardian trade model of Dornbusch, Fischer and Samuelson(1977), and show that this Cournot-Ricardo model can generate the patterns of trade consistent with empirical findings. The volume of trade increases as trading partners become more similar in terms of income. The intensity of intra-industry trade increases with similarity of trading partners, where similarity is measured either in terms of income or in the distribution of productivity across industries.

1. INTRODUCTION

The empirical findings that much of world trade is between industrial countries, and its large part consists of intra-industry trade(two-way trade in a single industry) bewildered trade economists. Traditional trade models predict that the volume of and the gains from trade increase with disparity between trading partners. Difference in relative productivity is the driving force of trade in the Ricardian model, and disparity in relative factor endowment is the fundamental cause of trade in the Heckscher-Ohlin model. Furthermore, from the viewpoint of these models, intra-industry trade is both pointless and unaccountable.

Challenged by the apparent paradox, Dixit and Norman(1980), Krugman(1979) and Lancaster(1979) independently initiated a new line of research. There exists potential demand for a large number of differentiated goods that can be produced with similar technologies. However, in the presence of increasing returns to scale, the number of varieties that can be produced in a single country is limited by its market size. Trade expands the number of varieties available to consumers, and increases the scope for utilizing increasing returns. Thus, trade can occur in the absence of differences in technology or factor endowments, and

in a single industry composed of firms using similar technologies. The Chamberlinian monopolistic competition model dominated the literature in the 1980's. Helpman(1981), Krugman(1981) and Helpman and Krugman(1985) demonstrate that the monopolistic competition model of trade, if combined with the Heckscher-Ohlin model, can generate trade and intra-industry trade increasing with similarity between trading partners, similarity being measured in terms of relative income or relative factor endowment. Increasing returns with product differentiation was regarded as the necessary ingredient for generating a trade model that matches empirical regularity.

In a recent article, Davis(1995) raises a simple, but powerful criticism of the accepted wisdom. He shows that adding a small amount of Ricardian flavor to the Heckscher-Ohlin model is sufficient for generating intra-industry trade. Suppose we have two industries, one capital-intensive and the other labor-intensive. In one of them, two varieties of a good can be produced with technologies of the same factor intensity. As the transformation curve between the two varieties is linear, an infinitesimal difference between countries in the slope of the curve will lead to complete specialization of each variety by each country, thus generating two-way trade in this industry. At the same time, there will be trade across the two industries, which is governed by difference in relative factor endowments. He also shows that this hybrid model of Ricardo and Heckscher-Ohlin is consistent with empirical findings that intra-industry trade is prevalent between countries of similar size and with similar factor endowments. Perfect competition under constant returns is totally consistent with intra-industry trade, only if we allow for a small difference in technology between trading partners.

This paper tries to build yet another model of trade that can potentially explain the prevalence of intra-industry trade between similar countries. Suppose a home firm and a foreign firm producing an identical product compete à la Cournot in both the home and the foreign market. These markets are completely segmented. Each firm makes distinct quantity decisions for each market, treating the other firm's decisions as given. Unless the difference between the two firms' unit costs is too large, each firm will have positive shares in both markets, generating intra-industry trade. This insight of Brander(1981) that pure strategic perception of firms can generate intra-industry trade has been widely adopted in the literature. Brander and Krugman(1983), Krugman(1984) and Venables(1985) use this Cournot model of

trade to address trade policy issues in a partial equilibrium framework. However, to my knowledge, there was no attempt to incorporate this idea in a general equilibrium setting. To analyze interactions between comparative advantages and intra-industry trade generated by Cournot competition, I merge the idea of Brander(1981) with a Ricardian model of trade. I drop the perfect competition assumption from the Ricardian trade model invented by Dornbusch, Fischer and Samuelson(1977), and replace it by the assumption that each industry is governed by Cournot rivalry between a domestic firm and a foreign firm. I show that this Cournot-Ricardo approach to trade can generate the pattern of trade consistent with empirical findings. The volume of trade increases as trading partners become more similar in terms of relative income. The importance of intra-industry trade in total trade also increases with similarity of trading partners, where similarity is measured either in relative income or in the distribution of productivities across industries. Thus, the Cournot-Ricardo model suggests a third candidate for explaining the prevalence of trade and intra-industry trade between similar countries.

The paper is organized as follows. Section 2 builds up the model. Section 3 examines the pattern of trade implied by the model. Section 4 concludes the paper.

2. THE MODEL

The specifications for technologies and preferences are the same as in the Ricardian model of trade with a continuum of goods by Dornbusch, Fischer and Samuelson(1977)(henceforth, the DFS model). There is a continuum of goods indexed on the unit interval [0, 1]. Labor alone is used to produce goods. For each good z on the interval, there are unit labor requirements in the home and in the foreign country, $a(z)$ and $a^*(z)$. We index goods such that home country comparative advantage diminishes as z increases. Defining relative unit labor requirements as

(2.1) $$A(z) \equiv \frac{a^*(z)}{a(z)},$$

$A(z)$ is a decreasing function of z. Labor is perfectly mobile between industries. w and w^* will denote the competitive wage in the home and in the foreign country, respectively. ω will express the relative wage of the home country, defined as w/w^*.

The two countries are populated by consumers with identical Cobb-Douglas tastes. Denoting the constant expenditure share on good z by $b(z)$, the world demand for good z is given by

$$(2.2) \qquad q(z) = \frac{b(z)(Y + Y^*)}{p(z)},$$

$$\text{where } \int_0^1 b(z)dz = 1.$$

$p(z)$ is the price of good z, and Y and Y^* are national income of the home country and the foreign country, respectively.

The DFS model assumes that each industry is perfectly competitive, composed of numerous price-taking firms. We depart from this Ricardian tradition by assuming that each industry is a Cournot duopoly composed of a home firm and a foreign firm. The duopoly is maintained by a technology barrier. Each firm in the industry is a technology leader in its own country and the technology cannot be imitated for legal or technical reasons. Assuming duopoly across industries certainly is a very severe restriction. It just provides a minimal way of capturing imperfect competition in the general equilibrium framework. In addition, it may be as restrictive as assuming perfect competition in all industries.

Each firm in industry z chooses the output level to maximize the profit, regarding its rival's output level as given. The resulting Cournot equilibrium in each industry is determined by the following set of equations.

$$p(z) = wa(z) + w^*a^*(z),$$
$$q(z) = \frac{b(z)(Y + Y^*)}{p(z)},$$

$$(2.3) \qquad s(z) = \frac{w^*a^*(z)}{wa(z) + w^*a^*(z)} = \frac{A(z)}{A(z) + \omega}$$

The price p is determined by the sum of the two firms' unit costs. The market supply q decreases with this sum of unit costs. The market is divided between the two firms according to s, which is the market share of the home firm. Note that s is a measure of the home firm's cost advantage. This measure increases with the home country's relative productivity, $A(z)$ and decreases with its relative wage ω. A notable feature of the equilibrium defined in(2.3) is that a country supplies every market, regardless of its comparative advantage and its relative wage. There is no complete specialization. This feature of the model crucially depends on the assumption that the demand curve is unit-elastic. A monopolist would charge an infinite price, providing the opportunity of profitable entry for any firm with a finite unit cost.

Let us define $E[s]$ as the mean of $s(z)$, where the weights are given by the expenditure shares $b(z)$.

$$E[s] \equiv \int_0^1 s(z)b(z)dz$$

Similarly, define $E[s^2]$ as

$$E[s^2] \equiv \int_0^1 s(z)^2 b(z)dz.$$

Now consider the labor market clearing condition. In the home country, the labor supply of L must be equal to the sum of the home firms' labor demand in all industries.

$$(2.4) \qquad \begin{aligned} L &= \int_0^1 a(z)s(z)q(z)dz \\ &= \int_0^1 s(z)\frac{wa(z)}{wa(z) + w^*a^*(z)}b(z)dz \frac{Y + Y^*}{w} \\ &= \int_0^1 s(z)(1 - s(z))b(z)dz \frac{Y + Y^*}{w} \\ &= (E[s] - E[s^2])\frac{Y + Y^*}{w} \end{aligned}$$

All the equalities in(2.4) follow from the equations in(2.3). Similarly, in the foreign country, the labor supply of L^* must be equal to the total demand by the foreign firms.

$$
\begin{aligned}
L^* &= \int_0^1 a^*(z)(1 - s(z))q(z)dz \\
&= \int_0^1 (1 - s(z)) \frac{w^*a^*(z)}{wa(z) + w^*a^*(z)} dz \frac{Y + Y^*}{w^*} \\
&= \int_0^1 (1 - s(z))s(z)b(z)dz \frac{Y + Y^*}{w} \\
&= (E[s] - E[s^2]) \frac{Y + Y^*}{w^*}
\end{aligned}
$$

(2.5)

Dividing(2.5) by(2.4), we get

$$
\omega = \frac{w}{w^*} = \frac{L^*}{L}.
$$

(2.6)

Equation(2.6) says that the relative wage is a function of the relative labor endowment alone. It does not depend on the technology gap between the two countries. A higher labor productivity of the home country boosts the demand for home labor as it increases the market shares of the home firms. However, at the same time, it decreases the demand for home labor as the home firms need less labor to produce a given quantity of output. These two effects exactly cancel out in our model, while the former effect exceeds the latter in most other models. I do not want to emphasize this somewhat annoying result. It clearly depends on the unit-elastic demand. The only function that it serves here is its simplifying power.

Using(2.6), we can express the equilibrium market share of the home country in each market as a function of the two parameters: comparative advantage and relative labor endowment.

$$
s(z) = \frac{A(z)}{A(z) + L^*/L}
$$

(2.7)

National income and its distribution can be determined in the following way. National income of the home country must be equal to the total expenditure on domestically produced goods.

(2.8) $$Y = \int_0^1 s(z)b(z)dz(Y + Y^*) = E[s](Y + Y^*)$$

Using(2.4) and(2.8),

(2.9) $$Y = \frac{wL}{1 - \dfrac{E[s^2]}{E[s]}}$$

The foreign counterparts of equations(2.8) and(2.9) can be derived in the same way.

3. THE PATTERN OF TRADE

The pattern of trade emerging from this model is drastically different from that in a traditional Ricardian model. First of all, there is no specialization. Both countries produce in all industries. Comparative advantages affect only the distribution of a country's market shares over industries. We can also generate a two-way trade in each industry as in the Cournot competition model of Brander(1981) in the internationally-segmented markets. Suppose that the home market and the foreign market for each good z are completely segmented. Each firm makes distinct quantity decisions for each market, treating the other firm's decisions in each market as given. In the resulting Cournot equilibrium, the home firm supplies the fraction $s(z)$ of the foreign market, whose size is equal to $b(z)Y^*$. Thus, the export of the home country in this industry is given by

(3.1) $$x(z) = s(z)b(z)Y^* = s(z)b(z)(1 - E[s])(Y + Y^*).$$

In the home market whose size is equal to $b(z)Y$, the foreign firm supplies the fraction $1 - s(z)$. Thus, the import of the home country in this industry equals

(3.2) $\qquad m(z) = (1 - s(z))b(z)Y = (1 - s(z))b(z)E[s](Y + Y^*).$

Thus, we have both exports and imports in a single industry. The volume of trade in this industry is equal to

(3.3) $\qquad x(z) + m(z) = [s(z)(1 - E(s)) + (1 - s(z))E(s)]b(z)(Y + Y^*).$

The net export of good z is given by

(3.4) $\qquad x(z) - m(z) = (s(z) - E[s])b(z)(Y + Y^*).$

The pattern of net trade implied by equation(3.4) is shown in <figure 1>. $\bar{z}$ is the industry at which the home country's market share is equal to its national mean. Note that $s(z)$ is decreasing in z in equation(2.7). Thus, the ratio of the net export to the market size decreases as comparative advantage of the home country diminishes. In industries where the home country is more competitive than in the average market, it becomes a net exporter. In industries where the reverse is true, it becomes a net importer. In this sense, the Cournot-Ricardo model preserves the basic Ricardian flavor. Each country's pattern of net trade reflects its comparative advantages.[1]
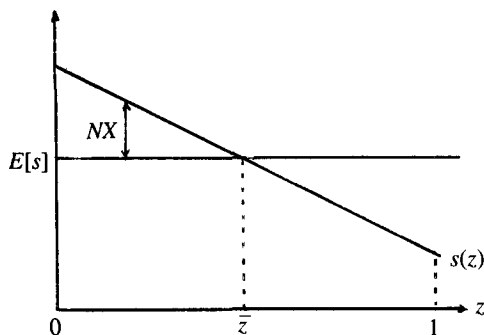
<Figure 1> The pattern of net trade in the Cournot-Ricardo Model

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(1) This property does not depend on the segmented market assumption. Even when firms set quantities in the integrated world market, it is still valid if we replace the term net trade by trade.

The pattern of intra-industry trade can be examined by constructing the following index for each industry, which measures the portion of pure cross-hauling in total trade.

$$(3.5) \quad I(z) = 1 - \frac{|x(z) - m(z)|}{x(z) + m(z)} = 1 - \frac{|s(z) - E[s]|}{s(z)(1 - E[s]) + (1 - s(z))E[s]}$$

We can easily show that $I(z)$ is increasing in z for $z \in [0, \bar{z}]$, reaching 1 at $\bar{z}$, and decreasing in z for $z \in [\bar{z}, 1]$. In industries where a country's relative cost is unusually high or unusually low, inter-industry trade is dominant. In industries where it is close to the average, intra-industry trade is dominant.

The total volume of trade between the two countries can be calculated as

$$(3.6) \qquad \int_0^1 x(z) + m(z)dz = 2E[s](1 - E[s])(Y + Y^*)$$

Note that the ratio of trade to world income achieves its maximum when $E[s]$ equals 1/2 or when the two countries are identical in terms of national income. As the disparity in national income increases, the ratio of trade to world income falls. Thus, our model predicts that there will be more trade between similar countries, where similarity is defined in terms of relative income.

Now we turn to the volume of intra-industry trade. For this, we calculate the Grubel-Lloyd index of intra-industry trade:

$$(3.7) \qquad I = 1 - \frac{\int_0^1 |x(z) - m(z)|dz}{\int_0^1 x(z) + m(z)dz} = 1 - \frac{E[|s(z) - E[s]|]}{2E[s](1 - E[s])}.$$

Note that $E[|s(z) - E[s]|]$ is the mean absolute deviation of a country's market shares off its national mean, which measures the dispersion of the market shares over industries. Suppose the two countries become more similar in terms of national income and $E[s]$ approaches 1/2. As we noted above, the total volume of trade as a ratio to world income increases. If this happens without changing the dispersion of the market shares over industries, the index of

intra-industry trade increases. This result is due to the fact that inter-industry trade depends on the 'dispersion' of the market shares over industries, but the total volume of trade increases with symmetry in the national means of the market shares. Our model predicts that intra-industry trade will be prevalent between similar countries. Here, similarity is defined in terms of national income, which in turn depends on overall productivity level and population size. Suppose instead the two countries are similar in terms of the 'distribution' of productivities over industries, keeping the national means constant. In other words, in industries where the home country's productivity is high(low) relative to its national mean, the foreign country's productivity is also high(low) relative to its national mean. This will make the comparative advantage curve $A(z)$ flat and we will have a low dispersion of the market shares over industries. Thus, the index of intra-industry will be high for similar countries, where similarity is defined in terms of the distribution of productivities over industries.

4. CONCLUDING REMARKS

I constructed a simple Cournot-Ricardo model of trade by replacing the competitive market assumption of the DFS model by the assumption that each industry is a Cournot duopoly in internationally segmented markets. In this model, the volume and the nature of trade depends on two factors. One is similarity between countries measured in terms of the distance of the PPF from the origin or income size. The other is similarity between countries measured in terms of the slopes of the PPF, which determines the dispersion of the market shares over industries. The volume of trade as a ratio to income increases as similarity in the former sense increases. The model also implies that the intensity of intra-industry trade increases·as similarity between countries increases in both senses. Thus, the Cournot-Ricardo approach provides a third conceptual framework for understanding the prevalence of intra-industry trade among similar countries, on top of the Chamberlinian model of trade and the Heckscher-Ohlin-Ricardo approach.

The simple formulas that we obtained heavily depend on the specific assumptions made. For example, using a CES utility function instead of the Cobb-Douglass one would generate complete specialization in some industries, especially around the two ends of the commodity

interval. The share parameters $b(z)$ would also depend on the relative prices of goods, much complicating the analysis. Allowing for transportation costs, which this paper assumed away, would generate sectors with no trade. However, I believe that the main force identified by this paper would survive various extensions, as it is based on the following simple observation. The inter-industry portion of trade in an industry is caused by the difference between exports and imports. Suppose the home market and the foreign market are of equal size. As net export is determined by the share of the home firm in the foreign market less the share of the foreign firm in the home market, it increases with disparity in the two firms' market shares, which reflect relative unit costs. Thus, we can see that the importance of inter-industry trade would increase as relative productivity varies a lot across industries. However, the argument above does not really depend on the equal-size assumption. If the foreign markets are a lot bigger than the home markets, the market shares of the home firms must be, on average, a lot smaller than those of the foreign firms. Thus, in the 'average' industry, the disparity in market size is exactly canceled out by the disparity of the market shares, implying no net trade. Therefore, we can observe that what really determines the volume of net trade is the deviation of the market shares off the mean or the variation of relative productivity across industries.

A more fundamental criticism can be raised against the mode of competition adopted by the paper. As intra-industry is generated by pure strategic perception, it can be regarded as fragile unless we can supply a solid micro foundation. Venables(1990) and Ben-Zvi and Helpman(1992) show that intra-industry trade vanishes if firms set world-wide capacities first and then compete á la Bertrand in segmented markets. As this specification of the game is exactly the one used by Kreps and Scheinkman(1983) to rationalize Cournot for a single market competition, these results should be accepted as a serious criticism of the popularity of the Brander model. The relevance of this paper is thus limited by the intuitive appeal of the model and the possibility of providing its micro-foundation.

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