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INTRAINDUSTRY TRADE OF INTERMEDIATE GOODS: DETERMINANTS AND WELFARE

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The purpose of this paper is to develop a simple model which considers economies of scale and product differentiation in intermediate goods and to examine the implications for trade patterns and welfare. We have shown that the intersectoral pattern of trade is determined by the cross-country difference in relative factor endowments but that there also is intraindustry trade. In addition, the share of intraindustry trade in total trade is increasing as countries become similar in relative factor endowments. The more important the intermediate goods in the production of the final goods, the more differentiated the intermediate goods, and the more capital abundant the home country, both factors can gain from trade.

I. INTRODUTION

The traditional theory of international trade has yielded many useful insights about a trading world economy. It explains trade entirely by differences among countries, especially differences in their relative endowments of factors of production. In practice, however, nearly half the world's trade consists of trade between industrial countries that are relatively similar in their relative factor endowments. Greenaway and Milner(1986), an excellent literature survey of the empirical analyses on intraindustry trade, have shown that actual trade patterns between industrial countries include substantial two-way trade in goods of similar factor intensity. This intraindustry trade seems hard to explain from the point of view of a conventional trade analysis.

During the past ten years a growing body of literature explaining the intraindustry trade model have assumed that only final good are differentiated products [e.g., Krugman (1979, 1981), Lancaster (1980), Helpman (1981), and Lawrence and Spiller (1982)]. However, a large proportion of trade is in intermediate in-

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puts. Ethier (1982) has argued that it is in intermediate rather than final goods production that product differentiation is most important, and that producers' goods are in fact much more prominent in trade than are consumers' goods.

The purpose of this paper is to combine the effect of economies of scale and monopolistic competition in the intermediate good sector into a model and to examine the implications on patterns of trade and on welfare. We explore how the share of intraindustry trade and welfare depend on the relative size of economies and relative factor endowment differentials. We also analyze the impact of trade on the implications for income distribution and welfare.

Our model is similar to Ethier's (1982) in treating the differentiated intermediate goods. On the other hand, it differs from Ethier's(1982) structure of an economy. We consider an economy in which there is only one type of final goods assembled from intermediate goods, while Ethier (1982) considers two types of final goods-one is a homogeneous product and the other is an assembled final product. Ethier(1982) has assumed that assembled final goods are not tradable, but they are assumed to be tradable in our model.

Section II describes the structure of a model and the equilibrium of the integrated world. In Section III, we divide the world into two countries by means of a division of resources and then we investigate how the pattern of trade and volume of trade depend on this division. Section IV examines the effects of trade on income distribution and welfare. Section V summarizes the results.

II. INTEGRATED EQUILIBRIUM

We will construct a two-sector, two-factor model and describe its equilibrium for an integrated world economy.[1] Suppose that there are two goods produced in the world economy: a homogeneous final product, and a differentiated intermediate product. We also assume there are two factors of production, that is, labor and capital. A homogeneous final product is produced at constant returns to scale, using not only labor but also a number of varieties of intermediate input, and in perfectly competitive markets. An intermediate product is produced with variety-specific increasing returns to scale, and the market for intermediate goods is characterized by monopolistic competition.

The production function of the final product is assumed to be[2]

$$(1)\quad Y = L_y^{1-\alpha} \left(\sum_{i=1}^{n} x_i^{\theta} \right)^{\alpha/\theta}, \quad 0<\alpha,\theta<1$$

[1]See Helpman and Krugman(1985) for detailed explanation to the concept of the integrated equilibrium.

[2]This production function is a variant of Ethier's (1982), and it is also similar to Dixit and Stiglitz's (1977) utility function.

where Y is a homogeneous commodity produced in a competitive market, and x_i is the quantity of the ith intermediate product, while L_y is labor employed in the production of Y, and n is the number of intermediate goods. Lower values of θ correspond to greater "product differentiation".[3]

This production function is associated with the cost function:[4]

$$(2)\quad C(w, q_i, Y) = Aw^{1-\alpha} \left(\sum_{i=1}^{n} q_i^{-p} \right)^{-\alpha/p} Y$$

where $A = \alpha^{-\alpha} (1-\alpha)^{\alpha-1}$, and $p = \theta/(1-\theta) > 0$. Here, w is the wage rate, and q_i is the price of the ith intermediate product.

We assume that intermediate goods are all producible from capital and labor, and that the cost function for any x_i is

$$(3)\quad C(w, r, x_i) = rf + w\beta x_i \quad \text{for all } i = 1....n$$

where f is the capital setup cost, r is the rental rate, and $1/\beta$ is the marginal product of labor. The production cost of the ith intermediate product involves fixed costs (rf) and variable costs ($w\beta x_i$). The inclusion of a fixed cost implies that average costs will decrease as output increases, and that there are increasing returns to scale in producing any x_i. Therefore, no two firms will produce the same xi and each firm specializes in one product.

Furthermore, since all varieties of the intermediate product enter into the production function(1), and each variety of intermediate product is assumed to be produced via identical production function, in equilibrium all intermediate goods actually produced will be produced in equal amounts and at the same price, so that we can denote $x = xi$ and $q = qi$ for all i. Thus equations(1) and (2) can be rewritten as (1)′ and (2)′:

$$(1)'\quad Y = n^{\alpha/\theta} L y^{1-\alpha} x^{\alpha} \text{ and}$$
$$(2)'\quad C(w, q, n, Y) = An^{-\alpha/\rho} w^{1-\alpha} q^{\alpha} Y.$$

Since the final product is produced in a competitive market, profits of the final good sector are always zero. The zero profit equilibrium is

$$(4)\quad P = An^{-\alpha/p} w^{1-\alpha} q^{\alpha}$$

where P is the price of final product Y.

We assume that the number of intermediate goods n is sufficiently large. Under

[3]See Dixit and Stiglitz (1977), Krugman (1979) and Ethier (1982).

[4]See Varian (1984, ch. 2).

this assumption, each individual firm, being small relative to the economy, can ignore the effects of its decisions on the decisions of other firms. In that case the elasticity of demand for each x_i is $1/(1-\theta)$ [5] Each firm producing x will choose its price to maximize its profits. The condition for profit maximization is to equate marginal revenue to marginal cost. This condition is

(5) $q = \beta w/\theta$ for all i.

Profits will be driven to zero by the entry of new firms. The zero profit equilibrium for all x_i is

(6) $qx = rf + w\beta x$.

As is well known [Varian (1984, ch. 2)], demand functions for factors of production can be obtained from the properties of the cost functions. The factor market clearing conditions are given by

(7) $\beta nx + A(1-\alpha)n^{-\alpha/p}(q/w)^{\alpha} Y = L$
(8) $nf = K$

where L is the endowment of labor and K is the endowment of capital.

The market clearing condition for intermediate goods is

(9) $nx = nx_d = A\alpha n^{-\alpha/p}(q/w)^{\alpha-1} Y$

where x_d is the quantity of the representative intermediate product demanded in the production of Y.

The system of equilibrium conditions for the integrated economy is represented by equations (4), (5), (6), (7), (8), and (9). It provides, therefore, a solution to Y, x, n and three relative prices, say p/w, q/w and r/w.[6]

We can obtain the relative price of intermediate product q/w and the number of intermediate products n from (5) and (8) respectively. They are

(10) $q/w = \beta/\theta$ and
(11) $n = K/f$.

The relative price of x depends on the marginal product of labor and on the elasticity of demand for x. The higher the elasticity of demand for x (i.e., the larger

[5]See Helpman and Krugman (1985, ch. 6).

[6]We choose wage rate as numeraire, and we always assume the existence of an equilibrium.

the value of θ), the lower its price. The number of varieties depends on the endowment of capital and the magnitude of capital setup cost.

Using (7) and (9), we can obtain the size of x plant and output of Y:

$$(12)\quad x = (\alpha f/B)\,(L/K) \text{ and}$$
$$(13)\quad Y = L/[AB(q/w)^{(\alpha-1)}n^{-\alpha/p}]$$

where $B = (1-\alpha)\,(q/w) + \alpha\beta$.

Substituting (12) into (6), we get

$$(14)\quad r/w = [\alpha((q/w)-\beta)/B]\,(L/K).$$

Expression (12) means that the higher the L/K ratio, the larger the production of x. This is so, since a larger L/K implies lower variable cost, and hence firms increase their output.[7] If capital requirement f rises, so will x, since a larger output of x is needed to cover the higher fixed costs.[8]

Substituting (10) and (11) into (4), we get the relative price of Y:

$$(15)\quad P/w = An^{-\alpha/p}\,(q/w)^{\alpha}.$$

The relative price of Y is negatively correlated with the number of intermediate goods. Thus the price of Y will be relatively low in capital abundant country, since it will have a greater variety of intermediate goods.

III. TRADE PATTERNS AND TRADE VOLUME

Suppose the world consists of two countries. Let us also assume that the two countries have identical preferences and the same production conditions, and that free trade exists. Then commodity prices, P/w and q/w, will be equalized between the two countries through free trade. Moreover, the relative factor price, r/w. and output per firm in the intermediate good sector will also be equalized.[9] Therefore, among six endogenous variables only the variables n and Y are different between the two countries. The number of varieties n and the production of Y in each country are determined by a division of factor endowments.

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[7]We can see from (14) that the higher the L/K ratio is, the larger the r/w ratio is. Moreover, since capital is a fixed input and labor is a variable input, a larger r/w implies lower variable cost.

[8]The parameter f can be thought of as the counterpart of the minimum efficient size variable used in the industrial organization literature.

[9]Since x is used symmetrically in producing Y, output x per firm must be the same in both countries. In this case, the r/w ratio must also be the same in both countries to satisfy Equation (6).

In order to simplify the discussion, let us introduce the following relationships of differential factor endowments: [10]

(16) $K^F = agK^H$; $L^F = (2\text{-}a)gL^H$; $0<a<2$, and $g>0$

where a is a measure of the capital-labor differential and g is a measure of country size. We will use "H" and "F" to denote the variable of the home country and that of the foreign country respectively. If $a>1$, the home country is capital abundant, while for $a<1$, the home country is labor abundant. If $g<1$, the home country is larger than the foreign country and vice versa for $g<1$. If $g=1$, the two countries are of the same size, and if $a=1$, the two countries are endowed with identical relative factor endowments.

The world capital and labor endowments are

(17) $K = K^H + K^F = (1+ag)K^H$; $L = L^H + L^F = [1+(2\text{-}a)\,g]L^H$.

The international capital-labor ratio k is

(18) $k = \delta k^H$

where $\delta = (1+ag)/[1+(2+a)g]$, and k^H is the domestic capital-labor ratio.

By utilizing labor endowment constraint(7), we can find the post-trade production of Y in the home country:

$$(19)\quad Y^H = \frac{L^H}{(1\text{-}\alpha)\,(p/w)}\left(1-\frac{\alpha\beta k^H}{Bk}\right).$$

Since there is only one type of final product, all income is spent to buy the final product Y. Post-trade demand for Y in the home country is

(20) $Y_dH = I^H/P$

where $I^H = wL^H + rK^H$, that is the total income of the home country.

Therefore, the surplus in trade of Y goods is then [11]

$$(21)\quad E_y{}^H = (PY^H - I^H)/w = \left(\frac{\alpha L^H}{1\text{-}\alpha}\right)\left(1-\frac{k^H}{k}\right)$$

where E_y is the exports of Y in the home country.

[10]This relationship is the same as Lawrence and Spiller's (1983).

[11]Since wage rate is used as numeraire, we measure trade surplus by the labor unit.

Substituting (17) and (18) into (21), we get

$$(22)\quad E_y^H = \left(\frac{2\alpha L}{1-\alpha}\right)\left(\frac{(a-1)g}{[1+(2-a)g]\,[1+ag]}\right).$$

From the above expression, it is clear that the sign depends on the sign (a-1) but it does not depend on the magintude of g. Since the sign (a-1) determines which country is capital abundant, relative factor endowments determine which country is an exporter or an importer of the final product Y. Moreover, there will be intraindustry trade in intermediate goods. Since intermediate goods are differentiated and there are economies of scale in producing them, each country will specialize in the production of different varieties. Therefore, domestically produced varieties n^H will be exported and varieties produced by the foreign country will be imported. Because trade is balanced, an exporter of final goods will become a net importer of intermediate goods.

From the above discussion, we can state the following proposition for trade patterns:

Proposition 1. The labor abundant country is an exporter of final product Y and a net importer of intermediate product. The trade pattern is independent of the country size.

The production Y uses some proportion of the output x of every variety. Therefore, home demand for intermediate goods consists of n^H varieties that are domestically produced and varieties that are imported. If x_d^H stands for home demand for the intermediate product, then $x_d^F(=x-x_d^H)$ will be the foreign demand for the intermediate product. Hence we have

$$(23)\quad E_x^F = (q/w)\, n^F x_d^H \text{ and}$$
$$(24)\quad E_x^H = (q/w)\, n^H x_d^F$$

where E_x^i $(i=H,F)$ is exports of x in country i, and x_d^i is the demand for intermediate goods in country i.

From (9) and (15), we get

$$(25)\quad x_d^H = \frac{\alpha P}{qn} Y^H \text{ and}$$

$$(26)\quad x_d^F = \frac{\alpha P}{qn} Y^F.$$

Substituting (19) and (25) into (23), we get

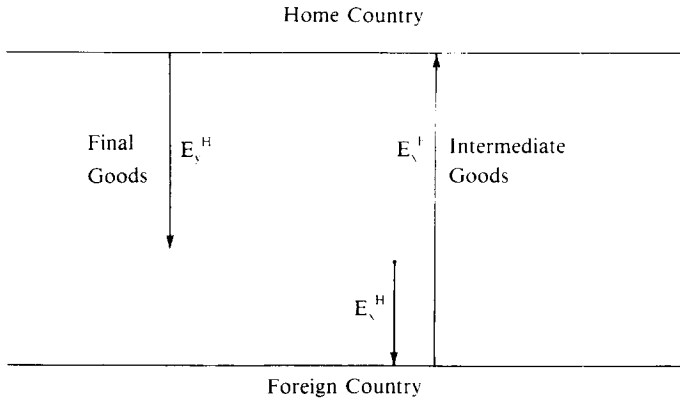
$$(23)' \quad E_x^F = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{n^F}{n}\right)\left(L^H - \frac{\lambda}{k} K^H\right)$$

where $\lambda = \alpha\beta/Bk$. Similarly,

$$(24)' \quad E_x^H = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{n^H}{n}\right)\left(L^F - \frac{\lambda}{k} K^F\right).$$

We consider only the case that the home country is relatively labor abundant, that is a>1. Hence it becomes an exporter of final goods and a net-importer of intermediate goods. Figure 1 portrays these trade flows. The length of every arrow describes the value of exports in an industry. [12] The volume of trade is equal to the sum of the length of these arrows.

We now turn to the determinants of the decomposition of trade flows into an intraindustry and an intersectoral trade. It is clear from figure 1 that the net flows within every industry describe what one would normally call intersectoral trade. Thus for the case described in the figure it seems appropriate to define the volume of intersectoral trade as exports of final goods by the home country plus net exports of intermediate goods by the foreign country. In this case the volume of intraindustry trade, which equals the total trade volume minus the volume of intersectoral trade, is equal to twice the exports of intermediate goods by the home country (which is a net importer of intermediate goods). Because trade is balanc-



[**Figure 1**] Trade Flows

[12]We can easily show that $E_y^H = E_x^F - E_x^H$.

ed, the volume of trade also equals twice the exports of the home country as well as twice the exports of the foreign country.

The Grubel-Lloyd (1975) index which is defined as the share of intraindustry trade in the total volume of trade is

$$(27)\quad G=(2E_x)/(2E_x^*) \qquad ,1<a<2$$

where G is the Grubel-Lloyd intraindustry trade index.

Substituting (17), (18), (23)', and (24)' into (27), we get

$$(27)'\quad G=\frac{[(2-a)\,\delta-\lambda a]}{[a\delta-\lambda a]} \qquad ,\ 1<a<2.$$

From (27)', we easily derive the following:

$$(28)\quad (\partial G/\partial a)<0; \qquad (\partial G/\partial g)>0.$$

and if $a=1$, then $G=1$

From the expressions (27)' and (28), we can state proposition 2:

Proposition 2. For a given world distribution of country size, the lower the difference of relative factor endowments, the higher is the share of intraindustry trade. In particular, that share becomes one for $a=1$. For a given difference of relative factor abundance, the share of intraindustry trade is higher, the larger the trading partner.

This proposition implies that the intraindustry share is increasing in similarity of relative factor endowments, and it depends on country size. It is apparent that the smaller the difference in relative factor endowments, the larger is the share of intra-industry trade, and that the labor abundant country, which is an exporter of final goods and a net importer of intermediate goods, will have a high share of intraindustry trade in trade with the larger country.

IV. WELFARE

Imperfect competition does not lead the economy to an optimum. [13] As a result it is not at all clear whether countries will gain from trade. However, Krugman (1981) and Lawrence and Spiller (1983) argue that in the presence of increasing returns and product differentiations, there will be gains from trade over and above

[13]Lawrence and Spiller (1983) shows that in a monopolistic competitive market an allocation of resources is not consistent with Pareto optimality.

those from conventional comparative advantage.

The basic result for income distribution from the Heckscher-Ohlin model is that owners of factors of production which are scarcer in a particular country than they are in the world as a whole are likely to lose as a result of trade. In particular, the real rentals of some factors necessarily decline in terms of goods as a result of trade. This is well known as the Stolper-Samuelson theorem.

We now turn to a consideration of the role of the extra gains from trade in modifying the implications of trade for income distribution. Let a prime on a variable indicate its free trade value while unmarked variables refer to autarky.

Using (15) and (17), we can show that the ratio of a real wage rate in terms of final goods after trade to before trade is

$$(29)\quad W = \frac{(w/P)'}{(w/P)} = (1+ag)^{\alpha/p}$$

where W denotes the change of a real wage rate. Similarly, using (14), (15), and (17), we can obtain

$$(30)\quad R = \frac{(r/P)'}{(r/P)} = [1 + (2\text{-}a)g]\,[1+ag]^{(\alpha/p)-1}$$

where R denotes the change in a real reward of capital in terms of final goods after trade. If both W and R are greater than one, then we can say that both factors are better off after trade.

Expressions (29) and (30) give us one immediate result: If $\alpha/p>1$, then both factors necessarily gain from trade. Recall that α is a share of intermediate goods in output of Y, and that p is a measure of the substitutability between any two x-products. Therefore, this result implies that if intermediate goods are more important than labor in production of Y and they are sufficiently differentiated, both factors gain from trade.

Expression (29) shows that labor always gains from trade, not depending on whether labor is abundant or scarce, and that the labor's gains from trade will be larger, the larger the relative labor endowments of the home country and the larger the size of the partner country.

However, if $\alpha/p<1$, whether capital gains depends on the relative size of the countries as well as on the factor endowment differential. Let us consider the case where the home country is extremely capital or labor abundant; i.e., $a=0$ or $a=2$. Equation (30) becomes

$$(30)'\quad R_{a=0} = (1+2g);\ R_{a=2} = (1+2g)^{(\alpha/p)-1}$$

where $R_{a=j}$ $(j=0, 2)$ denotes the value of R when $a=j$.

Differentiating (30) by a, we obtain

$$(31)\quad \partial R/\partial a = [(\alpha/p)-(\delta+1)]g\,[1+(2-a)\,g]\,[1+ag]^{(\alpha/p)-2}.$$

From (30)' we learn that if $\alpha/p<1$, then $R_{a=0}>1$, and $R_{a=2}<1$. Moreover, from (31) we observe that when $\alpha/p/<1$, $\partial R/\partial a<0$. This means that an increase in a reduces capital's real rental of the home country monotonically after trade. Therefore, there is a unique a° $(0<a^\circ<2)$, such that capital's real rental remains the same after trade. [14] Hence when the home country is sufficiently labor abundant, that is $a^\circ<a$, capital in the home country will lose from trade. When $a<a^\circ$, capital in the home country gains from trade.

Proposition 3. The more differentiated the intermediate goods are and the more capital abundant the home country is ($a<a^\circ$), both factors gain from trade.

Let us now examine the effects of trade on the welfare of the whole economy. Since we consider an economy in which there is only one type of final product, utility of an economy depends on its income and the price of the final product: (I/P). Then the change in utility of an economy is

$$(32)\quad U = \frac{(I/P)'}{(I/P)} + \frac{(w/P)'L + (r/P)'K}{(w/P)L + (r/P)K}$$

where U denotes the change in utility of an economy after trade. If $U>1$, then free trade income and prices enable the economy to purchase autarky aggregate consumption quantities. Using (29) and (30), we can rewrite (32) as

$$(32)'\quad U = (1-\phi)\,W + \phi R, \qquad \text{where } \phi = \alpha\,(1-\theta).$$

Expression (32)' shows that U is the weighted average level of W and R, and the weighting factor ϕ is in turn determined by α and θ. U can be greater than one, if $R<1$, but W or ϕ is sufficiently large. Therefore, even if capital loses from trade in a labor abundant country, the total welfare of an economy can be increased after trade. This will presumably happen because increasing returns provide additional gains.

V. CONCLUDING REMARKS

This paper has developed a simple model in order to analyze how relative fac-

[14] We can find a° from (30); i.e., $R_{a=a0}=1$. Thus a° depends on α/p and g.

tor abundance and the country size affect the share of intraindustry and factor rewards.

We have shown that the intersectoral pattern of trade is determined by the cross-country difference in relative factor endowments but that there also is intraindustry trade when countries do not differ too much in the composition of factor endowments. In addition, the share of intraindustry trade in total trade increases as countries become similar in relative factor endowments.

In the presence of increasing returns, trade always offers the opportunity for a simultaneous increase in the diversity of products available and in the scale at which each product is produced. If the world in fact takes advantage of this opportunity, there will be gains from trade over and above those from the conventional comparative advantage. We have shown that income-redistribution effects can be outweighed by the gains from a larger market. The more differentiated the intermediate goods and the more capital abundant the home country, both factors gain from trade.

It must be emphasized that the model presented here is in no sense a general one. Most of the results are derived on the basis of a specific production function and a specific economic structure. Therefore, the results of the analysis are at best suggestive. Nonetheless, they seem intuitively plausible and also seem to have something to do with actual experience.

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