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INTERNATIONAL TRADE AND INCOME DISTRIBUTION: A RECONSIDERATION

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Introduction

In principle, free trade can make everyone better off; but received theory, from Stolper and Samuelson (1941) to Jones (1971), suggests that this is unlikely to happen in practice. The changes in relative goods prices that come with expanded trade produce changes in the distribution of income; and in the simple models which make up the core of trade theory these changes in income distribution invariably leave the owners of some factors of production absolutely worse off. The implication is that trade liberalization always involves trading off gains for some against losses for others, suggesting that moves toward freer trade will occur only rarely and after severe political struggles.

If one looks at the historical record, however, especially in the postwar period, it begins to appear as if this is one of those unusual cases in which theory has been too pessimistic about the consequences of *laissez-faire*. The last thirty years have been marked by a great increase in trade, especially among the industrial countries, with very few problems of adjustment. Only in recent years, with the growth of imports from the newly industrializing countries, have the pressures for protection again become strong. This experience of painless growth in trade is in itself a major riddle, but it is wrapped in the larger enigma of the pattern of trade. Standard theory predicts trade between countries with different factor endowments, with countries specializing in goods with different factor intensities. Yet the growth in trade has largely been among the industrial countries, which appear to be fairly similar in factor endowment and surely have become more similar over time. And the trade among these countries is largely, and increasingly, two-way trade in similar products. Thus there are three great paradoxes of international trade: who trades with whom, what they trade in, and why it hurts so little.

The purpose of this paper is to provide a tentative explanation of these paradoxes, one which gives some guide to identifying situations in which expansion of trade will and will not pose serious problems of income distribution. The explanation is not a new one: it is essentially the same as that put forward by Balassa (1967), Grubel (1970), and Kravis (1971), among others. What this paper does is put the argument in terms of a formal model, a step which may be of some help in clarifying and disseminating ideas which have been "in the air" for some time.

Briefly, the argument runs as follows. There are two kinds of trade: Heckscher-Ohlin trade, which is based on differences in factor proportions, and "intraindustry" trade, which is based on the interaction of economies of scale with product differentiation. Countries with similar factor endowments will have little incentive for engaging in Heckscher-Olin trade, but will still engage in intraindustry trade. But intraindustry trade does not have the strong distributional effects of Heckscher-Ohlin trade. The result is that expansion of trade between countries with sufficiently similar factor endowments will not pose the distributional problems which Heckscher-Ohlin theory leads us to expect.

Obviously, the crucial step in formalizing this argument is to model intraindustry trade. In this paper I use a simple model of intraindustry trade which was developed in an earlier paper (Krugman 1979), and extend it to a two-industry, two-factor world. The structure of this model and the determination of this model's equilibrium in a closed economy is set forth in Section 1. Section 2 shows how the pattern of trade between two countries is determined in the model, developing the basic relationship between differences in factor endowments and the extent of intraindustry trade. Section 3 then examines the effects of trade on income distribution, and shows how the extent of intraindustry trade determines whether scarce factors of production gain or lose from trade. Finally, Section 4 summarizes the results and discusses some implications for theory and policy.

It must be emphasized that the model presented here is in no sense a general one. In addition to making strong assumptions about functional forms of cost and utility functions, I impose a great deal of symmetry on the model to simplify the analysis and give a natural meaning to the concept of "similarity" in factor proportions. Thus 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.

1. The Model in a Closed Economy

Intraindustry trade depends on the existence of unexhausted economies of scale in production. The main problem in modelling this kind of trade is how to handle these scale economies, which must lead to a breakdown of perfect competition (unless they are wholly external to firms). In this paper, as in an earlier paper (Krugman 1979), I will use the device of Chamberlinian monopolistic competition, basing the model on recent work by Dixit and Stiglitz (1977). An "industry" will consist of a large number of firms, all producing somewhat differentiated products, all operating on the downward-sloping parts of their average cost curves. There will be two-way international trade within an industry, because firms in different countries will produce different differentiated products. What prevents countries from producing a complete range of products domestically is the existence of fixed costs in production; thus scale economies are the basic cause of intraindustry trade.

Let us begin, however, with a two-industry model of a closed economy. All of the products in each industry will enter symmetrically into demand, with the two industries--industry 1 and industry 2--themselves playing symmetric roles. All individuals will have the convenient utility function

$$U = \ell n\left(\sum_{i=1}^{n_1} c_{1,i}^{\theta}\right)^{1/\theta} + \ell n\left(\sum_{j=1}^{n_2} c_{2,j}^{\theta}\right)^{1/\theta} \tag{1}$$

$$0<\theta<1$$

where $c_{1,i}$ is consumption of the i^{th} product of industry 1; $c_{2,j}$ is consumption of the j^{th} product of industry 2; and n_1, n_2 are the number of products actually produced in each industry. The utility function (1) has several useful properties. First, it ensures that half of income will always be spent on industry 1's products, half on industry 2's products. Second, if the number of products in each industry is large, it implies that every producer faces a demand curve with elasticity $1/1-\theta$. Finally, (1) will allow us to represent the gains and losses from trade in a particularly simple way.

On the demand side, then, an industry is assumed to consist of a number of products which are imperfect substitutes for one another. On the supply side, however, they will be assumed to be perfect substitutes. There will be only two factors of production, type 1 labor and type 2 labor, each of which is wholly specific to an industry but nonspecific among products within an industry. Thus type 1 labor will be used only in industry 1, type 2 only in industry 2. Within each industry the labor required to produce a particular product will consist of a fixed set-up cost and a constant variable cost:

$$\ell_{1,i} = \alpha + \beta x_{1,i} \qquad i=1,\ldots,n_1 \tag{2}$$

$$\ell_{2,j} = \alpha + \beta x_{2,j} \qquad j=1,\ldots,n_2$$

where $\ell_{1,i}$ is labor used in producing the i^{th} product of industry 1; $x_{1,i}$ is the output of that product; and so on. To go from these required labor inputs to nominal costs we must multiply by the wage rates of the two types of labor, w_1 and w_2.

To close the model, we begin by noting that output of each product, x, is the sum of individual consumptions of the product. At the same time, total employment in each industry is the sum of employment in producing all the individual products. Assuming full employment, we have

$$\sum_{i=1}^{n_1} \ell_{1,i} = L_1 = 2-z \tag{3}$$

$$0<z<1$$

$$\sum_{j=1}^{n_2} \ell_{2,j} = L_2 = z$$

Thus the total labor force is set equal to 2, with the parameter z measuring factor proportions. As we will see below, z will assume crucial significance in determining the importance of intraindustry trade and the effect of trade on income distribution.

We are now prepared to examine the determination of equilibrium in this model. This involves determining how many products are actually produced in each industry, the output of each product, the prices of products, and the relative wages of the two kinds of labor. We should note at the outset that it is indeterminate <u>which</u> products are produced--but it is also unimportant.

Our first step is to determine the pricing policy of firms. We assume that producers can always costlessly differentiate their products. This means that each product will be produced by only one firm. If there are many products the elasticity of demand for each product will, as already noted, be $1/1-\theta$. (This is proved in the Appendix). Thus each firm will face a demand curve of constant elasticity. We then have the familiar result that the profit-maximizing price will be marginal cost plus a constant percentage makeup:

$$p_1 = \theta^{-1}\beta\, w_1 \tag{4}$$

$$p_2 = \theta^{-1}\beta\, w_2$$

where p_1, p_2 are the prices of any products in industry 1 and 2 respectively which are actually produced.

Given the pricing policy of firms, actual profits depend on sales:

$$\pi_1 = p_1 x_1 - (\alpha + \beta\, x_1) w_1 \tag{5}$$

$$\pi_2 = p_2 x_2 - (\alpha + \beta\, x_2) w_2$$

where x_1, x_2 are sales of representative firms in the two industries.

But in this model there will be free entry of firms, driving each industry to Chamberlin's "tangency solution" where profits are zero. Thus we can use the condition of zero profits in equilibrium to determine the equilibrium size and number of firms. Setting $\pi_1 = \pi_2 = 0$, and using (4) and (5), we have

$$x_1 = x_2 = \frac{\alpha}{\beta} \cdot \frac{\theta}{1-\theta} \tag{6}$$

for the size of firms. The number of firms can then be determined from the full-employment condition:

$$n_1 = (2-z)/(\alpha+\beta\, x_1) \tag{7}$$

$$n_2 = z/(\alpha+\beta\, x_2)$$

The final step in determining equilibrium is to determine relative wages. This can be done very simply by noting that the industries receive equal shares of expenditure, and that since profits are zero in equilibrium these receipts go entirely to the wages of the industry-specific labor forces. So $w_1 L_1 = w_2 L_2$, implying

$$w_1/w_2 = z/(2-z) \tag{8}$$

We now have a completely worked-out equilibrium for a two-sector, monopolistically competitive economy. It is indeterminate which of the range of potential products within each industry are actually produced, but since all products appear symmetrically, this is of no welfare significance. The character of the economy is determined by the two parameters z and θ. The value of z determines relative wages: if z is low, type 2 labor will receive much higher wages than type 1 labor. The value of θ measures the degree of substitutability among products within an industry. It is also, in equilibrium, a measure of the importance of scale economies. From (4) we have $\theta = \beta w_1/p_1 = \beta w_2/p_2$. But βw_1, βw_2 are the marginal costs of production, while in equilibrium price equals average cost. Thus θ is the ratio of marginal to average cost (which is also the elasticity of cost with respect to output).

2. Factor Proportions and the Pattern of Trade

In the last section we saw how equilibrium can be determined in a simple closed-economy model with scale economies and differentiated products. We can now examine what happens when two such economies trade. What we are principally concerned with is the proposition, advanced in the introduction, that countries with similar factor endowments will engage in "intraindustry" trade, while countries with very different endowments will engage in Heckscher-Ohlin trade.

As a first step we need a working measure of the extent of intraindustry trade. The empirical literature on intraindustry trade (e.g., Hufbauer and Chilas 1974, Grubel and Lloyd 1975) generally concentrates on an index of trade overlap, i.e.,

$$I = 1 - \frac{\sum_k |X_k - M_k|}{\sum_k (X_k + M_k)} \tag{9}$$

where X_k is a country's exports in industry k, M_k is imports in that industry. This index has the property that if trade is balanced industry by industry, it equals one, while if there is complete international specialization, so that every industry is either an export or import industry, it equals zero. As we will see, this index fits in quite well with the model of this paper.

The other concept we need to tie down is that of "similarity" in factor endowments. In general this is not well defined. What I will do in this paper, however, is to consider a special case in which the concept does have a natural meaning, without trying to arrive at a general definition.

Let us suppose, then, that there are two countries, the home country and the foreign country. The home country will be just as described in Section 1. The foreign country will be identical, except for one thing: the relative sizes of the two industries' labor forces will be reversed. That is, the foreign country will be a mirror image of the home country. If we use a star on a variable to indicate that it refers to the foreign country, we have

$$L_1 = 2-z \qquad L_2 = z \tag{10}$$

$$L_1^* = z \qquad L_2^* = 2-z$$

Obviously, given this pattern of endowments we can regard z as an index of similarity in factor proportions. If $z = 1$, the countries have identical endowments. As z gets smaller, the factor proportions become increasingly different.

Now suppose these countries are able to trade, at zero transportation cost. As before, we can determine pricing behavior, the size and number of firms, and relative wages. In addition, we can determine the volume of pattern of trade.

The first point to note is that the elasticity of demand for any particular product is still $1/1-\theta$. This gives us price equations exactly the same as before:

$$p_1 = \theta^{-1} \beta w_1 \tag{11}$$

$$p_2 = \theta^{-1} \beta w_2$$

$$p_1^* = \theta^{-1} \beta w_1^*$$

$$p_2^* = \theta^{-1} \beta w_2^*$$

Now, however, the symmetry of the setup insures that all wages will be equal, both across industries and internationally:

$$w_1 = w_1^* = w_2 = w_2^* \tag{12}$$

The zero-profit condition will determine the equilibrium size of firm, x, which will be the same for both industries in both countries:

$$x = \alpha\theta/\beta(1-\theta) \tag{13}$$

Finally, full-employment determines the number of firms in each industry in each country:

$$n_1 = n_2^* = (2-z)/(\alpha+\beta x) \tag{14}$$

$$n_2 = n_1^* = z/(\alpha+\beta x)$$

What these results show is that trade will lead to factor price equalization, while leaving the pattern of production unchanged. Our remaining task is to determine the volume and pattern of trade. We can do this by noting two points. First, everyone will devote equal shares of expenditure to the two industries. Second, everyone will spend an equal amount on each of the products within an industry. This means that the share of all individuals' income falling on, say, industry 1 products produced in the foreign country is $\frac{1}{2} \cdot \frac{n_1^*}{n_1+n_1^*}$ --that is, the industry share in expenditure times that country's share of the industry. But the number of products is proportional to the labor force. Thus if we let Y be the home country's income, (equal to the foreign country's), X_1 be exports of industry 1 products, X_2 be exports of industry 2 products, M_1 be imports of industry 1 products, and M_2 be imports of industry 2 products, we have

$$X_1 = \frac{1}{2} Y \cdot (2-z/2) \tag{15}$$
$$X_2 = \frac{1}{2} Y \cdot (z/2)$$
$$M_1 = \frac{1}{2} Y \cdot (z/2$$
$$M_2 = \frac{1}{2} Y \cdot (2-z/2)$$

Now the relations (15) have two important implications. First, consider the volume of trade. Total home country exports are $X_1 + X_2 = \frac{1}{2} Y$. Thus the ratio of trade to income is independent of z, the index of similarity in factor proportions. This can be regarded as an answer to the first empirical paradox mentioned in the introduction, the large volume of trade among similar countries. In this model similar countries will trade just as much as dissimilar countries.

The second empirical paradox was the prevalence, in trade among similar countries, of two-way trade in similar products. If we substitute (15) into our expression for intraindustry trade (9), we get a simple, striking result:

$$I = z \tag{16}$$

The index of intraindustry trade equals the index of similarity in factor proportions.

This still leaves us with the third empirical paradox, which was that expansion of trade, when it involves largely intraindustry trade, seems to involve few problems of income distribution. To see how this can be understood is the task of the next section.

3. Gains and Losses from Trade

In this section we must again begin by tying down a concept which I have been using loosely. This is the idea of the "seriousness" of distribution problems. What we need is a clear way of formulating the notion that distribution problems from opening trade will not be serious if countries are sufficiently similar in factor proportions, so that the trade which results is primarily intraindustry trade.

The criterion I will use to define nonserious distribution problems is the following: distribution problems arising from trade will be held not to be serious if both factors gain from trade. This of course begs some questions, since there may be difficulties in getting groups to accept a relative decline in income even if they are absolutely better off. But this criterion is fairly reasonable, and turns out to give suggestive results.

To find out whether factors gain from trade, we need to know how utility depends on the variables of the model. Suppose an individual receives a wage w, and has the utility function (1). He will then spend $w/2$ on the products of each industry, and divide his expenditure equally among the products within an industry. Thus his utility will depend on his wage, the prices of representative products in each industry, and the number of products available:

$$U = \ell n\left[n_1(w/2n_1p_1)^{\theta}\right]^{1/\theta} + \ell n\left[n_2(w/2n_2p_2)^{\theta}\right]^{1/\theta} \tag{17}$$

$$= -2\ell n\ 2 + \ell n\ w/p_1 + \ell n\ w/p_2$$

$$+ \frac{1-\theta}{\theta}\ \ell n\ n_1 + \frac{1-\theta}{\theta}\ \ell n\ n_2$$

The function (17) has the convenient property that all the effects enter additively. Utility depends on real wages in terms of representative products and on diversity.

To analyze the effects of trade on welfare, it is useful to introduce some more notation.

U_1, U_2 = utility of workers in industry 1, 2

w_{11}, w_{12} = real wage of industry 1 workers in terms of products of industries 1 and 2

w_{21}, w_{22} = real wage of industry 2 workers in terms of products of industries 1 and 2

Then we can substitute into (17) to get (suppressing the constant term)

$$U_1 = \ell n\ w_{11} + \ell n\ w_{12} + \frac{1-\theta}{\theta}\ \ell n\ n_1 + \frac{1-\theta}{\theta}\ \ell n\ n_2 \tag{18}$$

$$U_2 = \ell n\ w_{21} + \ell n\ w_{22} + \frac{1-\theta}{\theta}\ \ell n\ n_1 + \frac{1-\theta}{\theta}\ \ell n\ n_2$$

We are now in a position to measure the welfare effects of trade. Suppose we start from a position of autarky, as in Section 1, then move to free trade, as in Section 2. There will then be two kinds of effects. First, there will be a "Stolper-Samuelson" effect as factor prices are equalized. As one can easily verify, labor's real wage remains the same in terms of the products of its own industry, while rising or falling in terms of the other industry's products depending on whether the factor is abundant or scarce. Thus in the home country this effect benefits labor in industry 1, hurts labor in industry 2.

The second effect comes from the increase in the size of the market, which makes a greater variety of products available. This works to everyone's benefit.

Since both effects work in its favor, the abundant factor must be made better off. This leaves us with the problem of determining the change in utility of the scarce factor--industry 2 labor in the home country, and the symmetrically placed industry 1 labor in the foreign country.

Let a prime on a variable indicate its free trade value, while unmarked variables refer to autarky. Then as we move from the autarky solution in Section 1 to the free trade solution in Section 2 the change in U_2 is

$$\begin{aligned} U_2' - U_2 &= \ln w_{21}'/w_{21} + \\ &\quad + \frac{1-\theta}{\theta} \ln n_1'/n_1 + \frac{1-\theta}{\theta} \ln n_2'/n_2 \\ &= \ln z/2-z + \frac{1-\theta}{\theta} \ln 2/2-z \\ &\quad + \frac{1-\theta}{\theta} \ln 2/z \end{aligned} \tag{19}$$

where the first term is negative, and represents the Stolper-Samuelson distribution loss; and the remaining terms are positive, and represent the gains from being part of a larger market. The question is under what conditions these terms will outweigh the first term.

By collecting terms, we can rewrite (19) as

$$U_2' - U_2 = \frac{2\theta-1}{\theta}\,\ell n\; z - \frac{1}{\theta}\,\ell n\; 2\text{-}z + \frac{2-2\theta}{\theta}\,\ell n\; 2 \tag{20}$$

This gives us one immediate result: if $\theta < 0.5$, the scarce factor necessarily gains from trade, since the first term will be positive and the third term will outweigh the second. Recall that θ is, in equilibrium, the ratio of marginal to average cost, and can thus be regarded as an index of the importance of economies of scale. What this result then says is that <u>if scale economies are sufficiently important, both factors gain from trade</u>.

If $\theta > 0.5$, whether both factors gain depends on the extent to which trade is intraindustry in character, which in turn depends on how similar the countries are in factor proportions. When $\theta > 0.5$, the function (20) has three properties: (i) as z approaches 1, $U_2' - U_2$ goes to $\frac{2-2\theta}{\theta}\,\ell n\; 2 > 0$;

(ii) as z goes to zero, $U_2' - U_2$ goes to minus infinity;

(iii) $U_2' - U_2$ is strictly increasing in z_1.

Thus if we were to graph (20), it would look like Figure 1. There is a critical value of z, $\bar{z}$, for which $U_2' - U_2 = 0$. If $z > \bar{z}$ both factors gain; if $z < \bar{z}$ the scarce factor loses. But z is our measure of similarity in factor proportions. Thus what we have shown is that <u>if countries have sufficiently similar factor endowments, both factors gain from trade</u>.

What is particularly nice about this result is that we have already seen that there is a one-for-one relationship between similarity of factor endowments and intraindustry trade. So this result can be taken as a vindication of the arguments of such authors as Kravis (1971) and Hufbauer and Chilas (1974) that intraindustry trade poses fewer adjustment problems than Heckscher-Ohlin trade.

We should note, however, that the critical value of intraindustry trade depends on the importance of scale economies. The function (20) is decreasing in θ: $\partial(U_2' - U_2)/\partial\theta = \theta^{-2}\,\ell n\; z(2-z) < 0$. So an increase in θ will shift the function down. As illustrated in Figure 2, this will increase $\bar{z}$. <u>The less</u>

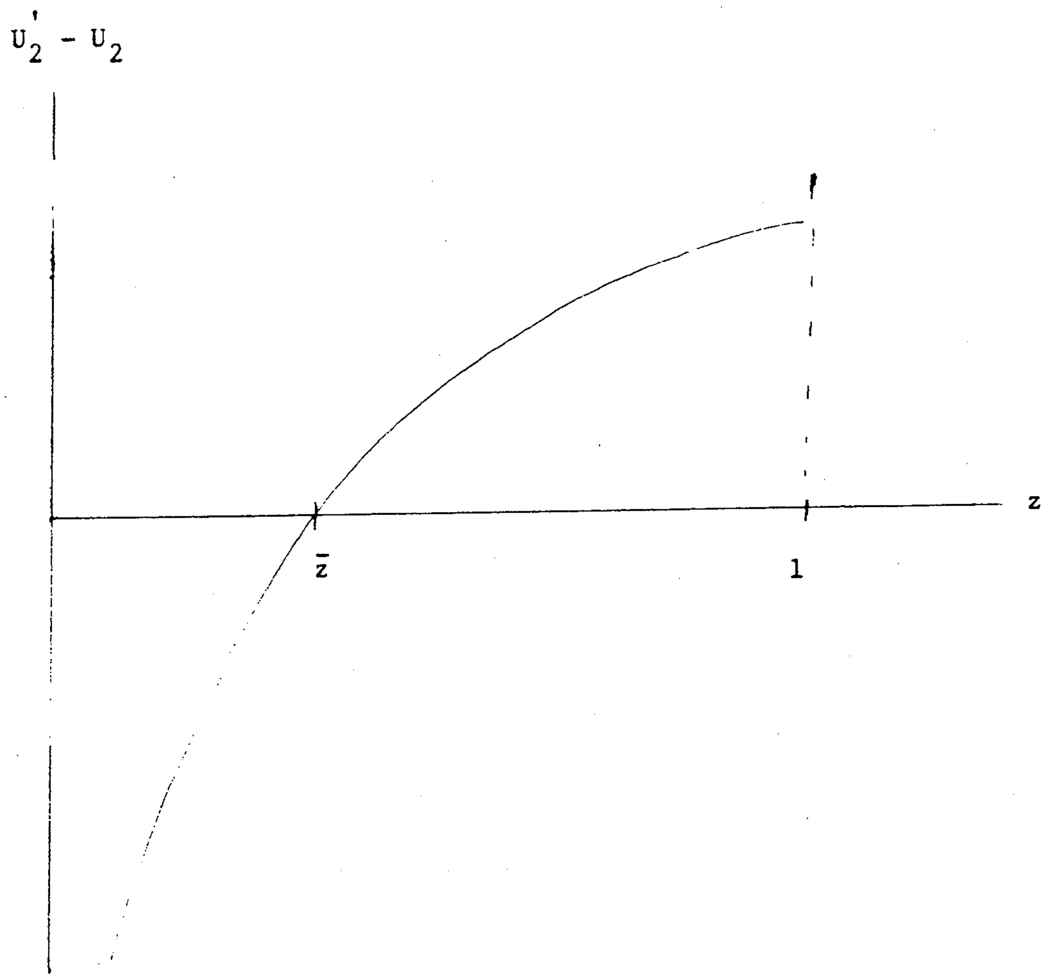

Figure 1

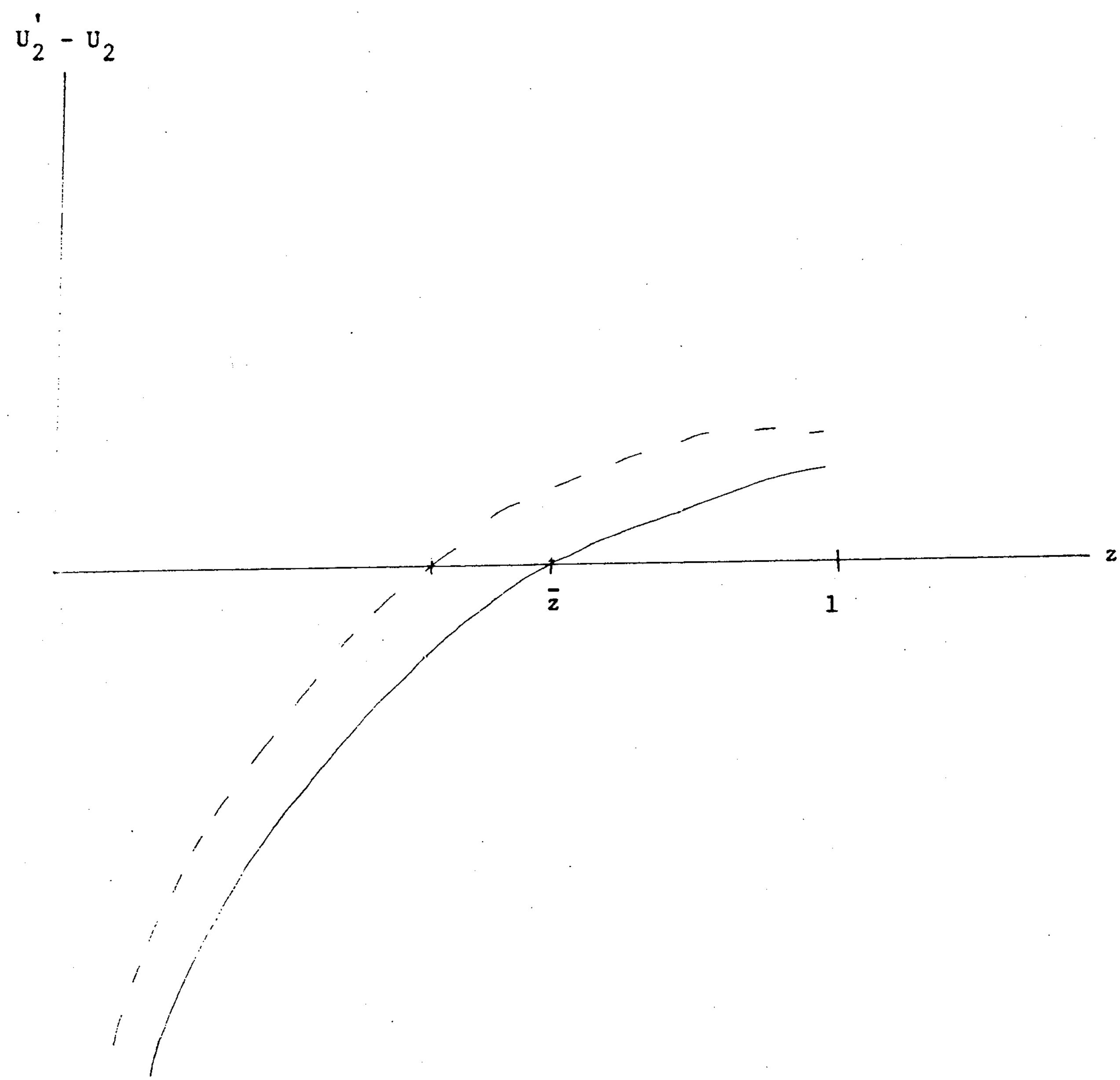

Figure 2

<u>important are scale economies, the more similar countries must be if both factors are to gain from trade.</u>

We can actually calculate $\bar{z}$ for selected values of θ, to illustrate the point:

θ	$\bar{z}$
0.6	.490
0.7	.692
0.8	.825
0.9	.923

In the limit, as θ goes to 1, so does $\bar{z}$. What this says is that a world in which scale economies are unimportant is a Heckscher-Ohlin world to which the Stolper-Samuelson theorem applies. But in this model this is only a limiting case.

4. Summary and Conclusions

This paper began with three "paradoxes" about international trade. Since they do not seem so paradoxical in the light of this model, perhaps we should state them as "stylized facts":

(i) Much of world trade is between countries with similar factor endowments;

(ii) The trade between similar countries is largely "intraindustry" in character, i.e., it consists of two-way trade in similar products;

(iii) The growth of intraindustry trade has not posed serious income distribution problems.

The model developed in this paper, which combines factor proportions theory with what is sometimes called "scale economies with differentiated products" theory, provides a simple--perhaps too simple--explanation of these stylized facts. In this model, countries with similar factor proportions will trade just as much as countries with dissimilar factor proportions. Intraindustry trade and similarity of factor proportions are directly related. And trade between sufficiently similar countries will benefit scarce as well as abundant factors.

In addition to helping make sense of some puzzling empirical results, this paper is, I hope, of some interest from the standpoint of pure theory. The model dispenses with the two most fundamental assumptions of standard trade theory: perfect competition and constant returns to scale. Instead, I have dealt in this paper with a world in which economies of scale are pervasive and all firms have monopoly power. While the model depends on extremely restrictive assumptions, it does show that it is possible for trade theory to make at least some progress into this virtually unexplored territory.

Finally, the model appears to have some policy relevance. For it provides some theoretical justification for the commonly made argument that trade in manufactured goods poses less of a problem if it takes place between developed countries than if it takes place between developed and less-developed countries. What this suggests is that it may have been economic forces as much as political wisdom which made possible the great postwar liberalization of trade among the industrial countries. These same economic forces are now, unfortunately, working to block the growth of exports from today's newly industrializing countries.

Appendix: Elasticity of Demand for Individual Products

The analysis in Section 1 depends on the result that the elasticity of demand for any particular product is $1/1-\theta$. This appendix gives a demonstration of this.

Consider an individual maximizing his utility function (1) subject to a budget constraint. The first-order conditions from that maximization will have the form

$$p_{1,i} = \frac{c_{1,i}^{-(1-\theta)}}{\lambda \sum_k c_{1,k}^{\theta}} \qquad i=1,\ldots,n_1$$

$$p_{2,j} = \frac{c_{2,j}^{-(1-\theta)}}{\lambda \sum_m c_{2,m}^{\theta}} \qquad j=1,\ldots,n_2$$

where λ is the shadow price on the budget constraint, i.e., the marginal utility of income.

If there are many products, however, the firm producing a particular product can take the denominators of these expressions as given. Thus each individual's demand for a particular product, and therefore also market demand, will have elasticity $1/1-\theta$.

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