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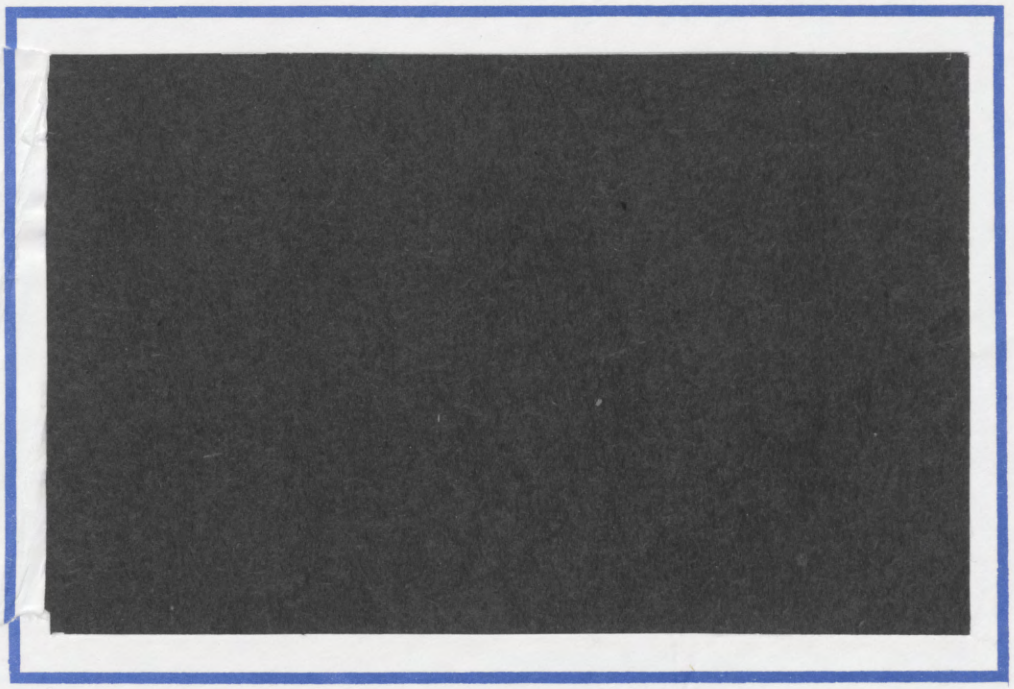

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IMPERFECT COMPETITION AND INTERNATIONAL TRADE: EVIDENCE FROM FOURTEEN INDUSTRIAL COUNTRIES

By

Elhanan Helpman

Working Paper No.35-84

November, 1984

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A B S T R A C T

Specialization that results from comparative advantage in the production of homogeneous and differentiated products is used to derive hypotheses about the volume of trade and its composition. These hypotheses are examined empirically for a sample of fourteen industrial countries during the post-war period. The examination relies on cross-country comparisons as well as on comparisons of the group of countries at different points of time. The data seems to be consistent with the hypotheses.

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November, 1984

Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries

by

Elhanan Helpman*

Tel Aviv University

1. Introduction

Recent developments in the theory of international trade in the presence of economies of scale and imperfect competition have shed new light on observed trade patterns. Particularly useful in this respect has been the work on monopolistic competition in differentiated products (see Lancaster (1980), Dixit and Norman (1980, ch. 9), Krugman (1981) and Helpman (1981)). For example, this theory explains the existence of larger volumes of trade among similar countries with a factor proportions view of intersectoral trade flows.

Although the success of the new models in explaining stylized facts is encouraging, it is very desirable to examine more carefully their consistency with the data. There are at least two reasons for this. First, there exist empirical hypotheses which are implied by these models and which have not been tested (see, for example, Helpman (1981)). And second, by subjecting the implications of models to empirical testing, one may hope to discover weak points which need further theoretical development.

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*The computations for this study were performed by Per Skedinger and Peter Salin at the Institute for International Economic Studies, University of Stockholm. I would like to thank the Bank of Sweden Tercentenary Foundation for financing the acquisition of the data set and the computations. The first draft was written when I was a visiting professor in the Department of Economics at MIT.

This paper reports evidence on three empirical hypotheses that emerge from models of international trade that are based on monopolistic competition in differentiated products. Two of these hypotheses concern the behavior of the share of intra-industry trade. The third hypothesis concerns the behavior of the volume of trade. The theoretical derivation of these hypotheses relies on Helpman and Krugman (1984, ch. 8). The theory and evidence concerning the volume of trade are presented in Section 2, while the theory and evidence concerning the share of intra-industry trade are presented in Section 3.

2. The Volume of Trade

The factor proportions theory contributes very little to our understanding of the determination of the volume of trade in the world economy, or the volume of trade within groups of countries. The Ricardian view of comparative advantage is also of little help in this respect. Nevertheless, there seem to exist certain regular relationships between income levels of trading partners and the volume of trade which economists have tried to explain for many years (see Deardorff (1984)). Models of monopolistic competition in differentiated products can contribute to the explanation of these links.

Consider a 2x2x2 economy, in which capital and labor are the only factors of production. If both sectors X and Y produce homogeneous products with constant returns to scale, then the factor price equalization set is represented by the parallelogram OQO*Q' in Figure 1, where OQ is the vector of employment in X and QO* is the vector of employment in Y in an equilibrium

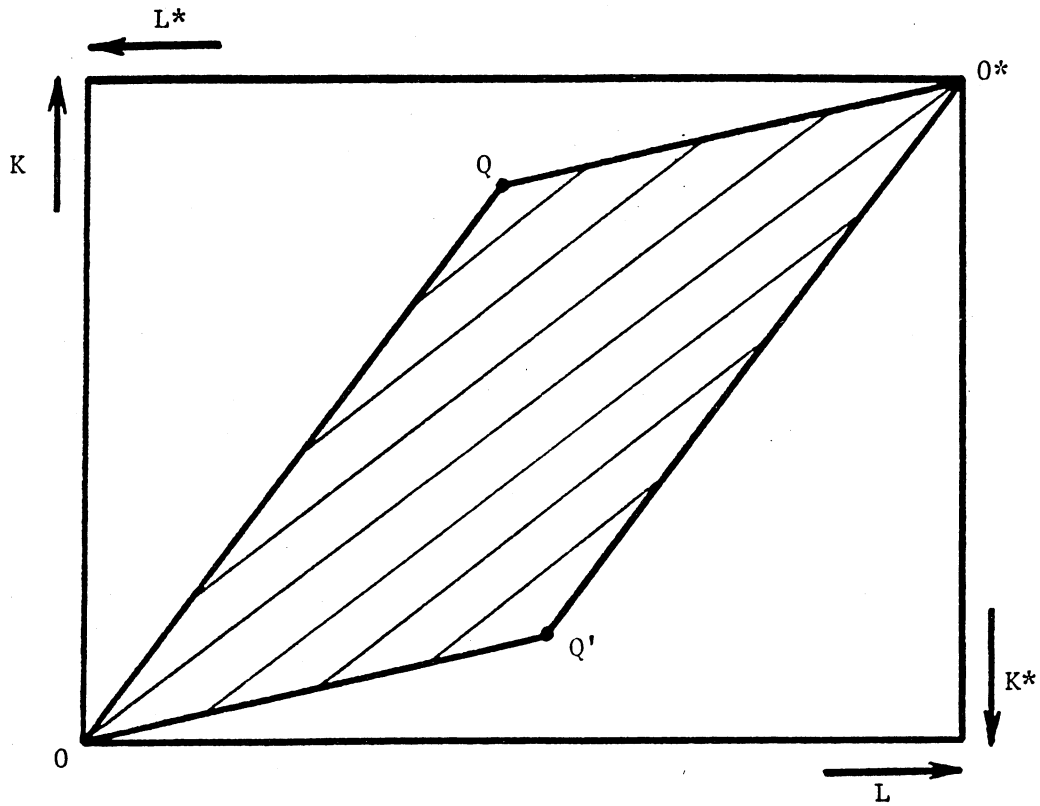

Figure 1

that would have resulted if labor and capital could move freely across countries as they do across industries within a given country. The origin of the home country is O and the origin of the foreign country is O*.

In a trading equilibrium without international factor mobility allocations in OQO* make the home country import Y and export X. The volume of trade is defined to be the sum of exports. Assuming identical homothetic preferences and free trade, the volume of trade is given by:

$$V = p_x(X-s\overline{X}) + p_y(Y^*-s^*\overline{Y})$$

where s (s*) is the share of the home (foreign) country in world spending, X is the output level of X in the home country, Y* is the output level of Y in the foreign country, and $\overline{X}$ and $\overline{Y}$ are world output levels of X and Y, respectively. Assuming balanced trade, the volume of trade is equal to:

$$(1) \quad V = 2p_x(X-s\overline{X}) \qquad \text{for endowments in OQO*}$$

Now, at all endowment points in the factor price equalization set p_x is constant and both X and s are linear functions of the endowment point. Hence, the iso-volume-of-trade curves that correspond to this model are straight lines. Moreover, they have to be parallel to the diagonal OO*, and they are, therefore, represented by the lines within the parallelogram of Fig.1(see Helpman and Krugman (1984, ch.8)). The farther away a line is from the diagonal, the larger is the volume of trade that it represents.

It is clear from Figure 1 that in this model larger volumes of trade are associated with larger differences in factor composition. Differences in

relative country size, on the other hand--as measured by GDP--have no particular effect. This prediction, which is inconsistent with the evidence (see Deardorff (1984)), does not change when the model is extended to many countries and goods.

Next change the model, and suppose that X is a differentiated product. There are economies of scale in the production of every variety, and monopolistic competition prevails in the industry. In the equilibrium attained with free factor mobility industry X is occupied by a large number of firms, each one producing a different variety, and each one making zero profits. Suppose that all varieties are equally priced and produced in the same quantity. The vectors OQ and QO* still represent employment in sectors X and Y, respectively. But this time OQ is employed by n firms, each one producing a different variety. Contrary to the constant returns to scale model, here the number of firms n is well determined and of great importance for many issues. The world output level of x, $\bar{X}$, is still a valid measure of aggregate output in the industry, but this time it consists of $\bar{n}$ varieties, with output per variety being:

$$x = \bar{X}/\bar{n}$$

OQO*Q' remain the factor price equalization set for trading equilibria without factor mobility.

Figure 2 reproduces the relevant features of Figure 1. Suppose E is the endowment point; the home country is relatively capital-rich. Then full employment with factor price equalization is attained when the home country employs OP_X in the differentiated product sector and OP_Y in the homogeneous product sector. By drawing through E a downward sloping line BB' whose slope

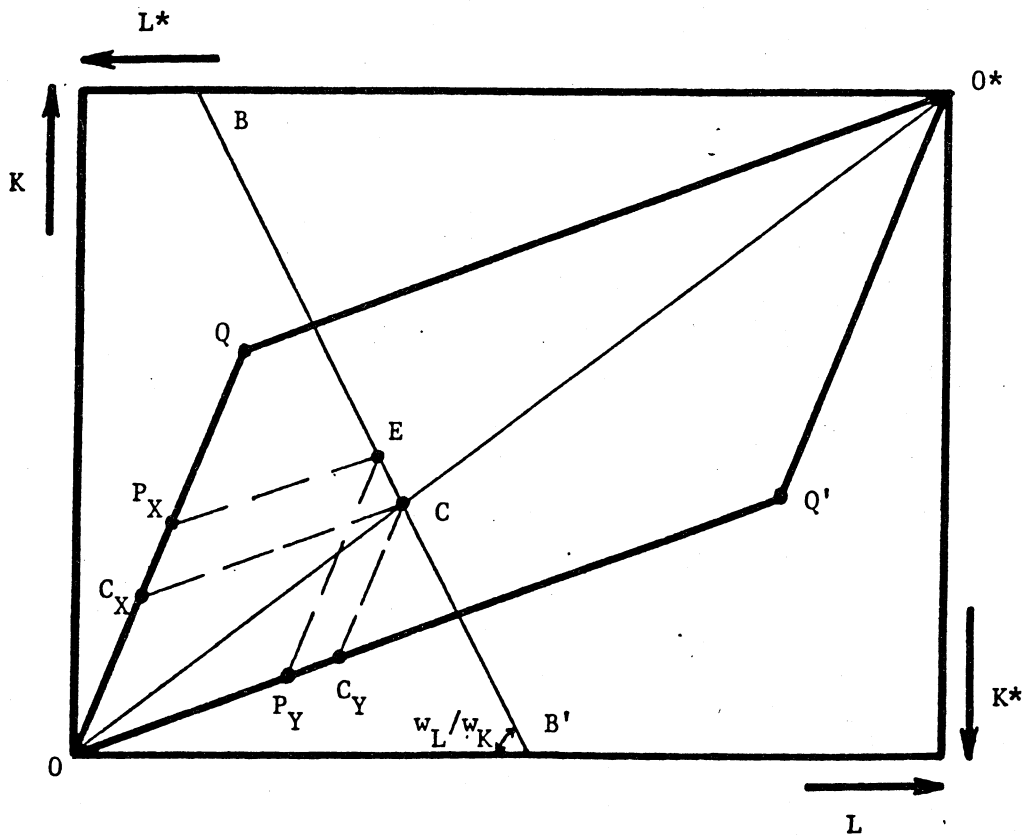

Figure 2

equals the wage rental ratio, we obtain point C, which represents the distribution of income across the two countries. Then, if trade is balanced, OC_Y represents consumption of Y in the home country and OC_X represents aggregate consumption of X in the home country, provided we normalize units of measurement so that $\overline{X} = OQ$ and $\overline{Y} = OQ'$. It is clear from the figure that the home country imports Y and it is a net exporter of X.

The fact that every firm produces a different variety of X and the assumption that all varieties are demanded in every country imply that there is intra-industry trade in differentiated products. The home country produces:

$$n = \frac{\overline{OP_x}}{x}$$

varieties and the foreign country produces:

$$n^* = \frac{\overline{P_x Q}}{x}$$

varieties. Provided preferences are identical and homothetic in both countries, the value of X-exports from the home country is:

$$s^* p_x n x$$

and the value of X-exports from the foreign country is:

$sp_x n^* x$

Hence, there is two-way trade in X products. The volume of trade is now equal to:

$$V = s^* p_x nx + sp_x n^* x + p_y(Y^* - s\overline{Y})$$

Again assuming balanced trade, this reduces to:

(2) $V = 2s^* p_x nx$ for $E \varepsilon OQO^*$

It is shown in Helpman and Krugman (1984, ch. 8) that the curves on which (2) obtains constant values look like the curves in Figure 3. They are tangent on BB' (that passes through the center of OO*) to rays through O. The farther away a curve is from the diagonal, the larger is the volume of trade that it represents. In OQO* the volume of trade is maximized at E; when the difference in factor composition is largest for countries of equal size. By comparing Figure 3 with Figure 1 it is seen clearly how the existence of a differentiated product introduces a new dimension to the determinant of the volume of trade; i.e., relative country size. Now the volume of trade is larger the larger the difference in factor composition and the smaller the difference in relative size.

Relative country size becomes <u>the</u> determinant of the volume of trade when both X and Y are differentiated products. In this case the volume of trade is:

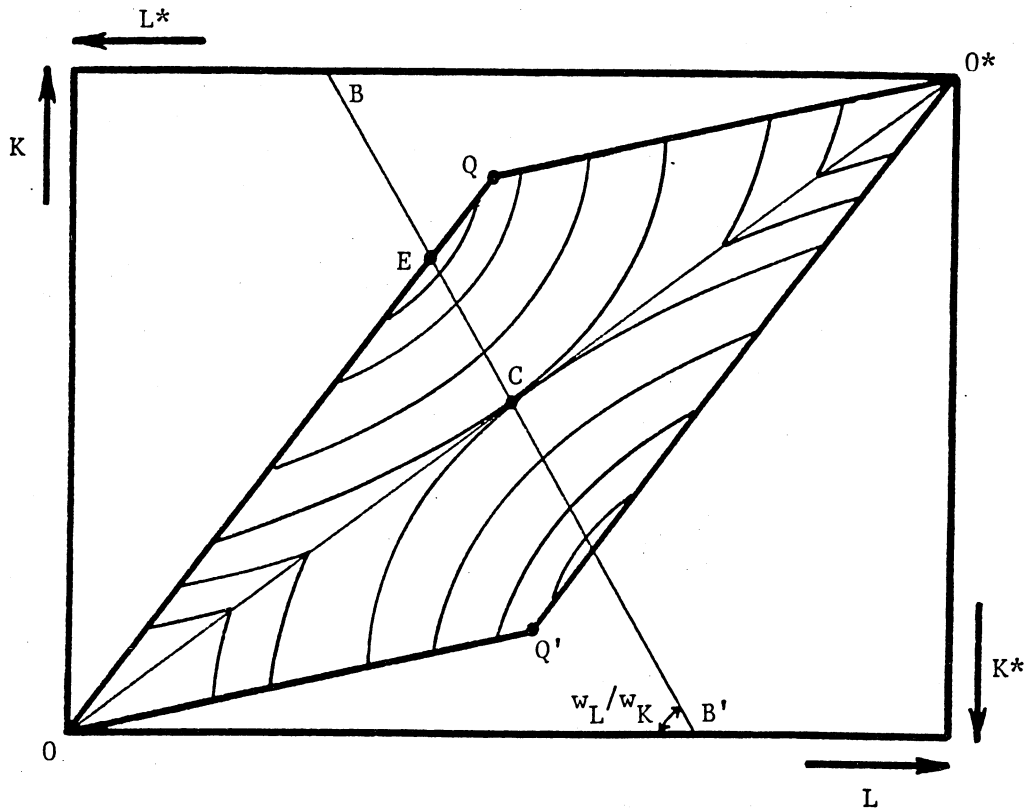

Figure 3

$$V = s(p_x X^* + p_y y^*) + s^*(p_x X + p_y Y)$$

Given balanced trade this yields:

$$(3) \quad V = 2ss^*\overline{GDP}$$

where $\overline{GDP}$ is gross domestic product in the world economy. Hence the volume of trade depends on ss^*; or relative country size. Figure 4 describes the corresponding equal-volume-of-trade curves. They are downward sloping lines with the slope equal to the wage rental ratio. The further a line is from BB' (that represents equal size countries), the lower is the volume of trade that it represents.

Figures 1, 3, and 4 make the point that the larger the share of differentiated product industries in output, the more important is relative country size in the determination of the volume of trade.

More generally, when no good is produced in more than one country, the distribution of country size is the sole determinant of the share of world GDP that is traded. Thus, the more specialization there is in production, the more important is the role of relative country size. The existence of differentiated products that are produced with economies of scale leads to specialization of this type (in the presence of monopolistic competition). However, other forms of specialization that stem from scale economies will also do for current purposes. For with specialization of this type, the bilateral volume of trade between country j and country k is:

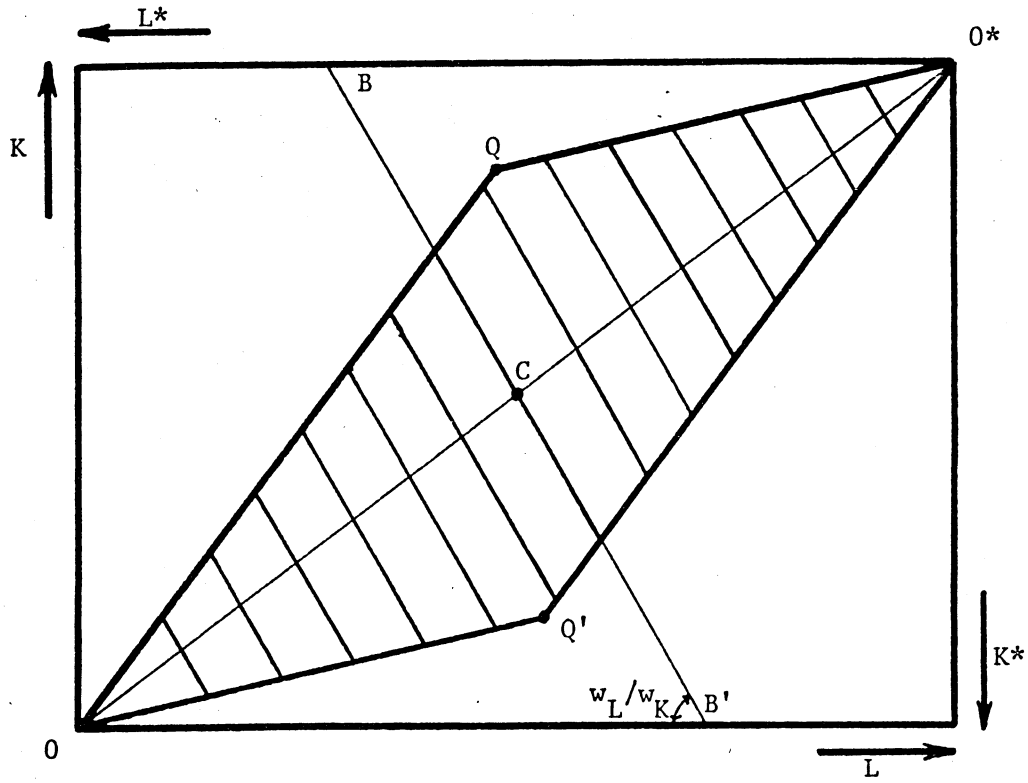

Figure 4

$$V^{jk} = s^j GDP^k + s^k GDP^j$$

where s^j is the share of country j in world spending and GDP^j is gross domestic product of country j. Assuming balanced trade this yields:

$$(4) \quad V^{jk} = 2s^j s^k \overline{GDP}$$

This provides a theoretical explanation of the gravity equation (see Anderson (1979) and Krugman (1980)) which has been successfully estimated using data on bilateral trade flows (e.g., Linnemann (1966)). Moreover, this has an important implication for the relationship between the ratio of world trade to GDP on one hand, and the distribution of country size on the other. By direct calculation we obtain (see Helpman (1983)):

$$(5) \quad \frac{V}{\overline{GDP}} = \frac{1}{2} \sum_j \sum_{k \neq j} s^j s^k = [1 - \sum_j (s^j)^2]$$

Equation (5) suggests a possible explanation of the observed fact that in the post-war period the volume of trade grew faster than income ; during this period the relative size of countries has declined, so that the dispersion index on the right hand size of (5) has grown over time. In order to examine this hypothesis, we need to develop a formula that is applicable to <u>groups</u> of countries, and which takes into account trade imbalances. This is done next.

Let A be a set of indexes for a group of countries. Then the group's gross domestic product is:

$$GDP^A = \sum_{j \varepsilon A} GDP^j$$

and we define:

$$e_A^j = \frac{GDP^j}{GDP^A}, \qquad e_A = \frac{GDP^A}{GDP}$$

as the share of country j in the group's GDP, and the share of the group in world GDD, respectively.

Also define T^j to be the excess of exports over imports in country j and:

$$t_A^j = \frac{T^j}{GDP^A}, \qquad t_A = \sum_{j \varepsilon A} t_A^j$$

Then the within group volume of trade is:

$$V^A = \sum_{j \varepsilon A} \sum_{\substack{k \varepsilon A \\ k \neq j}} s^j GDP^k$$

$$= \sum_{j \varepsilon A} \sum_{\substack{k \varepsilon A \\ k \neq j}} s^j e_A^k GDP^A = GDP^A \sum_{j \varepsilon A} s^j (1 - e_A^j)$$

However,

$$s^j = \frac{e_A^j GDP^A - T^j}{\overline{GDP}} = e_A(e_A^j - t_A^j)$$

Hence,

$$(6) \quad \frac{V^A}{GDP^A} = e_A[1 - t_A + \sum_{j \varepsilon A} e_A^j t_A^j - \sum_{j \varepsilon A} (e_A^i)^2]$$

In this case the intra-group trade volume grows faster than its combined income if the adjusted size dispersion index, given by the bracketed term on the right hand side of (6), grows over time (given a constant share of the group in world income).

Table 1 contains the calculations of the trade imbalance unadjusted size dispersion index and the trade imbalance adjusted size dispersion index for a group of 14 industrial countries during the years 1956-1981. It is clear from the table that trade imbalance adjustments do not change significantly the time series properties of this index. The reason for this is that trade imbalances as a proportion of income were quite small for those countries, including the external imbalances that were generated by the oil shocks and the shocks to primary commodity prices. Table 1 presents also the time series of the ratio of intra-group trade to the group's income. It is evident from these data that during this period the ratio of trade to income has risen and so has our dispersion index (the latter resulting

Table 1

	(1) Size Dispersion Index	(2) Trade Imbalance Adjusted Size Dispersion Index	(3) Trade Income Ratio
1956	0.631	0.634	0.048
1957	0.638	0.640	0.049
1958	0.643	0.643	0.045
1959	0.645	0.638	0.048
1960	0.654	0.655	0.051
1961	0.670	0.670	0.052
1962	0.672	0.675	0.052
1963	0.680	0.677	0.053
1964	0.690	0.686	0.056
1965	0.691	0.686	0.057
1966	0.696	0.691	0.059
1967	0.695	0.690	0.058
1968	0.691	0.686	0.062
1969	0.723	0.718	0.070
1970	0.715	0.710	0.068
1971	0.725	0.725	0.069
1972	0.744	0.738	0.071
1973	0.767	0.763	0.080
1974	0.773	0.776	0.092
1975	0.782	0.776	0.083
1976	0.776	0.776	0.088
1977	0.778	0.778	0.088
1978	0.791	0.788	0.088
1979	0.799	0.805	0.097
1980	0.804	0.811	0.100
1981	0.776	0.777	0.092

The countries in the sample are: Canada, U.S., Japan, Austria, Belgium-Luxembourg, Denmark, France, Germany, Ireland, Italy, Netherlands, Sweden, Switzerland, and U.K.

The calculations were made by converting all national currency variables into U.S. dollars by means of the average exchange rate (row af in the IFS).

(1) This index is:

$$[1 - \sum_{j \varepsilon A} (e_A^j)^2]$$

(2) This index is:

$$[1 - t_A - \sum_{j \varepsilon A} (e_A^j t_A^j + \sum_{j \varepsilon A} e_A^j)^2]$$

(3) The trade income ratio is the within group volume of trade divided by the group's income.

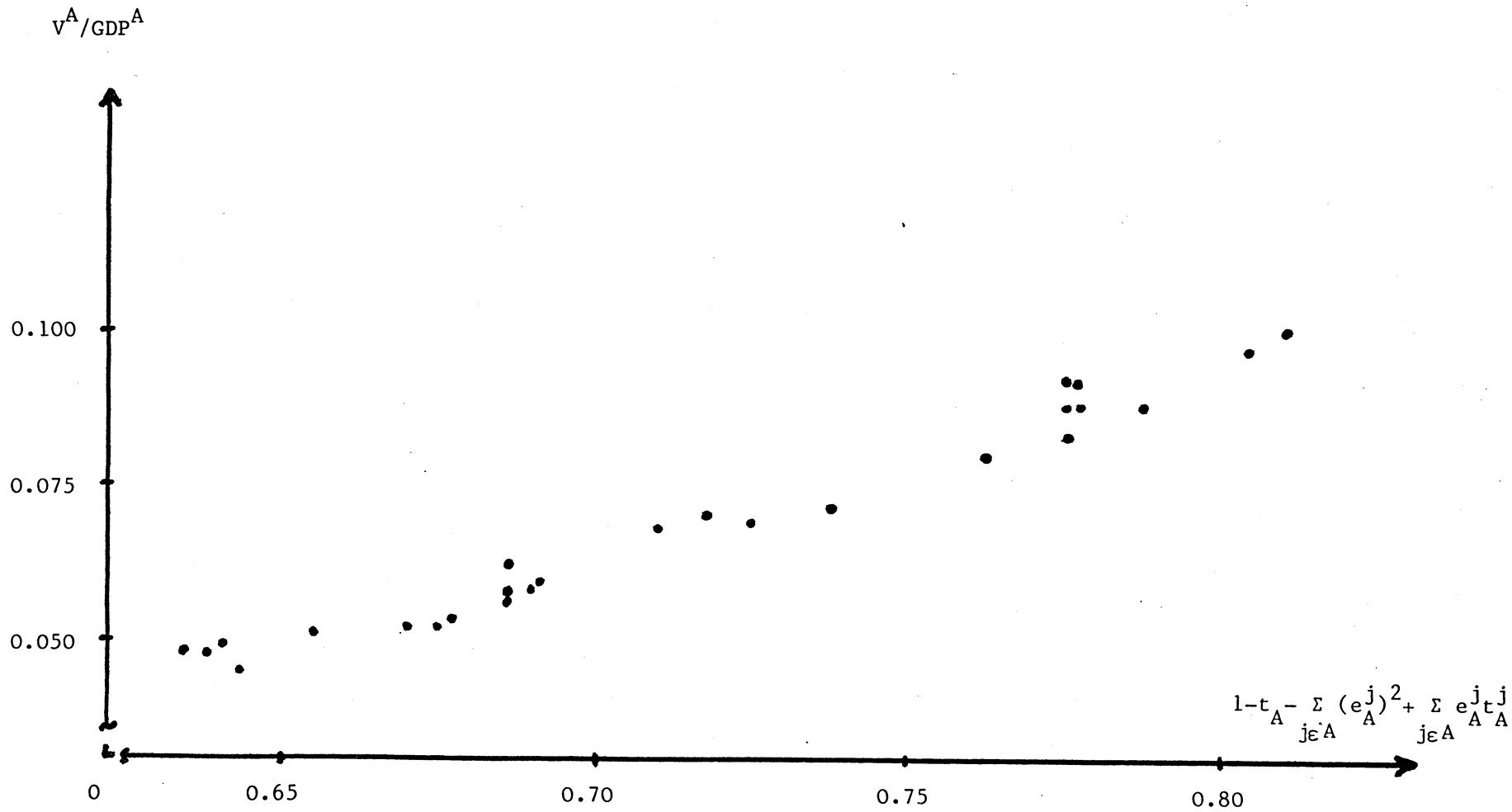
V^A/GDP^A
0.100
0.075
0.050
0
0.65
0.70
0.75
0.80
$1-t_A - \sum_{j\varepsilon A} (e_A^j)^2 + \sum_{j\varepsilon A} e_A^j t_A^j$

Figure 5

from a reduction in relative country size). The trade imbalance adjusted size dispersion index is plotted in Figure 5 against the trade income ratio. It is clear from the figure that they are positively related. Thus, the decline in relative country size contributes to some extent to the explanation of the differential rates of trade and income growth for this group of countries. However, two warnings are in order. First, this evidence is no substitute for a proper statistical test of the hypothesis. And second, the evidence is sensitive to country composition. If the U.S. and Japan are excluded from the sample then the link between the size dispersion index and the trade income ratio is substantially weakened.

3. Share of Intra-Industry Trade

We have seen in the discussion of the 2x2x2 model that when sector X produces differentiated products (and it is relatively capital-intensive), the relatively capital-rich country imports Y as well as varieties of X that are produced abroad, and it exports domestically produced varieties of X. The value of its X-exports exceeds the value of its X-imports so that it is a net exporter of differentiated products (assuming balanced trade). This pattern of trade is described by the arrows in Figure 6. The volume of trade is equal to the sum of these arrows. The volume of intra-industry trade is defined as the matching two-way flow of goods within every industry. Generally, it is:

$$V_{i-i} = \sum_j \sum_k \sum_i \min\,(E_i^{jk}, E_i^{kj}) = 2 \sum_j \sum_{k>j} \sum_i \min\,(E_i^{jk}, E_i^{kj})$$

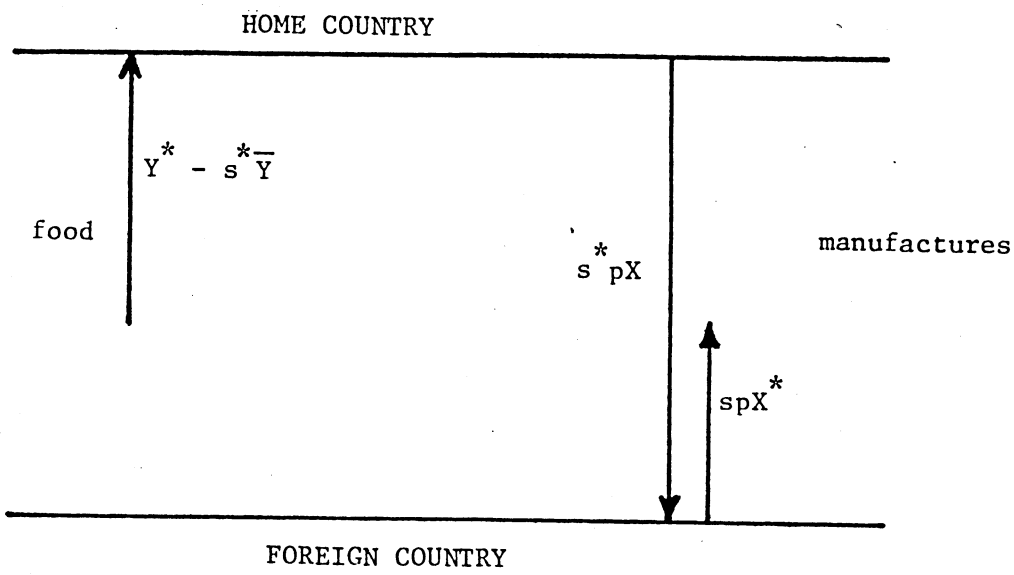
HOME COUNTRY
$Y^* - s^*\overline{Y}$
food
s^*pX
manufactures
spX^*
FOREIGN COUNTRY

Figure 6

where E_i^{jk} is exports of country j to country k of i-products.

In our 2x2x2 case the intra-industry trade volume formula reduces to:

$$(7) \quad V_{i-i} = 2spn^*x$$

This can be used to calculate the share of intra-industry trade as the ratio V_{i-i}/V. Using (2) and (7) this ratio is:

$$(8) \quad S_{i-i} = \frac{sn^*}{s^*n}$$

It was shown in Helpman (1981) that S_{i-i} is a declining function of the capital-labor ratio in the relatively capital-rich country and an increasing function of the capital-labor ratio in the relatively capital-poor country.

Constant intra-industry-share curves are depicted in Figure 7 for endowments in the factor price equalization set (see Helpman and Krugman (1984, ch. 8) for a proof of the properties of these curves). The diagonal represents a share equal to one while O*Q represents a share equal to zero. The share is lower the farther away a curve is from the diagonal. It is clear from this figure that larger differences in factor composition are associated with smaller shares of intra-industry trade, and that the larger the country that is a net exporter of differentiated products the smaller the

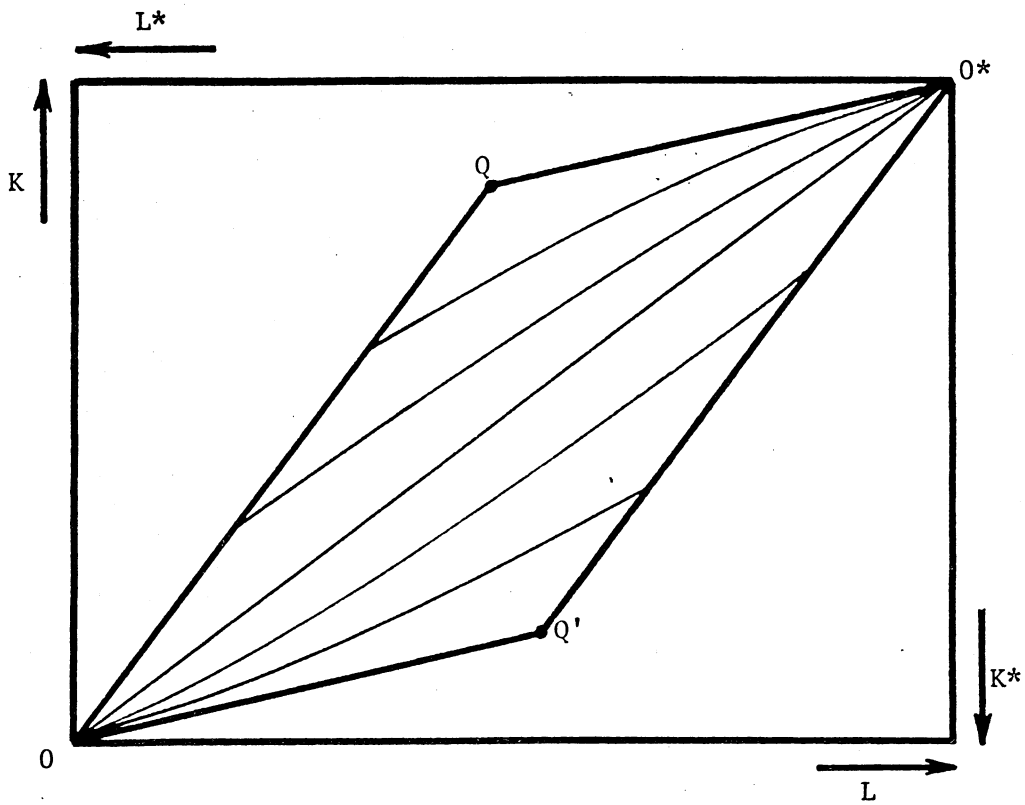

Figure 7

share of intra-industry trade. The second relationship may, however, be rather weak.

More insight into the determination of the share of intra-industry trade can be obtained by considering a many-country many-goods environment with only two factors of production, this time allowing for unequal factor rewards. A case of three countries and four industries is depicted in Figure 8 by means of a Lerner diagram (strictly speaking, this diagram is valid only when production functions are homothetic; see Helpman and Krugman (1984, ch. 8) for details). Every isoquant represents a dollar worth of output and every downward-sloping line represents a dollar worth of factor costs. Superscripts indicate countries (e.g., $w_L^j/w_K{}^j$ is the wage rental ratio in country j), while the rays through the origin describe the capital-labor ratios available in the three countries.

Given the structure described by the figure, country 1 produces products 1 and 2, country 2 produces products 2 and 3, and country 3 produces products 3 and 4. If these are differentiated products, then there exists intra-industry trade between countries 1 and 2, and between countries 2 and 3, but there is no intra-industry trade between countries 2 and 3. This insight can be generalized to state that with unequal factor rewards and many countries the share of intra-industry trade in the <u>bilateral</u> volume of trade should be larger for countries with more similar factor compositions. On the other hand, for a group of countries, the share of intra-industry trade in the within group trade volume should be larger the smaller the within group dispersion in factor composition.

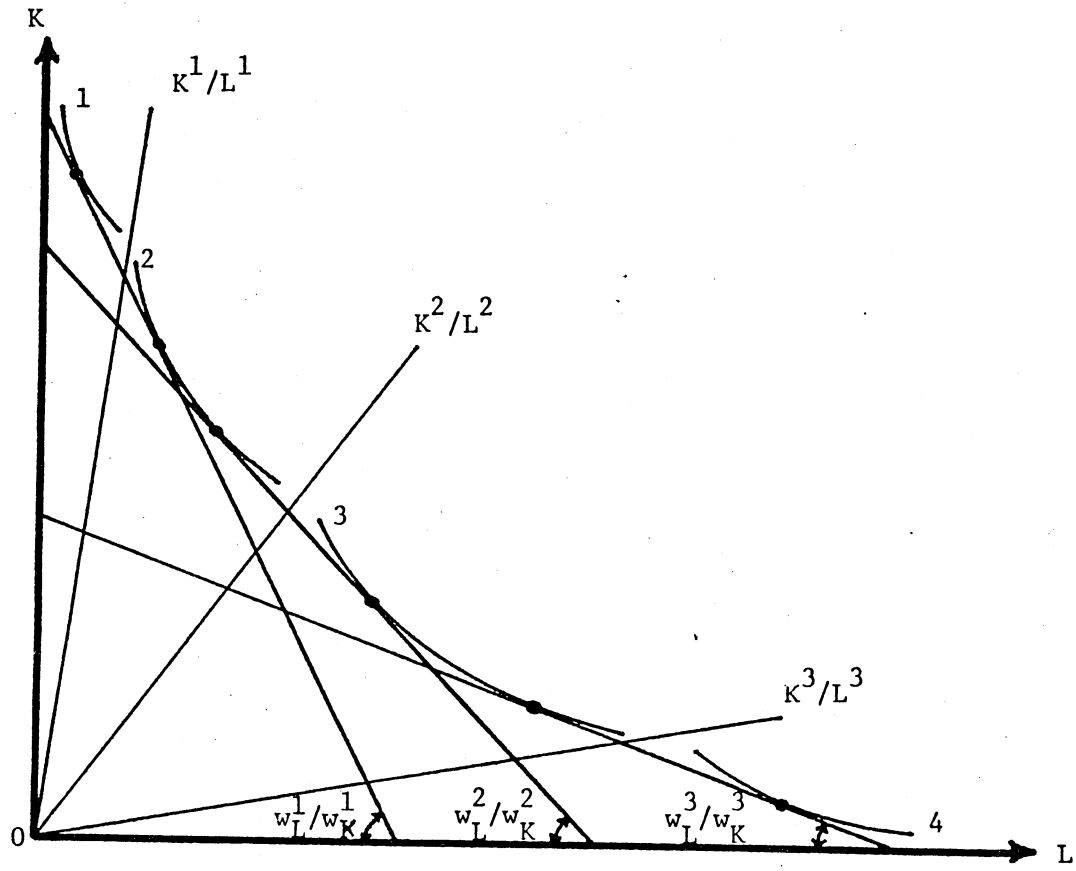

Figure 8

The difference across countries in factor composition can be measured by cross-country differences in income per capita. This method is accurate when there are only two factors of production and all goods are freely traded. Given this proxy, our analysis suggests two hypotheses, one about the composition of bilateral trade flows and one about the composition of within group trade flows (see Helpman (1981)):

(a) The share of intra-industry trade in bilateral trade flows should be larger for countries with similar incomes per capita; and

(b) The share of intra-industry trade in the within group trade volume should be larger in periods in which the within group dispersion of income per capita is smaller.

In order to examine the consistency of these hypotheses with the data, I have calculated bilateral and within group intra-industry trade shares for the 14 industrial countries in the sample, and for every year from 1970 to 1981. The bilateral shares were calculated as:

$$(9) \quad S^{jk}_{i-i} = \frac{2\sum_i \min\,(E^{jk}_i, E^{kj}_i)}{\sum_i (E^{jk}_i + E^{kj}_i)}$$

This was done for every pair of countries in every year.

It is well known that this index is biased in the presence of trade imbalance (see Aquino (1978)). The bias can be seen in Figure 6. If the trade imbalance is due to the home country exporting less of X (thus having a trade deficit), then this will reduce the denominator of (9) but will not

change the numerator, therefore yielding a larger share of intra-industry trade. If, on the other hand, the foreign country exports less differentiated products, S^{jk}_{i-i} will be smaller. Finally, if the foreign country exports less Y, then S^{jk}_{i-i} will be larger. We see, therefore, that the bias that is generated by trade imbalance depends on its source, and no simple adjustment is possible. For this reason, I report results that were estimated using (9).

In order to test the consistency of the data with the hypothesis concerning the bilateral trade flows, I have estimated the following equation on the cross-section data for every year from 1970 to 1981:

$$S^{jk}_{i-i} = \alpha_0 + \alpha_1 \log\left|\frac{GDP^j}{N^j} - \frac{GDP^k}{N^k}\right|$$

$$+ \alpha_2 \min(\log GDP^j, \log GDP^k) + \alpha_3 \max(\log GDP^j, \log GDP^k)$$

where N^j is the population of country j. The minimum and maximum of GDP levels were introduced in order to capture the importance of relative size (Loertscher and Wolter (1980), who estimated a similar equation for manufacturing industries, emphasized the importance of the combined size of the trading countries as represented by their joint GDP). The equation was estimated on 4-digit SITC data, using manufacturing as well as non-manufacturing sectors. The results are presented in Table 2, with t-values appearing in parentheses.

Table 2

	α_1	α_2	α_3	R^2
1970	-0.044 (-3.141)	0.055 (4.153)	-0.014 (-1.105)	0.266
1971	-0.041 (-3.495)	0.053 (4.003)	-0.016 (-1.260)	0.271
1972	-0.029 (-2.311)	0.056 (4.036)	-0.018 (-1.393)	0.223
1973	-0.017 (-1.389)	0.048 (3.390)	-0.019 (-1.428)	0.146
1974	-0.033 (-2.236)	0.038 (2.744)	-0.020 (-1.471)	0.146
1975	-0.032 (-2.252)	0.039 (2.602)	-0.18 (-1.185)	0.148
1976	-0.040 (-2.516)	0.035 (2.379)	-0.021 (-1.381)	0.141
1977	-0.021 (-1.361)	0.033 (2.109)	-0.018 (-1.150)	0.084
1978	-0.000 (-0.005)	0.043 (2.617)	-0.018 (-1.137)	0.076
1979	-0.023 (-1.860)	0.034 (2.079)	-0.011 (-0.715)	0.1000
1980	-0.022 (-1.397)	0.027 (1.641)	-0.013 (-0.812)	0.064
1981	-0.006 (-0.370)	0.027 (1.686)	-0.020 (-1.283)	0.039

Estimates of the equation:

$$S^{jk}_{i-i} = \alpha_0 + \alpha_1 \log \left| \frac{GDP^j}{N^j} - \frac{GDP^k}{N^k} \right| + \alpha_2 \log \min(GDP^j, GDP^k) + \alpha_3 \log \max(GDP^j, GDP^k)$$

where S^{jk}_{i-i} has been calculated on the basis of sectors in the 4-digit SITC.

Sample of the 14 industrial countries cited from Table 1.
t-values are given in parentheses.

It is seen from Table 2 that there does, indeed, exist in the sample a negative partial correlation between the share of intra-industry trade and dissimilarity in income per capita, which has weakened toward the end of the sample period. It is also interesting to observe that the size of the smaller country has a positive effect and the size of the larger country has a negative effect on the share of intra-industry trade, which is consistent with the hypothesis that the more similar countries are in size the larger the share of intra-industry trade. Moreover, since the estimates of $\alpha_2 + \alpha_3$ are positive, the joint size of two countries has a positive effect on the share of intra-industry trade between them. These results justify the use of a combined size variable, as has been done by Loertscher and Wolter (1980), although caution should be exercised in this interpretation because α_3 is not different from zero at the usual significance levels.

In order to examine directly the separate effects of combined size and relative size, Table 2 reports estimates of the following equation:

$$S_{i-i}^{jk} = \alpha_0' + \alpha_1' \log\left|\frac{GDP^j}{N^j} - \frac{GDP^k}{N^k}\right| + \alpha_2' \log(GDP^j + GDP^k)$$

$$+ \alpha_3' \log\left[1-\left(\frac{GDP^j}{GDP^j+GDP^k}\right)^2 - \left(\frac{GDP^k}{GDP^j+GDP^k}\right)^2\right]$$

These results support the previous conclusion, although the effect of combined size appears to be rather weak in the second half of the sample period. The coefficient α_3' represents the effect of relative country size.

In order to examine the second hypothesis, we need to calculate the share of intra-industry trade in the within group wolume of trade, and a measure of the within group dispersion of income per capita. This has been done as follows. The within group total volume of trade has been calculated by adding up bilateral exports within the group; i.e., as:

Table 3

	α'_1	α'_2	α'_3	R^2
1970	-0.044 (-3.108)	0.041 (3.003)	0.065 (3.728)	0.254
1971	-0.041 (-3.483)	0.037 (2.716)	0.065 (3.697)	0.262
1972	-0.029 (-2.290)	0.037 (2.646)	0.068 (3.738)	0.213
1973	-0.017 (-1.403)	0.028 (1.893	0.059 (3.199)	0.138
1974	-0.033 (-2.251)	0.017 (1.157)	0.048 (2.662)	0.141
1975	-0.032 (-2.248)	0.021 (1.267)	0.048 (2.443)	0.142
1976	-0.040 (-2.507)	0.014 (0.862)	0.044 (2.278)	0.136
1977	-0.022 (-1.383)	0.015 (0.867)	0.041 (1.989)	0.078
1978	-0.000 (-0.029)	0.024 (1.337)	0.053 (2.445)	0.069
1979	-0.023 (-1.885)	0.022 (1.283)	0.040 (1.875)	0.095
1980	-0.023 (-1.414)	0.013 (0.773)	0.031 (1.424)	0.057
1981	-0.005 (-0.343)	0.007 (0.444)	0.035 (1.621)	0.034

Estimates of the equation:

$$S^{jk}_{i-i} = \alpha'_0 + \alpha'_1 \log\left|\frac{GDP^j}{N^j} - \frac{GDP^k}{N^k}\right|$$

$$+ \alpha'_2 \log(GDP^j + GDP^k) + \alpha'_3 \log\left[1 - \left(\frac{GDP^j}{GDP^j + GDP^k}\right)^2 - \left(\frac{GDP^k}{GDP^j + GDP}\right)^2\right]$$

where S^{jk}_{i-i} has been calculated on the basis of sectors in the 4-digit SITC .

Sample of the 14 industrial countries cited from Table 1.
t-values are given in parentheses.

$$V^A = \sum_{j\varepsilon A} \sum_{k\varepsilon A} \sum_{i} E_i^{jk}$$

while the within group volume of intra-industry trade has been calculated as:

$$V_{i-i}^A = \sum_{j\varepsilon A} \sum_{\substack{k\varepsilon A \\ k\neq j}} \sum_{i} \min\,(E_i^{jk}, E_i^{kj}) = 2 \sum_{j\varepsilon A} \sum_{\substack{k\varepsilon A \\ k>j}} \sum_{i} \min\,(E_i^{jk}, E_i^{kj})$$

Then, the within group share of intra-industry trade has been calculated as:

$$(10)\quad S_{i-i}^A \equiv \frac{V_{i-i}^A}{V^A} = \frac{2 \sum_{j\varepsilon A} \sum_{\substack{k\varepsilon A \\ k>j}} \sum_{i} \min\,(E_i^{jk}, E_i^{kj})}{\sum_{j\varepsilon A} \sum_{k\varepsilon A} \sum_{i} E_i^{jk}}$$

The time series of these calculations, for the years 1970-1981, is reported in the first column of Table 3. They are based on the 4-digit SIT data and they were calculated for the sample of the 14 industrial countries that are listed at the bottom of Table 1, using <u>all</u> sectors in the calculation (and not only the manufacturing vectors).

One feature of the shares S_{i-i}^A reported in Table 4 is that they

Table 4

	S^A_{i-i}	$\sigma^A/\bar{g}^A$
1970	.342	.373
1971	.346	.354
1972	.356	.306
1973	.367	.260
1974	.362	.257
1975	.378	.245
1976	.379	.268
1977	.386	.246
1978	.387	.213
1979	.394	.201
1980	.389	.180
1981	.375	.192

$$S^A_{i-i} = \frac{2 \sum_{j \varepsilon A} \sum_{\substack{k \varepsilon A \\ k>j}} \sum_{i} \min (E_i^{jk}, E_i^{kj})}{\sum_{j \varepsilon A} \sum_{k \varepsilon A} \sum_{i} E_i^{jk}}$$

$$\frac{\sigma^A}{\bar{g}^A} = \frac{\sqrt{\sum_{j \varepsilon A} \pi_j^A (g_j - \bar{g}_j^A)^2}}{\sum_{j \varepsilon A} \pi_j^A g_j}$$

are smaller than other available calculations. Havrylyshyn (1983), for example, reports a share of .638 for a group of industrial countries in 1978. This is about 1.5 times larger than the figure reported in Table 3.

There are three reasons which explain the differences between my results and those of others: (a) Typical calculations (including Havrylyshyn (1983)) are based on manufacturing industries only, therefore biasing the results upwards. However, from a theoretical point of view, the hypotheses that have been derived at the beginning of this section are based on all sectors. Therefore, the appropriate index of intra-industry trade for the examination of these hypotheses is to consider all sectors and not only the manufacturing industries. (b) Typical calculations of within group intra-industry trade shares average out single country intra-industry trade shares in their trade volume with the rest of the world, using one or another system of weights. This procedure is not equivalent to calculating (10), and it introduces a bias whose direction and magnitude depends on the weighing system. However, (10) seems to be the variable suggested by the theory. (c) Typical calculations are done at the 3-digit disaggregation, while I have used the 4-digit disaggregation.

In order to examine the relationship between the within group share of intra-industry trade and the degree of dispersion in income per capita, we need a dispersion index. It seems appropriate to use for current purposes the ratio of the standard deviation of income per capita to its mean. Thus, taking g_j to be income per capita in country j, our index is:

$$(11) \quad \frac{\sigma^A}{\bar{g}^A} = \frac{\sqrt{\sum_{j \varepsilon A} \pi_j^A (g_j - \bar{g}_j^A)^2}}{\sum_{j \varepsilon A} \pi_j^A g_j}$$

where π_j^A is the share of country k in the group's population (i.e., $\pi_j^A = N^j / \sum_{k \varepsilon A} N^k$) and $\bar{g}^A$ is equal to the denominator of the right hand side of (11).

The second column of Table 3 presents the time series of (11) for the 14 countries in the sample. It is clear from a comparison of the two columns of Table 3 that the share of intra-industry trade is negatively correlated with dispersion in income per capita, as suggested by the second hypothesis. This relationship is exhibited in the scatter diagram of Figure 9.

In summary, both hypotheses concerning the behavior of the share of intra-industry trade--one applying to bilateral trade flows and the other applying to within group trade flows (the former applying to cross-section data while the latter applying to time series data)--find support in the evidence produced for the fourteen industrial countries during the seventies.

4. Concluding Comments

It has been shown that changes over time in relative country size can contribute to some extent to the explanation of rising trade income ratios. On the other hand, using the index of dispersion in income per capita (i.e., in factor composition) from Table 4, it can be seen that the decline over time of differences in factor composition cannot contribute to the explanation of a rising trade income ratio. More importantly, it has been shown that the evidence

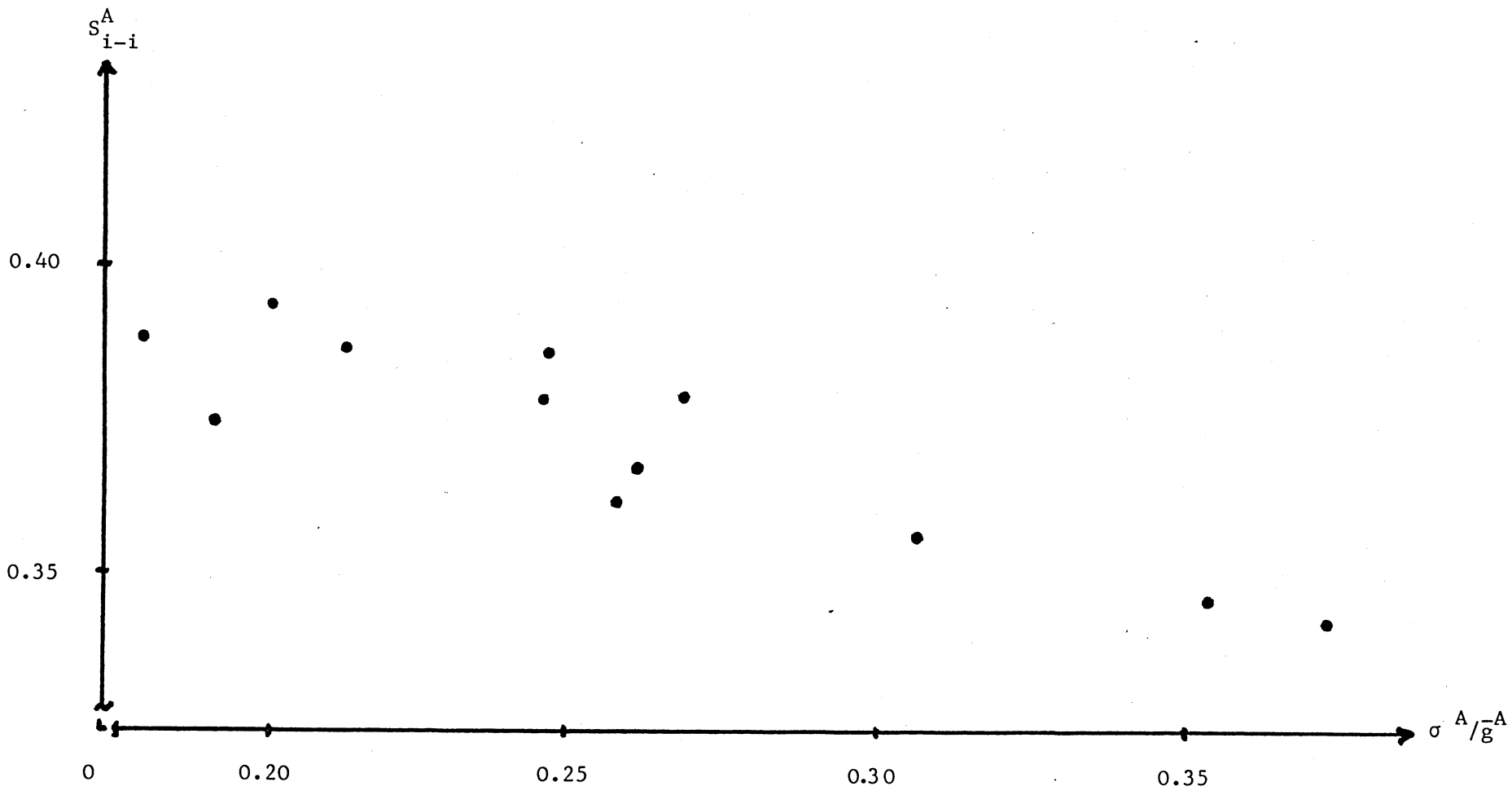

Figure 9

on trade volume composition is consistent with the hypotheses that were derived from models of trade in differentiated products. This has been done for both cross-section comparisons as well as for comparisons over time. The latter type of comparisons were not performed in previous studies. These results are encouraging, in particular in view of the fact that we have used highly disaggregated data and that contrary to other studies our calculations are based on both manufacturing and non-manufacturing industries. The use of manufacturing industries only is inappropriate, because the hypotheses of trade volume composition have been derived from theoretical models in which all industries have been accounted for. Our data set is also incomplete in this respect because it does not include services.

One interesting conclusion that emerges from this analysis is that in bilateral trade flows the link between the share of intra-industry trade and differences in factor composition has weakened over time. This trend may be the result of data contamination by differential trends in inflation rates and exchange rate movements. However, it may well be the result of real economic developments, and it deserves careful investigation. One possibility is that it is a result of the rising share of multinational corporations in world trade. This would be consistent with the theoretical findings in Helpman and Krugman (1984, chps. 12, 13). However, at this stage it remains an open question.

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