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DIFFERENTIATED PRODUCTS, ECONOMIES OF SCALE AND ACCESS TO THE JAPANESE MARKET

by

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Abstract

For much of the past thirty-five years Japan has imported a remarkably small share of the manufactured goods it consumes. This distinctive trade structure is regularly cited by policy makers as evidence that, despite the absence of formal barriers, foreign manufacturers are systemically denied access to the Japanese market. Alternative explanations of Japan's distinctive trade structure are possible. Using specifications directly derived from traditional models of comparative advantage, Japan's distinctive inter-industry trade structure can be largely explained by Japan's equally distinctive pattern of factor endowments. Scarcely any reference needs to be made at all to distinctive Japanese government trade policies.

Japan's participation in intra-industry trade in manufactures is also distinctively low. Traditional models of comparative advantage do not explain intra-industry trade. Such trade can be explained, however, if allowance is made for product differentiation and economies of scale. While traditional models of comparative advantage explain net trade as a linear function of factor endowments, with intra-industry trade models gross trade in imports and exports can still be a function of factor endowments. Indeed, if expressed as a share of GNP, gross imports are still a linear function of factor endowments. Using this framework, it can be shown that Japan's intra-industry trade, like Japan's inter-industry trade, does conform to international patterns. The removal of the remaining distinctive Japanese barriers, both formal and informal, to the import of manufactures, while highly desirable from a diplomatic standpoint, may have little impact on Japanese trade structure.

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The Low Share of Manufactures in Japanese Consumption

As seen in Table 1, by comparison with other advanced industrialized economies, Japan imports a remarkably small share of the manufacturing goods it consumes. And unlike the experience of other advanced industrialized economies, this small share has been virtually constant for decades. This distinctive trade structure is regularly cited by policy makers as evidence that foreign manufacturers are systematically denied access to the Japanese market (McDonald, 1982). Foreign manufacturers who have tried unsuccessfully to sell in the Japanese market always concede that formal barriers to imports of manufactured goods are low by any reasonable standard. They argue, however, that the regulatory environment within which most Japanese firms operate allows wide scope for arrangements keeping out those foreign manufactures which are directly competitive with domestic Japanese production (Schlosstein, 1984). These disappointed competitors suggest it is a mistake to look at lists of vanishing Japanese tariffs and quotas. It is said a protectionist record can be clearly seen in Japan's distinctive trade structure which otherwise seems to defy conventional economic explanation.

What the Theory of Comparative Advantage Tells Us

While there is a large literature which has collected the complaints of foreign manufacturers trying unsuccessfully to sell in Japan, there have also been a number of studies, which have attempted to provide an alternative explanation of Japan's distinctive trade structure (Saxonhouse and Stern, 1987). This work has investigated how well traditional models of comparative advantage can explain Japanese trade structure. In particular, both Leamer (1984, 1987) and Saxonhouse (1983, 1986) have estimated sectoral trade equations directly derived from Heckscher–Ohlin factor endowment theories of trade structure. Within the Heckscher–Ohlin framework, much of Japan's distinctive trade structure can be explained by Japan's distinctive pattern of factor endowments. If Japanese formal barriers are low and Japan's trade structure can be explained by conventional economic reasoning, it is difficult to take seriously the avalanche of complaints about Japan's supposedly distinctive protectionist trade and industrial policies.

Are such results believable? Their great virtue is that they're non-arbitrary. The specification used in these empirical analyses is dictated by the most widely known and widely taught theory of international trade. This is also their great problem. The assumptions behind the Heckscher–Ohlin framework, which Leamer and Saxonhouse estimate are severe. This empirical work assumes that national economies do not differ in their technologies and preferences, but only in their factor endowments. Scale economies and market power are assumed to be absent, and consumption preferences are assumed to be unaffected by income. Factors must be perfectly mobile within countries and totally immobile across national boundaries. Even factor endowments cannot be so dissimilar across countries such that something of all goods are not produced in all countries.[1]

[1] More detailed discussions of the assumptions behind the Heckscher–Ohlin results can be found in Caves and Jones (1981) and Leamer (1984).

What Traditional Theory Leaves Out

Lawrence (1987) has argued persuasively that empirical work on trade barriers using Heckscher–Ohlin equations misses out on at least one critical issue in current policy discussions. Heckscher–Ohlin equations are defined for net trade, yet it is frequently suggested that what is distinctive about Japan's trade pattern is its very meager participation in conventionally defined intra-industry trade in manufacturing (Sazanami, 1981). The structure of Japan's net trade flows might appear normal, even while, as seen in Table 2, its gross trade pattern might be highly distinctive.

It's been argued that this lack of participation in intra–industry trade is at the heart of Japan's diplomatic difficulties during the last ten or fifteen years. The Federal Republic of Germany with comparably large net exports of manufactures is rarely the object of protectionist complaints. Germany is an active participant in intra–industry trade in manufactures. Germany throughout the post–war period has imported lots of manufactured products. Perhaps, foreign manufacturers hurt by Germany competition have difficulty developing a unified position against German trade because within any foreign manufacturing industry, Germany, by virtue of its manufacturing imports, will have allies to balance against its enemies (Lawrence, 1988).

It is difficult to know whether such analyses are good political economy. Trade research which uses net trade as a dependent variable does ignore the possibility that Japanese policy may have worked to keep down both imports and exports. From the point of view of the trade policy debate in the United States, however, this may not be a serious omission. This research says it is unlikely that, compared to other countries, Japanese policy has unfairly kept down imports in dozens of manufacturing sectors unless it is simultaneously keeping down exports in precisely the same sectors. From the American side, U.S.–Jsapanese economic conflict is surely not about Japan exporting too little, and unhappily, from an economic point of view, it is often about quite narrowly defined sectoral trade balances. Economists have learned from American Congressmen about the auto deficit, the steel deficit, the textile deficit and the semi–conductor deficit, among others. It would seem that this politically salient part of the trade debate is well handled by investigations which use the Heckscher–Ohlin specification and look at sectoral net trade.

New Research Findings

Notwithstanding the virtues of looking at sectoral net trade, the determinants of gross imports and gross exports and therefore intra–industry trade, also deserve close scrutiny. The very development of the concept of intra–industry trade went hand in hand with the recognition that this type of trade does not reflect comparative advantage. Its existence reflects the importance of product differentiation and scale economies among other influences. Two economies with very similar factor endowments may still engage in substantial two–way trade if consumers in each have similar tastes for a wide variety of imperfectly substitutable products most of which are produced under conditions of increasing returns to scale (Helpman–Krugman, 1988).

Assume that all manufactured goods are differentiated by country of origin. Given the same identical homothetic preferences usually assumed in the Heckscher–Ohlin research, each economy will consume identical proportions of each variety of each good. This means that country j's consumption of all the different varieties of good i can be described by

(1) $$C_{ij} = M_{ij}^{+} + C_{ij}^{j}$$

(2) $$M_{ij}^{+} = S_j(Q_i - Q_{ij})$$

(3) $$C_{ij}^{j} = S_j Q_{ij}$$

where [2]

$$C_{ij} \equiv \text{consumption of good i by country j}$$

$$C_{ij}^{j} \equiv \text{consumption of variety j of good i by country j}$$

$$M_{ij}^{+} \equiv \text{imports of good i by country j}$$

$$Q_{ij} \equiv \text{production of good i in country j}$$

$$\bar{Q}_i \equiv \sum_j Q_{ij} \equiv \text{global production of good i}$$

$$\Pi_j \equiv \sum_i Q_{ij} \equiv \text{GNP of country j}$$

$$\Pi \equiv \sum_j \Pi_j \equiv \text{global GNP}$$

$$S_j \equiv \frac{\Pi_j}{\Pi} \equiv \text{share of country j in global GNP}$$

Equations (2) and (3) can be combined to obtain:

(4) $$\frac{M_{ij}^{+}}{M_{ij}^{+} + S_j Q_{ij}} = \frac{S_j(\bar{Q}_i - Q_{ij})}{M_{ij}^{+} + S_j Q_{ij}} = \frac{S_j(\bar{Q}_i - Q_{ij})}{S_j(\bar{Q}_i - Q_{ij}) + S_j Q_{ij}} = \frac{S_j(\bar{Q}_i - Q_{ij})}{S_j \bar{Q}_i} = 1 - \frac{Q_{ij}}{\bar{Q}_i}$$

[2] The properties of Π, the GNP function, are discussed in more detail in Gary R. Saxonhouse and Robert M. Stern (1987).

Equation (4) states that imports of good i by economy j as a proportion of total use of i by j will be equal to the proportion of good i that is produced outside of j. The less competitive a country is in the production of good i, the more it will import.

Alternatively,

$$(4') \qquad \frac{M_{ij}^{+}}{M_{ij}^{+} + S_jQ_{ij}} = 1 - \frac{Q_{ij}}{\bar{Q}_i} = 1 - \frac{(1-S_j)Q_{ij}}{(1-S_j)\bar{Q}_i} = 1 - \frac{X_{ij}^{+}}{(1-S_j)\bar{Q}_i}$$

where $X_{ij}^{+} \equiv$ exports of good i by economy j.

Imports of good i by economy j as a proportion of total consumption of i by j will be equal to the proportion of foreign consumption of i that is foreign produced. By global homotheticity, foreign and domestic consumption of any variety of any good will be proportionally the same.

Equations (4) and (4′) provide the basic framework for Lawrence's empirical work on cross-national trade structure. Lawrence, however, does not use cross-national data on trade structure and production to test the restrictions implied by (4) and (4′). Rather he argues that (4) and (4′) apply only to a world where distance imposes no cost on trade. In a world where transport costs are non-zero and a determinant of trade structure, Lawrence prefers to estimate the logarithmic version of (4) and (4′)

$$(4a) \qquad log\frac{M_{ij}^{+}}{M_{ij}^{+} + Q_{ij}} = u_i + v_i log\frac{Q_{ij}}{\bar{Q}_i} + y_i logT_j$$

and/or

$$(4a') \qquad log\frac{M_{ij}^{+}}{M_{ij}^{+} + Q_{ij}} = u_i^{*} + v_i^{*} log\frac{X_{ij}^{+}}{(1-s_j)\bar{Q}_i} + y_i^{*} logT_j$$

where $T^j \equiv$ transport costs or distance, and u_i, u_i^*, v_i, v_i^*, y_i and y_i^* are all parameters.

When estimating (4a) and (4a'), Lawrence finds he can confirm the impression given by Table 2. For many manufacturing sectors, Japanese shares of global production and/or Japanese shares of global export markets are too small to explain the small share that imports play in total Japanese consumption. Japan doesn't appear to be competitive enough abroad to explain why it has such a large market share at home.

Lawrence's work is most attractive in that it allows for important phenomena which cannot be considered by approaches based on the Heckscher–Ohlin framework. His use of production shares and export shares as explanatory variables, however, makes homotheticity the driving force of his interpretation of differences in trade structure. Indeed, his empirical findings can be viewed primarily as a test of this assumption. The quality of this test may be qualified by a number of specification errors.

Quite apart from unresolved issues such as what functional form is appropriate when transport costs are introduced into the Helpman–Krugman model and whether it is appropriate to introduce transport costs at all into an export share version of this model, Lawrence's import share, export share and production share variables are all jointly determined. The issue of simultaneity here is a very real one. In addition to non–trivial estimation bias, there are some important identification issues. While Lawrence is careful in interpreting his results to suggest that there is something distinctive about Japanese trade structure, he does not make clear why this distinctiveness should be associated with possible Japanese import barriers. For example, in his export share model, out of twenty manufacturing sectors only two appear to have unduly low imports in 1970, but no less than nine do in 1983. Is it really plausible to infer that Japanese protection for manufacturing increased substantially between 1970 and 1983? This is precisely the period when virtually all formal Japanese barriers to the import of manufactured goods were eliminated. If Japanese trade structure did become more distinctive between 1970 and 1983, this can be more properly attributed to increasing foreign barriers to Japanese exports. Japan's import shares of manufactures may be a better index of Japanese competitiveness than its export shares.

Factor Endowments and Intra-Industry Trade

In fact, neither export shares nor production shares need be used as explanatory variables in estimating the Helpman-Krugman model. From (2) and (4')

$$M_{ij}^{+} = S_j(Q_i - Q_{ij})$$

$$X_{ij}^{+} = (1 - S_j)Q_{ij}$$

but

$$S_j = \frac{\Pi_j}{\Pi} = \frac{\sum_s W_{sj} L_{sj}}{\sum_i Q_i} \tag{5}$$

where $L_{sj} \equiv$ endowment of factor of production s in economy j and $W_{sj} \equiv$ rental for factor of production s.

Following the approach taken in Heckscher–Ohlin analyses, if factor price equalization is assumed, then by Hotelling's Lemma if Π_j is differentiated [3]

$$Q_{ij} = \sum_{s=1}^{K} R_{is} L_{sj} \tag{6}$$

[3] The GNP function Π_j has been defined to allow for differentiated products and economies of scale. Following Helpman and Krugman, this can be done by including optimal firm scale in Π_j. Provided optimal firm scale is small relative to market size, change in industry output can be achieved by changes in the number of firms in the industry. Firms are assumed to be identical. This means at an industry level there will be constant returns to scale.

where R_{is} is a function of the parameters of Π_j and output prices which are assumed to be constant.

Substituting (5) and (6) into the expressions for gross imports and gross exports we get

$$(7) \qquad M_{ij}^{+} = \sum_{s=1}^{K} B_{is}^{+} L_{sj} - \sum_{s=1}^{K} \sum_{r=1}^{K} D_{isr}^{+} L_{sj} L_{rj} \qquad i = 1, \ldots, N$$

$$(8) \qquad X_{ij}^{+} = \sum_{s=1}^{K} R_{is} L_{sj} - \sum_{s=1}^{K} \sum_{r=1}^{K} D_{isr}^{+} L_{sj} L_{rj} \qquad i = 1, \ldots, N$$

where B_{is}^{+} and D_{isr}^{+} are functions of parameters of Π_j and where output prices will be constant under the assumptions already made. The linear in factor endowments terms in (7) represent economy j's demand for good i, while the linear terms in (8) represent economy j's supply of good i. The interaction terms in equations (7) and (8) represent economy j's demand for its domestic produced variety j of good i. M_{ij}^{+} in (7) can be interpreted as that part of economy j's demand for good i that cannot be satisfied by the domestically produced variety j. X_{ij}^{+} in (7) is the supply of variety j of good i available after domestic demand has been met. Neither M_{ij}^{+} nor X_{ij}^{+} can be negative. If (7) is subtracted from (8), net exports will be given by[4]

$$(9) \qquad (X_{ij}^{+} - M_{ij}^{+}) = \sum_{s=1}^{K} (R_{is} - B_{is}^{+}) L_{sj} \qquad i = 1, \ldots, N$$

Net exports reflect the balance between domestic demand for and supply of good i by economy j. Since domestic demand for the domestic variety of good i appears in both equations (7) and (8), these terms cancel out in equation (9).

By contrast with (7) and (8), (9) is the traditional Heckscher–Ohlin equation with net exports as a linear function of factor endowments [Saxonhouse (1983) and Leamer (1984)]. Within the Heckscher–Ohlin framework the non-linear terms in (7) and (8) cancel out. Since (9) can be derived from the Helpman-Krugman equations (7) and (8), this

[4] In the likely case that the number of goods exceeds the number of factors ($N > K$), trade will be indeterminant. In estimating models of this kind, Leamer (1984, p. 18) suggests that this indeterminancy can be resolved by assuming international transportation costs that deter and determine trade but are otherwise negligible. Alternatively, Saxonhouse (1983a, 1986) assumes that $N = K$, but that included and excluded dependent variables have properties such that the exclusion of relevant variables does not bias the parameters that are estimated.

It should be noted that derivation of equation (9) does not necessarily require that the trade balance be zero or exogenously fixed at all. If securities are incorporated into a Woodland (1982) indirect trade utility function then, with trade taking place in securities as well as goods, it is possible to use the same model to examine the influence of sectoral trade policy on both trade structure and the overall current account on international transactions. See Helpman and Razin (1978).

should demonstrate the compatibility of these two approaches. Contrary to what is often alleged (e.g. Zysman and Tyson 1983, p. 30) the incorporation of scale economies and product differentiation into conventional models of international trade in order to account for intra-industry trade need not invalidate the Heckscher–Ohlin interpretation of inter-industry trade [Helpman and Krugman (1985, p. 131)].

Equations (7) and (8) can be estimated in an effort to reconcile the contrasting approaches of Leamer/Saxonhouse and Lawrence. Like Lawrence, equations (7) and (8) by using gross imports or gross exports as a dependent variable do not net out intra-industry trade. Like Leamer and Saxonhouse, however, simultaneity problems are avoided by using factor endowments as the central explanatory variables.

The structure embodied in equations (7), (8), and (9) results from relaxing many of the strictest assumptions of the Heckscher–Ohlin model in order to incorporate hitherto neglected phenomena. Still further relaxation of assumptions is possible. For example, suppose that the assumption that strict factor price equalization across countries is dropped. Suppose rather that international trade equalizes factor prices only when factor units are normalized for differences in quality. For example, observed international differences in the compensation of ostensibly unskilled labor may be accounted for by differences in labor quality.[5] Instead of (7), (8), and (9) we have

$$(7') \qquad M_{ij}^{+} = \sum_{s=1}^{K} B_{is}^{+} a_s L_{sj} + \sum_{s=1}^{K}\sum_{r=1}^{K} D_{isr}^{+} a_s L_{sj} a_r L_{rj} \qquad i = 1, \ldots, N$$

$$(8') \qquad X_{ij}^{+} = \sum_{s=1}^{K} R_{is} a_s L_{sj} + \sum_{s=1}^{K}\sum_{r=1}^{K} D_{is}^{+} a_s L_{sj} a_r L_{rj} \qquad i = 1, \ldots, N$$

$$(9') \qquad (X_{ij}^{+} - M_{ij}^{+}) = \sum_{s=1}^{K} (R_{is} - B_{is}^{+}) a_s L_{sj} \qquad i = 1, \ldots, N$$

where $a_s \equiv$ quality of factor s.

Estimation Procedures

Equation (9′) can be estimated for N commodity groups from cross-national data. a_s is not directly observable but can be estimated from (9′). Formally the estimation of (9′) with a_s differing across countries and unknown is a multivariate, multiplicative errors in variable problem. Instrumental variable methods will allow consistent estimates of the $(R_{is} - B_{is}^{+})$. For any given net trade cross-section, a_s will not be identified. In the particular specification adopted in (8′), however, at any given time, there are N cross-sections that

[5] This line of reasoning was first advanced by Leontief (1956) more than thirty years ago as a possible explanation for the empirical feature of the simple Heckscher–Ohlin model.

contain the identical independent variables. This circumstance can be exploited to permit consistent estimation of the a_s.[6] Since the same error due to the unobservable quality terms will recur in equation after equation, it is possible to use this recurring error to obtain consistent estimates of the quality terms. These estimates of a_s can then be used to adjust the factor endowment data in (7′) and (8′) to obtain more efficient estimates of R_{is}, B^+ and D^+_{isr}.[7] In estimating (7′) and (8′), the D^+_{isr} can be constrained to be the same in both equations.

Estimating an Inter-Industry Trade Model

(9′) is estimated with data taken from the 41 countries listed in Table 3.[8] (9′) is estimated for each of the sixty-one trade sectors listed in Table 4 for 1979. The six factor endowments used in this estimation include directly productive capital stock, educational attainment, labor, petroleum reserves, coal, and arable land. Unlike Lawrence's work and earlier work by Saxonhouse (1983, 1986), distance is not treated as an independent variable and the Heckscher–Ohlin equations are assumed to hold up to an additive stochastic term.

The results of estimating equation (9′) are given in Tables 5 and 6. Note that fifty-five of the sixty-one sectoral net trade regressions are significant. For individual factor endowments, out of sixty-one estimated equations, capital has significant coefficients in twenty-eight, labor has significant coefficients in fourteen, education has nineteen, oil has sixteen, coal has twenty-two and land has a significant coefficient in twenty-two. Generally speaking, physical capital and human capital are sources of comparative disadvantage in the inter-industry trade in natural resource and labor intensive products and sources of comparative advantage for trade in capital-intensive and machinery products. Labor is a source of comparative disadvantage in inter-industry trade in natural resource products. Surprisingly, it has little influence on the trade of what are normally thought to be labor-intensive products. As expected oil and arable land are sources of comparative advantage for trade in natural resources and sources of comparative disadvantage for trade in virtually all manufactured products. By contrast, coal is a source of comparative disadvantage for most natural resource products save coal itself, and a source of comparative advantage for trade in machinery and chemicals.

Apart from their statistical significance, how important are each of these variables in explaining trade structure. Table 7 presents beta coefficients for each of the six explanatory

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[6] The approach taken here is analogous to the two-step "jack-knife" procedure proposed in Guilkey and Schmidt (1973) and Zellner (1962). As an example of the approach taken here, let $a_s = 1 + a'_s$, assuming $E(a'_s) = 0$. Using instrumental variable techniques in the presence of multiplicative errors allows consistent estimates of the $(R_{is} - B^+_{is})$. Using these estimates, for each economy an NX1 vector $[v_i]$ of the net trade residuals can be formed. Consistent estimates of the quality terms can be obtained from

$$[(R_{is} - B^+_{is})L_s]'[(R_{is} - B^+_{is})L_s]^{-1}[(R_{is} - B^+_{is})L_s]'[v_i]$$

[7] Following Durbin (1954) and in common with two stage least squares the approach taken here uses synthetic instrumental variables. Factor endowments are ordered according to size and rank is used as an instrument.

[8] Since the factor endowment variables in (9′) explain national development there is no need to limit the sample used here to just the most advanced economies.

variables for each of the sixty-one net trade equations (Kmenta, 1986, p. 422-423). These beta coefficients are directly proportional to the contribution each variable makes to a prediction of net trade (Leamer, 1978). Since equations such as (9′) are used to predict Japanese trade structure these results are of particular interest.

The beta values in Table 7 indicate the amount of change in standard deviation units of the net trade variable induced by a change of one standard deviation in the factor endowment. Following Leamer, if 0.5 is defined as a significant beta value, then education or human capital is significant in fifty-one out of sixty-one net trade equations. Arable land is significant forty-seven times, labor forty-three times, capital forty-one times, coal thirty-four and oil thirty-three times.

Cross-National Differences in Factor Quality and Measurement Error

In Table 8, Hausman's (1978) Test is used to check for unmeasured differences in factor quality and other errors in factor measurement across countries. In no less than 42 out of a total of 61 sectoral trade equations, the hypothesis that there are no cross-national unmeasured differences in factor quality cannot be accepted. This result is hardly surprising in view both of the quality of the data being used and the widely observed differences across countries in the compensation of ostensibly similar factors of production. In consequence, using the multiplicative errors in variables methods previously outlined, these differences have been estimated.

Cross-national estimates of factor quality and measurement error for 41 countries are presented in Table 9. These estimates are very difficult to interpret. They do not conform to any a priori beliefs about the relative quality of the various factors of production across countries. Cypriot, Honduran, Icelandic and Maltese workers are not credibly three or four times more efficient than their American counterparts. Rather these estimates may be dominated by errors of measurement that simply reflect poor data collection. For some countries, the estimated a_s may also reflect government policies aimed not so much at protecting particular sectors as at protecting particular factors of production. For example, Indonesian capital may greatly benefit by government policy at the expense of skilled and unskilled labor, while Turkish, Norwegian, and Danish labor may benefit at the expense of capital. It is also possible that some of the unusual findings in Table 9 are purely an artifact of the estimation procedures used. Cyprus, Honduras, Iceland and Malta with by far the highest measured factor efficiency, also have the smallest factor endowments of capital and skilled and unskilled labor in the forty-one country sample. While using rank order by size of factor endowments generates instruments which, in general, are closely correlated with the factor endowments, some countries obviously remain outliers. [9]

Estimating an Intra-Industry Model of Trade

Unlike the net trade equation (9′), the dependent variables in the gross trade equations (7′) and (8′) will never be negative, but will occasionally be zero. As seen in Table 10, some of the import equations and most of the export equations will contain some zero

[9] These same estimation techniques have been used by Saxonhouse (1983, 1986) in earlier work with multiplicative errors in variable models. Because this work used smaller and more homogeneous samples, the problems associated with using rank order instrumental variables did not arise.

observations. This suggests equations (7′) and (8′) should be specified as a Tobit Model. [10]

The presence of factor endowment interaction terms in equations (7′) and (8′) presents additional estimation problems. Given the available sample size and the large number of interaction terms, multicollinearity among the independent variables is likely to make precise estimation difficult.[11] In order to avoid this problem recall that from (5) and (7′)

$$M_{ij}^{+}=\sum_{s=1}^{K}B_{is}^{+}a_sL_{sj}-\sum_{s=1}^{K}\sum_{r=1}^{K}D_{isr}^{+}a_sL_{sj}L_{rj}=\frac{\Pi_j}{\Pi}\bar{Q}_i-\frac{\Pi_j}{\Pi}\sum_{s=1}^{K}R_{is}a_sL_{sj}$$

Dividing through by Π_j we get

$$\frac{M_{ij}^{+}}{\Pi_j}=\frac{\bar{Q}_i}{\Pi}-\frac{1}{\Pi}\sum_{s=1}^{K}R_{is}a_sL_{sj}=F_i-\sum_{s=1}^{K}R_{is}^{*}a_sL_{sj} \tag{10'}$$

where $F_i \equiv \frac{\bar{Q}_i}{\Pi} \equiv$ global sector i as a proportion of global GNP and $R_{is}^{*} \equiv \frac{R_{is}}{\Pi}$.

Equation (10′) makes it very easy to demonstrate that in a world with intra–industry trade, trade volume as a proportion of GNP can vary. By constrast in the Heckscher–Ohlin world of equation (9′), trade volume as a proportion of GNP cannot vary. From (10′) it is clear that if two economies are alike in all respects except size, the larger economy will have the relatively smaller foreign trade sector.

The results of estimating (10′), using the quality adjusted factor endowment data, but excluding Japan from the sample, are presented in Tables 11 and 12. In general, the results are interesting, occasionally surprising, but mostly plausible. For example, forty–nine out of sixty–one gross import regressions are statistically significant. These results mean it is possible to get a good explanation of the commodity structure of intra–industry trade even without any treatment of distance between trading partners.

The results here also appear to be generally in accord with the theory motivating equation (10′). Since it is impossible to have imports of a product which is nowhere produced, from (10′) it is clear that F_i, the constant term in this equation, should be positive. In fifty out of the sixty-one estimated gross import share equations, the F_i are statistically significantly greater than zero. From (6), it is also clear that the signs of the coefficients on the factor endowments in (10) will be negative the corresponding second derivatives of the GNP function. This means that at least some of the sixty-one coefficients on **each factor endowment** in (10′) are negative and that in the absence of widespread specialization by sector at least some of the coefficients on factor endowments in **each** of the sixty-one **import equations** will also be negative [Diewert, 1974, p. 143]. As estimated, equation (10') meets both these conditions.

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[10] Some of the import equations and many of the export equations will contain zero observations. Such modified least squares equations should be specified as a Tobit model. The estimation methods used here are described in Greene (1981), Greene (1983) and Chung and Goldberger (1984).

[11] See, however, the discussion in Saxonhouse and Stern (1987).

For individual factor endowments, by marked contrast with the estimated inter-industry trade model, the intra-industry trade model has a great many more significant coefficients. What are the determinants of gross imports? Capital once again has the most significant coefficients with forty-three, education has thirty-three, oil has thirty-four, and coal and land and labor all have significant coefficients in thirty-five. The determinants of gross imports do appear quite similar to the determinants of net trade. Endowments of capital and human capital do encourage imports of natural resource products and labor intensive products while discouraging imports of capital intensive, machinery and chemical products. As expected, arable land has just the opposite impact. Perversely, endowments in labor do appear to discourage imports of what are thought to be labor intensive products along with the imports of most natural resource products. Factor endowments of oil while encouraging net exports of many natural resource products, with the obvious exception of energy products, do encourage the gross imports of natural resource products. Coal's impact is just the opposite. With the exception of energy products, endowments of coal appear to encourage net imports of natural resource products. At the same time, however, they appear to discourage gross imports of these products.

Is Japanese Trade Behavior Distinctive?

Equation (10′) has been estimated without using Japanese observations.[12] Following earlier work by Saxonhouse (1983, 1986) forecasts are made successively on Japanese, Canadian, U.S. and Korean sectoral import shares using equation (10′). These forecasts are then compared with actual import shares. To the extent that equation (10′), estimated with non-Japan evidence, can replicate Japan's trade structure, it is difficult to argue that Japanese sectoral policies are yielding distinctive outcomes. This does not necessarily mean that Japan has a liberal trade regime. If all countries with relatively small amounts of arable land protect their wheat growers, Japan's behavior will not be seen as distinctive. At the same time under these circumstances, a change in Japanese trade policy will yield an increase in Japanese wheat imports. It should also be understood that even if equation (10′) cannot replicate Japan's trade structure, such a failure cannot necessarily be attributed to Japanese trade barriers. There may be other important variables, besides trade barriers, that have been excluded from the model underlying equation (10′).

The results of estimating (10′) are presented in Tables 13 and 14. Of the 61 actual observations on Japanese import shares, only 8 do not appear to come from the same population used to estimate (10′). These findings for gross import shares appear broadly consistent with earlier findings by Leamer and Saxonhouse for net trade.

Tables 13 and 14 contain findings for individual sectors. In order to test the null hypothesis that the ex post forecasts on all the extra sample values of Japanese, Canadian, Korean and U.S. trade structure, respectively, do not differ significantly from their historical values, the chi-squared test statistic

[12] Equation (10′) has also been re-estimated including Japan, but successively excluding Canada, United States and Korea from the sample.

(11) $$P = \sum_{i=1}^{61}[(\hat{\phi}_{ij} - \phi_{ij})\backslash\hat{\sigma}_{ij}]^2$$

where ϕ_{ij} = forecast of gross imports/GNP in the i^{th} sector in the j^{th} country and where $\hat{\sigma}_{\phi_{ij}}$ = estimated standard error can be utilized. Since the calculated values of P for Japan, Canada, Korea and the United States are 89.3, 114.3, 227.6 and 95.4 for 1979 and the 5% critical values is 109.4, it is apparent that for Japan and the United States the null hypothesis cannot be rejected. As before, this suggests whatever Japanese (and American) trade policies (and/or informal barriers) may have been, more than likely they have not been a major determinant of trade patterns. Further investigation of the Canadian and Korean results are clearly in order.

Finale

On the basis of the preceding research, it appears that the removal of the remaining distinctive formal and informal Japanese sectoral barriers to the import of manufactures, while highly desirable from a diplomatic standpoint, may have little impact on Japanese trade structure. Japan's intra-industry trade pattern, like Japan's inter-industry trade pattern, looks globally distinctive. When full allowance is made for economies of scale, differentiated products and Japan's distinctive national endowments, however, Japanese intra-industry trade, like Japan's inter-industry trade and like American trade, does conform to international patterns. If Japan is protectionist, it is protectionist in the same ways that other advanced, industrialized countries with scarce natural resources are protectionist. Whatever Japanese trade and industrial policies may have been in the 1950's, 1960's and 1970's, by the late 1970's it is difficult to find evidence of their distinctive, lasting impact on Japanese trade structure.

References

Caves, Richard E. and Ronald W. Jones. 1981. **World Trade and Payments**, 3rd ed. (Boston: Little, Brown & Co.)

Chung, Ching-Fan and Arthur S. Goldberger. 1984. "Proportional Projections in Limited Dependent Variable Models," **Econometrica** Vol. 54 (March).

Deardorff, Alan V. 1984. "Testing Trade Theories and Predicting Trade Flows" in Ronald W. Jones and Peter B. Kenen (ed.) **Handbook of International Economics,** Vol. 1 (Amsterdam: North Holland).

Diewert, W. E. 1974. "Applications of Duality Theory" in Michael D. Intriligator and David A. Kendrick (ed.) **Frontiers of Quantitative Economics** (Amsterdam: North Holland).

Durbin, James. 1954. "Errors in Variables," **Review of the International Statistical Institute**. Vol. 22.

Greene, William H. 1981. "On the Asymptotic Bias of the Ordinary Least Squares Estimator of the Tobit Model" **Econometrica** Vol. 49 (March).

Greene, William H. 1983. "Estimation of Limited Dependent Variable Models by Ordinary Least Squares and the Method of Moments," **Journal of Econometrics** Vol. 21 (February).

Guilkey, D. K. and P. Schmidt. 1981. "Estimation of Seemingly Unrelated Regressions with Vector-Autoregressive Errors," **Journal of the American Statistical Association**, Vol. 68 (September).

Hausman, Jerry A. 1978. "The Estimation of Economic Relationships Using Instrumental Variables" **Econometrica** Vol. 26 (July).

Havrylyshy, Oli and E. Cigan. 1984. "Inter-Industry Trade and the State of Development" in P.K.M. Tharaken (ed.) **The Economics of Intra–Industry Trade** (Amsterdam: North Holland).

Helpman, Elhanan and Paul R. Krugman. 1985. **Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy** (Cambridge: MIT Press).

Helpman, Elhanan and Assaf Razin. 1978. "Uncertainty and International Trade in the Presence of Stock Markets," **Review of Economic Studies** Vol. 45 (June).

Kmenta, Jan. 1986. **Elements of Econometrics**, 2nd ed. (New York: Macmillan).

Lawrence, Robert Z. 1987. "Does Japan Import Too Little: Closed Minds or Markets" **Brookings Papers in Economic Activity**, No. 2.

Leamer, Edward E. 1978. **Specification Searches** (New York: Wiley).

Leamer, Edward E. 1984. **Sources of International Comparative Advantage** (Cambridge: MIT Press).

Leamer, Edward E. 1987. "Measures of Openness," National Bureau of Economic Research Conference on Trade Policy Issues and Empirical Analysis, Cambridge, Mass., February 13-14.

Leontief, W. W. 1956. "Factor Properties and the Structure of American Trade: Further Theoretical and Empirical Analysis," **Review of Economic Studies** Vol. 38 (November).

McDonald, David R. 1982. "Statement" Subcommittee on Asian and Pacific Affairs, U.S. House of Representatives.

Saxonhouse, Gary R. 1983. "The Micro- and Macroeconomics of Foreign Sales to Japan" in William R. Cline (ed.) **Trade Policy for the 1980s** (Cambridge: MIT Press).

Saxonhouse, Gary R. 1986. "What's Wrong with Japanese Trade Structure?" **Pacific Economic Papers** No. 137 (July, 1986).

Saxonhouse, Gary R. and Robert M. Stern. 1987. "An Analytical Survey of Formal and Informal Barriers to International Trade and Investment in the United States, Canada and Japan" paper presented to Conference on U.S.-Canadian Trade and Investment Relations with Japan, April, 1987.

Sazanami, Yoko. 1981. "Possibilities of Expanding Intra-Industry Trade in Japan" **Keio Economic Studies** Vol. 18 No. 2.

Schlosstein, Steven. 1984. **Trade War** (New York: Congdon and Weed).

Woodland, A.D. 1982. **International Trade and Resource Allocation**. (Amsterdam: North Holland).

Zellner, Arnold. 1962. "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregative Bias," **Journal of American Statistical Association**, Vol. 57 (June).

Zysman, John and Laura Tyson. 1983. "American Industry in International Competition" in John Zysman and Laura Tyson (ed.) **American Industry in International Competition** (Ithaca, N.Y.: Cornell Univ. Press, 1983).

Appendix A: Data Sources and Methods

Directly Productive Capital Stock

a) Benchmarks for 1960 for each of the countries in the sample are estimated by cumulating gross domestic capital formation excluding residential housing investment and inventories from 1948. Estimates of real gross domestic capital formation in common currency terms are available in Robert Summers, Irving Kravis and Alan Heston, "International Comparison of Real Product and Its Components," **Review of Income and Wealth**, March, 1980. Residential housing investment and inventories are subtracted from these estimates. These data are available from the World Bank National Accounts data sheets for 1950, 1955 and 1960. They are converted to common currency basis using the Summers, Kravis and Heston purchasing power parity estimates for investment goods. For both the aggregate series and its components missing years are interpolated. It is assumed that the average annual rate of growth of gross domestic capital formation is the same for 1948-1950 as for 1950-1955. Gross domestic capital formation is converted to net domestic capital formation by assuming an average asset life of 12 years and applying the appropriate depreciation factor. A capital stock series for 1959-1979 is created by using World Bank data following these same procedures.

Labor Force

Benchmarks for 1979 for each of the countries in the sample are taken from the economically active population data given in International Labor Organization, **Yearbook of Labor Statistics**.

Educational Attainment

Benchmarks for 1979 for each of the countries in the sample (1968 for France, 1971 for the Netherlands and 1971 for the United Kingdom) are constructed using country specific survey of labor force data. Occupational groups in each country are aggregated using weights taken from Christensen, Cummings and Jorgenson, University of Wisconsin Social Systems Research Institute Discussion Papers Nos. 7505, 7528, 7529, 7530 and 7604.

Petroleum Resources and Coal Resources

a) Benchmarks for 1968 for each of the countries in the sample are obtained from the United Nations.

b) Petroleum resources series and coal resources series for 1959-1979 are created by adding or subtracting where appropriate crude petroleum production to the benchmarks. These production data are taken from United Nations, **Yearbook of World Energy Statistics**.

Arable Land

Arable land data are available in Food and Agricultural Organization, **Production Yearbook.**

Trade Data

Trade data are available in United Nations, **Commodity Trade Statistics** and United Nations, **Yearbook of International Trade Statistics.** Some re-classification because of a change in the SITC system in 1960. Trade flows are converted to U.S. dollars using prevailing exchange rates. Trade flows in current U.S. dollars deflated using U.S. export and import price indices. The price indices used are more aggregated than the commodity breakdown employed in the analysis here.

Appendix B: Estimating Equations (7') and (8')

The results of estimating (7') and (8') jointly, using the quality adjusted factor endowment data, but excluding Japan from the sample, are presented in Table B1. Tables B2 and B3 present the results of tests on the explanatory power of equations (7') and (8'). As reported in Table B2, fifty-nine out of total of sixty-one sectoral trade relationships are significant. Table B3 tests whether equations' (7') and (8') non-linear terms, taken together, contribute significantly to the explanation of gross trade flows. Does the Helpman-Krugman specification contribute to the explanation of gross trade flows? The results presented in Table B3 indicate that in forty-nine of the sixty-one sectoral regressions, the non-linear terms do contribute significantly to the explanation.

Table 1

Imports of Manufactures as Percent of Nominal GNP Selected Countries, 1962-1985

	1962	1973	1985
Japan	2.8%	2.8%	2.7%
U. S.	1.3	3.4	6.5
Federal Republic of Germany	6.0	9.1	15.0
France	4.8	9.5	13.1
United Kingdom	4.7	12.0	16.3

Source: Bank of Japan, **Kokusai hikaku tōkei, (International Comparative Statistics)**, various issues.

Table 2

Intra-Industry Manufacturing Trade Indices, 1980

Country	21 Sectors	94 Sectors
Australia	0.41	0.22
Belgium	0.87	0.79
Canada	0.67	0.68
Finland	0.58	0.49
France	0.88	0.82
Germany	0.69	0.66
Italy	0.71	0.61
Japan	0.30	0.25
Netherlands	0.77	0.78
Norway	0.62	0.51
Sweden	0.66	0.68
United Kingdom	0.82	0.78
United States	0.67	0.60
Korea	–	0.48
Switzerland	–	0.61

Notes. Source: Lawrence (1987) using

$$Index \quad j = \frac{\sum_{i=1}^{n}[(X_{ij} + M_{ij}) - |X_{ij} - M_{ij}|]}{\sum_{i=1}^{n}(X_{ij} + M_{ij})}$$

where i denotes manufacturing category, j denotes country, and X and M are exports and imports, respectively.

Table 3
Country Sample for "Economies of Scale, Differentiated Products and Access to the Japanese Market" Empirical Work

Argentina	Japan
Australia	South Korea
Austria	Malaysia
Belgium and Luxembourg	Malta
Brazil	Mexico
Canada	Netherlands
Sri Lanka	Nigeria
Cyprus	Norway
Denmark	Philippines
Finland	Portugal
France	Singapore
West Germany	Spain
Greece	Sweden
Honduras	Switzerland
Hong Kong	Thailand
Iceland	Turkey
India	United Arab Republic
Indonesia	United Kingdom
Ireland	United States
Israel	Yugoslavia
Italy	

Table 4

Trade Sectors in Sample

Petroleum, Petroleum Products (PETRO33)
Crude Materials, Crude Fertilizer (MAT27)
Metalliferous Ores, Metal Scrap (MAT28)
Coal, Coke Briquettes (MAT32)
Gas, Natural and Manufactured (MAT34)
Electrical Energy (MAT35)
Nonferrous Metals (MAT68)
Wood, Lumber, Cork (FOR24)
Pulp, Waste Paper (FOR25)
Wood, Cork Manufactures (FOR63)
Paper, Paperboard (FOR64)
Fruit, Vegetables (TROP5)
Sugar, Sugar Preparations, Honey (TROP6)
Coffee, Tea, Cocoa, Spices (TROP7)
Beverages (TROP11)
Crude Rubber (TROP23)
Live Animals (ANL0)
Meat, Meat Preparations (ANL1)
Dairy Products, Eggs (ANL2)
Fish, Fish Preparations (ANL3)
Hides, Skins, Furskins, Undressed (ANL21)
Crude Animal, Vegetable Minerals (ANL29)
Animal, Vegetable Oils, Fats, Processed (ANL45)
Animals, n.e.s. (ANL94)
Cereals, Cereal Preparations (CER4)
Feeding Stuff for Animals (CER8)
Miscellaneous Food Preparations (CER9)
Tobacco, Tobacco Manufactures (CER12)
Oil Seeds, Oil Nuts, Oil Kernels(CER22)
Textile Fibers (CER26)
Animal Oils, Fats (CER41)
Fixed Vegetable Oils (CER42)
Nonmetallic Mineral Manufactures (LAB66)
Furniture (LAB82)
Travel Goods, Handbags (LAB83)
Clothing (LAB84)

Table 4 continued

Footwear (LAB85)
Miscellaneous Manufactured Articles n.e.s. (LAB89)
Postal Pack Not Classified According to Kind (LAB91)
Special Trans. Not Classified According to Kind (LAB93)
Coins, Nongold, Noncurrent (LAB96)
Leather, Dressed Furskins (CAP61)
Rubber Manufactures, n.e.s. (CAP62)
Textile, Yarn, Fabrics (CAP65)
Iron and Steel (CAP67)
Manufactures of Metal (CAP69)
Sanitary Fixtures, Fittings (CAP81)
Machinery, Other Than Electrical (MACH71)
Electrical Machinery (MACH72)
Transport Equipment (MACH73)
Professional Goods, Watches, Instruments (MACH86)
Firearms, Ammunition (MACH95)
Chemical Elements, Compounds (CHEM51)
Mineral Tar and Crude Chemicals from Coal, Petroleum and Natural Gas (CHEM52)
Dyeing, Tanning, Coloring Matter (CHEM53)
Medicinal, Pharmaceutical Products (CHEM54)
Essential Oils, Perfume Matter (CHEM55)
Fertilizers, Manufactured (CHEM56)
Explosives, Pyrotechnic Products (CHEM57)
Plastic Materials, Cellulose (CHEM58)
Chemical Materials, n.e.s. (CHEM59)

Table 5

Estimation of Equation (9')

$$(X_{ij}^{+} - M_{ij}^{+}) = N_o$$

$$+N_1\text{CAPITAL} + N_2\text{LABOR} + N_3\text{EDUC}$$

$$+N_4\text{OIL} + N_5\text{COAL} + N_6\text{LAND ARA}$$

	R^2	$F(6/34)$
PETRO33	0.952	112**
MAT27	0.747	16.8**
MAT28	0.798	22.4**
MAT32	0.835	28.6**
MAT35	0.295	2.37**
MAT68	0.687	12.4**
FOR24	0.652	10.6**
FOR25	0.424	4.18**
FOR63	0.476	5.15**
FOR64	0.305	2.48**
TROP5	0.428	4.24**
TROP6	0.699	13.2**
TROP7	0.683	12.2**
TROP11	0.697	13.0**
TROP23	0.177	1.22
ANL0	0.045	0.27
ANL1	0.454	4.71**
ANL2	0.115	0.74
ANL3	0.953	116**
ANL21	0.587	8.05**
ANL29	0.334	2.84**
ANL43	0.323	2.71**
ANL94	0.436	4.38**
CER4	0.942	92.7**
CER8	0.653	10.7**
CER9	0.403	3.82**
CER12	0.823	26.3**
CER22	0.894	47.6**
CER26	0.739	16.1**
CER41	0.865	36.5**
CER42	0.096	0.60

Table 5 continued

LAB66	0.574	7.63**
LAB82	0.202	1.44
LAB83	0.535	26.52**
LAB84	0.413	3.99**
LAB85	0.515	6.02**
LAB89	0.754	17.4**
LAB91	0.540	6.64**
LAB93	0.570	7.51**
LAB96	0.137	0.90
CAP61	0.591	8.19**
CAP62	0.850	32.2**
CAP65	0.590	8.16**
CAP67	0.848	31.6**
CAP69	0.891	46.4**
CAP81	0.309	2.54**
MACH71	0.843	30.3**
MACH72	0.928	72.5**
MACH73	0.930	75.3**
MACH86	0.700	13.2**
MACH95	0.953	114**
CHEM51	0.693	12.8**
CHEM52	0.382	3.51**
CHEM53	0.510	5.89**
CHEM54	0.599	8.47**
CHEM55	0.650	10.6**
CHEM56	0.240	1.78
CHEM57	0.573	7.60**
CHEM58	0.689	12.6**
CHEM59	0.793	21.7**

$F(6,34)_{.05} = 2.34$

Table 6
Numbers of Significant (0.05) Coefficients in
Equation (9') by Sectoral Grouping, Factor Endowment and Sign

	Capital		Labor		Educ.		Petroleum		Coal		Land	
	+	-	+	-	+	-	+	-	+	-	+	-
(7)Petroleum and Raw Materials (PETRO33, MAT27-68)	-	3	-	1	-	1	2	-	1	-	2	-
(4)Forest Products (FOR24-63)	-	1	-	-	-	-	-	-	-	1	1	-
(5)Tropical Products (TROP5-23)	-	3	1	-	-	3	-	2	-	3	2	-
(8)Animal Products (ANL0-94)	-	3	-	-	-	1	1	-	-	-	2	-
(8)Cereals (CER4-42)	1	1	1	-	-	3	3	-	1	-	4	-
(8)Labor Intensive Manufactures (LAB66-96)	1	1	1	-	1	1	-	2	1	2	-	1
(6)Capital Intensive Manufact. (CAP61-81)	4	-	1	1	3	-	-	2	2	1	-	3
(5)Machin. (MACH71-95)	4	-	2	1	4	-	1	-	4	-	-	4
(9)Chemical Products (CHEM51-59)	4	2	3	2	2	1	-	3	6	-	-	4

Note: Numbers in parentheses at the left of sectoral grouping rows indicate the number of equations in each sectoral grouping.

Table 7

Beta Values from Equation (9')

	N_1	N_2	N_3	N_4	N_5	N_6
PETRO33	-1.16	-0.20	0.22	0.68	-0.15	-0.15
MAT27	-0.63	-0.75	-0.20	1.09	-0.13	0.85
MAT28	-1.62	1.42	-1.79	-0.45	-0.48	1.93
MAT32	-0.83	-0.68	-0.26	-0.21	1.85	0.48
MAT34	-0.94	0.97	-0.91	0.10	-0.96	0.86
MAT35	0.48	-1.15	0.21	1.06	-1.12	0.71
MAT68	0.41	-2.36	0.71	0.32	0.01	0.62
FOR24	-1.59	0.88	-0.88	0.58	-0.24	0.75
FOR25	0.48	-1.19	-0.02	0.97	-1.33	1.12
FOR63	-0.11	-1.31	0.16	0.36	-0.17	0.74
FOR64	1.16	-1.76	-0.48	0.88	-1.26	0.71
TROP5	-0.29	-0.28	-0.22	0.96	-1.20	0.94
TROP6	-0.86	1.19	-1.59	-1.70	-0.22	1.91
TROP7	-1.02	1.48	-0.62	-0.20	-1.08	0.42
TROP11	-1.47	4.57	-2.60	-1.77	-1.54	1.01
TROP23	-0.13	0.83	1.04	1.13	-0.07	-1.00
ANL0	-0.38	0.71	-0.62	-0.42	0.18	0.38
ANL1	-0.28	-0.52	-0.58	-0.10	-0.43	1.37
ANL2	0.06	0.52	-0.98	-0.42	-0.85	1.21
ANL3	-1.15	0.21	0.20	0.64	-0.13	-0.12
ANL21	-0.91	0.32	-0.80	0.14	0.44	0.90
ANL29	-0.88	0.82	-0.54	0.54	-1.05	0.65
ANL43	-1.69	1.58	-0.96	-0.16	0.29	0.22
ANL94	-2.06	2.22	-1.50	-0.61	0.52	0.58
CER4	-0.33	0.69	-1.22	0.18	-0.20	1.24
CER8	-0.77	0.98	-0.66	0.62	-0.48	0.73
CER9	0.15	-0.07	-0.09	0.32	0.21	0.09
CER12	-0.75	0.47	-0.47	0.78	-0.04	0.57
CER22	0.	0.02	0.01	0.00	0.29	0.01
CER26	-0.68	-0.15	-1.18	-0.66	0.78	1.79
CER41	0.41	-0.99	-0.14	0.68	0.00	0.91
CER42	-0.33	-0.37	0.38	0.80	-0.04	-0.31

Table 7 continued

Beta Values from Equation (9')

	N_1	N_2	N_3	N_4	N_5	N_6
LAB66	0.01	0.62	0.25	-1.11	0.63	-0.81
LAB82	0.51	-1.52	1.18	-0.15	1.12	-0.95
LAB83	-0.09	0.01	0.24	-0.02	-0.57	-0.20
LAB84	-0.50	0.47	-0.13	0.11	-0.75	0.13
LAB85	-0.28	0.87	-0.42	-0.31	-1.03	0.31
LAB89	1.23	-1.28	1.56	-0.22	0.44	-1.50
LAB91	-2.18	3.91	-1.48	-1.34	1.06	-0.82
LAB93	-0.18	1.66	-0.95	-0.57	-1.61	0.63
LAB96	0.57	-1.74	1.05	0.62	0.82	-0.57
CAP61	-0.90	1.84	-0.47	-0.75	-0.56	0.70
CAP62	0.75	1.27	-0.12	-1.00	-0.67	-0.55
CAP65	1.67	-1.72	1.85	0.38	0.08	-1.20
CAP67	2.69	-2.88	1.91	0.08	-0.13	-0.80
CAP69	1.62	-1.00	1.04	-0.88	0.88	-1.04
CAP81	0.45	-0.55	0.69	-0.36	1.25	-0.95
MACH71	1.07	-1.27	1.08	-0.17	1.60	-1.19
MACH72	2.22	-2.15	1.79	-0.02	0.67	-1.36
MACH73	2.12	-1.41	1.22	-0.31	0.16	-0.88
MACH86	2.08	-2.86	2.26	0.62	0.97	-1.63
MACH95	-0.18	0.35	-0.17	0.54	0.46	-0.12
CHEM51	1.58	-2.71	1.61	0.13	1.76	-1.04
CHEM52	-0.70	0.07	-0.63	0.92	-1.00	0.71
CHEM53	0.63	-1.09	0.87	-0.89	2.05	-1.06
CHEM54	-1.22	2.22	-1.04	-0.96	1.33	-0.43
CHEM55	-1.57	4.35	-2.27	-1.72	0.29	0.27
CHEM56	1.45	-3.15	1.35	1.16	0.20	-0.29
CHEM57	-1.46	2.98	-1.21	-1.04	1.05	-0.56
CHEM58	1.38	-1.82	1.45	0.16	1.30	-1.24
CHEM59	0.21	-0.53	0.54	-0.37	1.99	-0.99

Table 8

Hausman's Test on Factor Endowments

F test on errors in Capital, Labor and Education Variables

PETRO33	31.82*	CER41	2.95*
MAT27	12.38*	CER42	1.44
MAT28	21.97*	LAB66	1.69
MAT32	2.00	LAB82	3.94*
MAT35	3.54*	LAB83	3.10*
MAT68	1.68	LAB84	1.64
FOR24	2.71*	LAB85	6.85*
FOR25	3.05*	LAB89	2.77
FOR63	2.90*	LAB91	44.37*
FOR64	1.10	LAB93	3.71*
TROP5	7.74*	LAB96	0.81
TROP6	0.32	CAP61	2.36*
TROP7	3.51*	CAP62	8.62*
TROP11	1.05	CAP65	3.43*
TROP23	1.59	CAP67	4.31*
ANL0	27.30*	CAP81	5.07*
ANL1	5.64*	MACH71	3.28*
ANL2	1.17	MACH72	12.89*
ANL3	1.17	MACH73	27.75*
ANL21	0.23	MACH86	8.68*
ANL29	1.54	MACH95	1.99
ANL43	8.48*	CHEM51	7.52*
ANL94	14.13*	CHEM52	5.62*
CER4	1.11	CHEM53	11.41*
CER8	7.01*	CHEM54	4.28*
CER9	6.15*	CHEM55	0.81
CER12	10.70*	CHEM56	6.11*
CER22	13.89*	CHEM57	3.53*
CER26	10.35*	CHEM58	3.46*
		CHEM59	1.78

*Significant at .05 level

Table 9
Cross-National Estimates of Factory Quality and
Measurement Error a_s

	Capital	Labor	Education
Argentina	0.96	1.17	1.18
Australia	1.08	1.09	1.26
Austria	0.87	1.28	1.23
Belgium and Luxembourg	0.98	1.36	1.18
Brazil	0.71	0.70	0.83
Sri Lanka	2.48	1.07	1.36
Cyprus	4.13	3.76	5.04
Denmark	0.85	1.51	0.89
Finland	0.95	1.33	0.93
France	0.76	1.00	0.82
West Germany	1.15	1.03	1.06
Greece	0.78	1.13	1.39
Honduras	4.07	2.35	3.01
Hong Kong	1.78	1.22	1.30
Iceland	3.13	4.16	3.62
India	1.37	0.91	1.00
Indonesia	2.62	0.83	0.79
Ireland	2.61	1.57	1.44
Israel	1.40	1.38	1.17
Italy	0.93	0.94	0.87
Japan	0.93	0.89	0.94
Korea	1.22	0.83	1.09
Malaysia	1.69	0.99	1.04
Malta	5.01	3.97	4.16
Mexico	1.16	0.98	1.02
Netherlands	0.87	1.13	0.82
Nigeria	1.39	1.02	1.10
Norway	0.78	1.54	1.09
Philippines	1.40	0.67	0.85
Portugal	1.53	1.41	1.43
Singapore	1.67	1.70	1.48
Spain	0.77	1.06	1.11
Sweden	1.00	1.32	0.89
Switzerland	0.95	1.38	1.03
Thailand	1.13	0.85	1.31
Turkey	0.82	1.43	1.36
United Arab Republic	1.56	1.33	0.86
United Kingdom	10.99	0.76	0.85
United States	1.00	1.01	1.01
Yugoslavia	1.14	0.84	0.91

Table 10

Proportion of Zero Observations in Gross Trade Equation

	Imports	Exports
PETRO33	0	.073
MAT27	0	.024
MAT23	0	.195
MAT32	0	.195
MAT34	.049	.268
MAT35	.634	.683
MAT68	0	0
FOR24	0	.098
FOR25	.049	.098
FOR63	0	0
FOR64	0	0
TROP5	0	.024
TROP6	0	.049
TROP7	0	.024
TROP11	0	.049
TROP23	0	.122
ANL0	.268	NA
ANL1	.024	.024
ANL2	0	.073
ANL3	0	0
ANL21	.073	0
ANL29	0	0
ANL43	0	.122
ANL94	0	.122
CER4	0	.024
CER8	0	0
CER9	0	0
CER12	.049	.049
CER22	.024	.073
CER26	0	0
CER41	0	.146
CER42	0	.049

Table 10 continued

CAP61	0	0
CAP62	0	.024
CAP65	0	0
CAP67	0	.049
CAP69	0	0
CAP81	0	.049
MACH71	0	.024
MACH72	0	.049
MACH73	0	.024
MACH86	0	.049
MACH95	.171	.366
CHEM51	0	.024
CHEM52	0	.220
CHEM53	0	0
CHEM54	0	.024
CHEM55	0	.024
CHEM56	.024	.146
CHEM57	0	.146
CHEM58	0	.049
CHEM59	0	0

Table 11

The Estimation of $P_o + P_1$CAPITAL + P_2LABOR + P_3EDUC + P_4OIL + P_5COAL + P_6LAND ARA

	R^2	$F(6/33)$
PETRO33	0.999	6610.0**
MAT27	0.378	3.34**
MAT28	0.149	0.97
MAT32	0.120	0.75
MAT34	0.059	0.34
MAT35	0.085	0.51
MAT68	0.502	5.55**
FOR24	0.475	4.99**
FOR25	0.205	1.42
FOR63	0.589	7.89**
FOR64	0.523	6.10**
TROP5	0.820	25.1**
TROP6	0.420	3.98**
TROP7	0.716	13.9**
TROP11	0.607	8.49**
TROP23	0.920	62.8**
ANL0	0.688	12.1**
ANL1	0.570	7.28**
ANL2	0.582	7.65**
ANL3	0.999	1870.0**
ANL21	0.076	0.46
ANL29	0.654	10.4**
ANL43	0.899	48.7**
ANL94	0.691	12.3**
CER4	0.397	3.62**
CER8	0.435	4.23**
CER9	0.536	6.34**
CER12	0.395	3.59**
CER22	0.243	1.77
CER26	0.559	6.97**
CER41	0.067	0.39
CER42	0.746	18.3**

Table 11 continued

LAB66	0.646	10.0**
LAB82	0.280	2.14
LAB83	0.796	21.4**
LAB84	0.483	5.14**
LAB85	0.430	4.14**
LAB89	0.805	22.7**
LAB91	0.033	0.18
LAB93	0.362	3.12**
LAB96	0.370	3.23**
CAP61	0.545	6.58**
CAP62	0.454	4.57**
CAP65	0.818	24.7**
CAP67	0.815	24.2**
CAP69	0.780	19.5**
CAP81	0.705	13.2**
MACH71	0.864	34.9**
MACH72	0.903	51.3**
MACH73	0.914	58.6**
MACH86	0.792	20.9**
MACH95	0.132	0.84
CHEM51	0.374	3.28**
CHEM52	0.064	0.38
CHEM53	0.834	27.6**
CHEM54	0.466	4.80**
CHEM55	0.711	13.5**
CHEM56	0.108	0.66
CHEM57	0.738	15.5**
CHEM58	0.255	16.9**
CHEM59	0.416	3.92**

** = significant at .05 level; $F(6,33)_{.05} = 2.33$

Table 12
Number of Significant (.05) Coefficients in
Equation (10') by Sectoral Grouping and
Factor Endowment and Sign

	F_i	Capital		Labor		Education		Oil		Coal		Arable Land	
		+	-	+	-	+	-	+	-	+	-	+	-
(7)Petroleum and Raw Materials (PETRO33, MAT27-68)	3	2	1	1	1	1	1	-	2	-	1	-	2
(4)Forest Products (FOR24-63)	2	1	-	2	1	-	2	-	2	-	-	2	-
(5)Tropical Products (TROP5-23)	5	3	1	1	3	2	2	3	1	1	3	-	-
(8)Animal Products (ANL0-94)	7	4	2	2	3	4	1	4	2	4	2	1	5
(8)Cereals (CER4-42)	6	3	2	-	4	3	2	1	2	1	3	0	5
(8)Labor Intensive Manufactures (LAB66-96)	7	3	2	-	6	3	2	3	2	3	2	2	3
(6)Capital Intensive Manufact. (CAP61-81)	6	2	4	2	2	2	3	3	2	1	3	3	1
(5)Machin. (MACH71-95)	4	1	3	1	2	1	3	1	1	-	4	2	2
(9)Chemical Products (CHEM51-59)	7	2	5	1	4	1	3	3	1	-	5	3	1

*findings suggest perhaps surprisingly that it is possible that the commodity structure of intra-industry trade can be explained without any treatment of distance betwen trading partners. Forty-nine out of the sixty-one gross import share regressions are statistically significant.

Table 13

Extreme Observations Imports, 1979

Japan	United States
Wood, Lumber, Cork	Metalliferous ores
Wood, cork, manufactures	Petroleum products
Meat, meat prep.	Plastic materials
Dairy products and eggs	Rubber manufactures
Feedstuff for animals	(n.e.s.)
Tobacco, tobacco	Textile yarn, fabrics
products	Clothing
Clothing	Footwear
Footwear	

Canada	Korea
Dairy products, eggs	Coal, coke briquettes
Fish, fish prepar.	Fruit, vegetables
Oil seeds, oil nuts and	Cereals, ceral prepar.
oil kernels	Tobacco, tobacco manufactures
Wood, lumber, cork	Oil seeds, oil nuts, oil kernels
Wood, cork manufactures	Textile fibers
Leather, dressed	Hides, skins, furskins, undressed
Rubber manufactures	Crude animals, vegetables, minerals
Paper, paperboard and	Wood, lumber, cork
manufactures	Wood, cork manufactures
Textile yarn, fabrics	Footwear
Manufactures of metal	Rubber manufactures (n.e.s.)
machinery	Metal manufactures
	Machinery, other than electrical
	Electrical machinery
	Transport equipment
	Plastic materials, cellulose
	Chemical materials, n.e.s.

Table 14

Does $\frac{M_{ij}}{\Pi_j}$ come

from the Same Population as $\frac{M_{ij}}{\Pi_j}$

T-tests on Forecasts and Historical Values

	Japan	U.S.	Canada	Korea
PETRO33	0.33	2.38*	0.67	0.67
MAT27	0.84	0.84	0.91	1.41
MAT28	1.56	2.53*	0.89	1.25
MAT32	1.07	1.85	1.36	3.16*
MAT34	1.50	0.61	1.28	1.48
MAT35	0.74	1.21	1.03	1.19
MAT68	1.37	1.02	1.84	1.02
FOR24	2.14*	1.56	2.61*	2.68*
FOR25	0.85	1.36	1.50	1.61
FOR63	2.68*	0.28	2.50*	4.51*
FOR64	1.08	0.74	3.02*	1.03
TROP5	0.19	0.04	1.08	2.87*
TROP6	1.08	1.02	0.84	1.02
TROP7	0.06	1.71	1.36	1.50
TROP11	0.61	0.28	1.48	0.42
TROP23	0.17	0.34	1.33	0.28
ANL0	0.63	0.02	0.79	0.68
ANL1	2.85*	1.03	0.81	0.41
ANL2	2.31*	1.63	2.21*	0.54
ANL3	1.43	0.35	0.02	0.42
ANL21	1.02	0.51	1.46	0.07
ANL29	0.67	0.55	1.27	3.11*
ANL45	0.41	0.94	1.02	0.82
ANL94	0.77	1.48	0.81	1.19
CER4	0.48	0.41	0.59	0.50
CER8	2.96*	0.81	1.27	0.92
CER9	0.27	0.83	0.80	0.94
CER12	2.51*	0.81	1.01	0.02
CER22	0.31	0.25	3.41*	4.32*
CER26	0.34	0.47	0.27	2.90*
CER41	0.36	0.47	1.26	0.43
CER42	0.51	0.77	0.21	0.89

Table 14 continued

LAB66	0.61	0.87	0.97	0.85
LAB82	0.85	0.33	0.69	0.69
LAB83	0.85	0.41	0.87	0.96
LAB84	2.38*	2.64*	0.68	1.89
LAB85	3.09*	3.16*	0.43	1.15
LAB89	1.17	0.48	0.71	0.66
LAB91	0.69	0.24	0.57	0.52
LAB93	0.65	0.37	0.60	1.04
LAB96	0.09	0.09	0.11	0.06
CAP61	0.11	0.75	2.80*	1.64
CAP62	0.08	2.67*	3.24*	2.98*
CAP65	0.35	3.50*	0.67	1.18
CAP67	1.23	1.44	1.84	0.28
CAP69	0.69	0.61	2.73*	2.27*
CAP81	0.01	0.93	0.85	1.28
MACH71	0.97	1.02	0.28	6.18*
MACH72	0.69	0.61	0.91	3.76*
MACH73	0.38	0.87	0.01	6.59*
MACH86	0.67	0.63	1.21	1.50
MACH95	0.88	0.39	0.96	1.11
CHEM51	0.77	1.23	0.60	1.16
CHEM52	0.21	0.54	0.56	1.06
CHEM53	0.01	0.46	0.37	0.77
CHEM54	0.22	0.44	0.05	1.49
CHEM55	0.55	0.93	0.57	0.95
CHEM56	1.36	1.07	1.04	1.07
CHEM57	0.62	1.00	0.82	0.86
CHEM58	0.54	2.51*	0.66	4.73*
CHEM59	1.42	1.48	1.39	3.20*

** – Hypothesis that forecast and historical values come from same population not accepted (critical region = .05).

Table B1
Numbers of Significant (.05) Coefficients in
Equations (7') and (8') by Sectoral Grouping
and Factor Endowment

		Linear Terms						Interaction Terms					
		Cap.	Lab.	Educ.	Petr.	Coal	Land	Cap.	Lab.	Educ.	Petr.	Coal	Land
Petroleum	M	3	1	2	3	3	3						
and Raw								6	3	2	8	3	3
Materials	X	4	2	1	1	4	2						
(PETRO33													
MAT27-68)													
Forest	M	1	2	2	2	0	3						
Products								9	5	7	8	7	5
(FOR24-63)	X	3	3	1	0	0	3						
Tropical	M	2	0	1	1	2	2						
Products								7	3	4	2	2	1
(TROP5-23)	X	1	0	0	2	1	3						
Animal	M	1	2	4	0	3	4						
Products								12	9	7	3	3	2
(ANLO-94)	X	2	1	4	4	1	1						
Cereals	M	0	0	0	1	4	6						
(CER4-42)								6	5	4	1	5	2
	X	1	1	1	3	6	4						
Labor	M	3	0	1	0	5	6						
Intensive													
Manufact.								12	5	8	3	8	2
(LAB66-96)	X	3	2	4	0	3	5						
Capital	M	2	1	3	1	5	3						
Intensive													
Manufact.								9	5	6	0	7	3
(CAP61-81)	X	2	1	3	1	5	6						
Machinery	M	1	4	5	1	3	2						
(MACH71-95)								9	4	5	0	2	1
	X	5	2	2	0	2	2						
Chemical	M	4	3	7	1	7	6						
Products								12	11	17	6	12	6
(CHEM51-59)	X	3	1	0	0	3	4						

Table B2

Test on the Significance of Each Sectoral Regression

$F_{.05(33,47)} = 1.70$

PETRO33	30.9*	CER42	12.5*
MAT27	4.8*	LAB66	6.3*
MAT28	21.0*	LAB82	4.8*
MAT32	8.4*	LAB83	37.8*
MAT34	33.0*	LAB84	27.0*
MAT35	9.7*	LAB85	58.8*
MAT68	5.2*	LAB89	19.1*
FOR24	18.1*	LAB91	1.6*
FOR25	71.8*	LAB93	111.0*
FOR63	17.8*	LAB96	1.2
FOR64	4.1*	CAP61	35.4*
TROP5	26.9*	CAP62	30.4*
TROP6	69.0*	CAP65	7.5*
TROP7	31.3*	CAP67	26.4*
TROP17	30.3*	CAP69	9.4*
TROP23	2.0*	CAP81	5.3*
ANL0	14.6*	MACH71	18.4*
ANL1	132.1*	MACH72	12.5*
ANL2	15.9*	MACH73	19.3*
ANL3	33.1*	MACH86	12.8*
ANL21	67.0*	MACH95	3.1*
ANL29	22.9*	CHEM51	9.1*
ANL43	7.0*	CHEM52	176.5*
ANL94	40.5*	CHEM53	6.9*
CER4	3.6*	CHEM54	6.2*
CER8	1.9*	CHEM55	6.7*
CER9	5.2*	CHEM56	21.4*
CER12	7.9*	CHEM57	5.8*
CER22	4.3*	CHEM58	12.1*
CER26	13.3*	CHEM59	8.0*
CER41	2.2*		

* = Test statistic significant at .05 level

Table B3
Test on the Significance of Each
Sectoral Regression's Interaction Terms
H_o: $D_{11} = D_{12} = D_{13} =$
$\ldots = D_{56} = D_{66} = 0$
$F_{.05} = 1.77$

PETRO33	3.8*	CER42	1.5
MAT27	1.8	LAB66	2.3*
MAT28	4.1*	LAB82	2.7*
MAT32	1.9*	LAB83	3.3*
MAT34	0.8	LAB84	1.3
MAT35	3.4*	LAB85	3.1*
MAT68	4.7*	LAB89	8.2*
FOR24	8.0*	LAB91	0.3
FOR25	15.2*	LAB93	14.0*
FOR63	6.5*	LAB96	0.8
FOR64	2.2*	CAP61	26.1*
TROP5	1.8	CAP62	3.6*
TROP6	26.5*	CAP65	4.9*
TROP7	4.0*	CAP67	9.1*
TROP11	5.0*	CAP69	3.5*
TROP23	0.5	CAP81	2.4*
ANL0	4.1*	MACH71	4.6*
ANL1	0.5	MACH72	1.9*
ANL2	0.7	MACH73	2.3*
ANL3	3.2*	MACH86	3.4*
ANL21	12.6*	MACH95	2.7*
ANL29	0.2	CHEM51	8.4*
ANL43	1.6	CHEM52	2.2*
ANL94	11.6*	CHEM53	5.1*
CER4	1.9*	CHEM54	5.2*
CER8	2.1*	CHEM55	5.1*
CER9	1.5	CHEM56	4.0*
CER12	2.8*	CHEM57	2.3*
CER22	2.4*	CHEM58	6.0*
CER26	1.9*	CHEM59	4.9*
CER41	0.9		