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Hypotheses and the Tests of Trade Patterns

The Impact of National Characteristics & Technology on the Commodity Composition of Trade in Manufactured Goods

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It was once fashionable to hear about a "notorious lag" between international trade theory and other branches of economic analysis. The lag may still exist, but in the meantime new theories have surfaced—theories which explain export and import patterns in terms of "technological" variables. These theories often perform well when applied to a single group of commodities or a limited range of countries. But how do they fare when pitted against one another on common commodities and countries? To answer this question is an ambitious task, and the evaluation offered here has several limitations: it deals with the broad sweep of trade theories, often in rashly over-simplified form; it confines itself to manufactured goods; and it examines only the commodity composition of trade. Our principal goal has been to develop empirical measures to test hypotheses in the broadest possible terms, and this goal has been pursued at the expense of theoretical analysis. We are not much interested in the impact of natural resource location on trade

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flows; therefore the analysis has been limited to manufactured goods. The problems of a dual economy are ignored although these problems may significantly affect trade flows. Nor are we concerned with the forces determining the growth and fluctuation of trade. Instead the focus is on commodity composition.[1]

Table 1 outlines the seven trade theories which concern us. All seven have this in common: each views trade as the offspring of an economic marriage between product characteristics and national attributes. The first six theories find in trade a compensating mechanism for international structural differences, but the seventh theory sees an exchange of *similar* goods.

These propositions are illustrated by Figure 1. The vertical axis depicts relative prices.[2] The horizontal axis specifies the national attribute. Goods are distinguished by the presence of the connecting characteristic. For example, the characteristic might be commodity standardization, and the related national attribute, industrial sophistication. Country A, not very sophisticated, enjoys a comparative advantage in making Good 1, a standardized commodity. This is shown by the price relations which prevail in Country A as opposed to other nations. Country B has a comparative advantage in making Good 2, a moderately sophisticated product, while Country C commands the lead in highly sophisticated Good 3. The commodity composition of exports, according to the six "orthodox" theories, reflects these advantages and disadvantages: Country A sells Good 1 in abundance, Country B sells Good 2, and so forth.

S. B. Linder's theory, the seventh, requires a different interpretation of Figure 1. The nonhomogeneity of manufactures is emphasized: goods

[1] Kuznets and Linnemann have quantified the forces determining the growth of trade and the size of bilateral trade flows. These topics are accordingly avoided [cf. 38 and 45]. The literature on trade fluctuations is too abundant for citation here. However, I. B. Kravis and R. E. Lipsey have some work under way at the National Bureau of Economic Research which indicates that cyclical fluctuations can sometimes change the composition of national exports. For example, during the Suez crisis, American shipyards received substantial foreign orders on the basis of quick delivery, despite very disadvantageous prices.

[2] The concept of "price," as used here, means more than warehouse price. One nation may offer lower warehouse prices than another, but for lack of quality control, marketing facilities, or ability to meet delivery schedules, its effective prices may be higher. In this paper we assume that abundant exports are the necessary and sufficient indicator of low prices.

TABLE 1

Synopsis of Theories of International Trade

Basic Composition of Trade Theory	Selected Proponents	Essential Commodity Characteristics	National Attributes Pertinent to Exports of Manufactured Goods
1. Factor proportions	Heckscher, Ohlin[a]	Capital = labor ratios	Relative abundance of physical capital leads to export of capital-intensive goods; abundance of labor leads to export of labor-intensive goods.
2. Human skills	Leontief, Bhagwati, Kenen, Kravis, Keesing, Waehrer, Kenen-Yudin, Roskamp-McMeekin, Bharadwaj-Bhagwati, Lary[b]	Skill requirements of production and distribution	Relative abundance of professional personnel and highly trained labor leads to export of skill-intensive goods; abundance of unskilled labor promotes export of goods requiring few skills.
3. Scale economy	Ohlin, Dreze, Hufbauer, Keesing[c]	Extent of scale economies in production and distribution	Large home market is conducive to export of goods produced under increasing returns to scale; small home market is conducive to export of goods produced under constant returns to scale.
4. Stage of production	Import Substitution School[d]	Economic "distance" from the final consumer	Sophistication abets producers' goods exports; simplicity abets consumer goods exports, especially "light" consumer goods.

(continued)

TABLE 1 (concluded)

Basic Composition of Trade Theory	Selected Proponents	Essential Commodity Characteristics	National Attributes Pertinent to Exports of Manufactured Goods
5. Technological gap	Tucker, Kravis, Posner, Hufbauer, Douglass, Egendorf, Gruber-Mehta-Vernon, Keesing[e]	Sequential national entry to production	Early manufacture of new goods confers an export advantage; later producers must rely on lower wages or other static features to promote exports.
6. Product cycle	Hirsch, Vernon, Wells, Stobaugh[f]	Differentiation of commodities	Sophistication and early manufacture leads to export of differentiated goods; lack of sophistication leads to export of standardized goods.
7. Preference similarity	Linder[g]	Similarity between imports, exports, and production for the home market.	Trade is most intensive between countries of highly similar economic structure, least intensive between countries of very different economic structure.

Notes to Table 1

[a]E. F. Heckscher [18]. For a modern restatement, see S. Mookerjee [48a].

[b]On a theoretical plane, the skill approach was suggested as a possible resolution of the Leontief paradox by W. W. Leontief himself (albeit in "labor efficiency" form) [41]. The same suggestion was made along more definite lines by J. Bhagwati [5]. Similar theoretical suggestions appear in P. B. Kenen [31, 32]. For the empirical thread of analysis, see: I. B. Kravis [36], D. B. Keesing [25, 26], H. Y. Waehrer [78], P. B. Kenen and E. Yudin [33], R. Bharadwaj and J. Bhagwati [6], and K. W. Roskamp and G. C. McMeekin [54], and H. B. Lary [39].

[c]The scale economy theory was mentioned by Ohlin [51, Chap. 3]. J. Dreze skillfully blends the scale economy theory with a commodity-standardization argument to explain Belgium's specialization in semifabricated industrial goods [11]. The statistical support for this argument appears in [12]. Cf. also G. C. Hufbauer [21] and D. B. Keesing [29].

[d]The stage of production thesis typically finds a place in the unspoken assumptions underlying an import substitution strategy, through the thesis is seldom endorsed openly as a normative guide to commercial policy. Cf. [12a, 14, 20, 12].

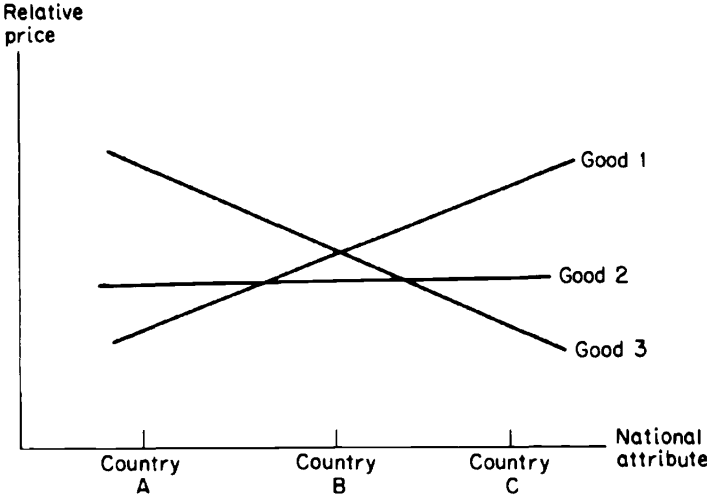
[e]The distinction between technological gap and product cycle is quite arbitrary. In particular, the R & D analysis has been assigned to technological gap, but it could as easily travel under the product cycle label. [61, 35, 52, 21, 10, 13, 16, 27].

[f]See the introduction to note (e). [19, 76, 81, 57].

change in form and quality to suit the country of manufacture. Figure 1, seen in this light, depicts nine quasidistinct commodities, three in each country, with some qualitative overlap between adjacent countries. Adaptability of domestic production to foreign consumption determines the pattern of trade. The result may be a cross-exchange between B and C of Good 3, between A and B of Good 1, with very little trade between A and C.

The propositions illustrated by Figure 1 suggest two kinds of empirical evaluation, one concerned with nature-of-trade, the other with gains-from-trade. First, to what extent do trade flows reflect economic structure? In other words, how strong are the links between characteristics embodied in trade and national attributes? Second, do imports and exports compensate for structural differences? Or, as Linder argues, do

FIGURE 1



they merely extend, in a marginal way, the existing range of consumption alternatives? This paper is based on these inquiries.

THE DATA

Statistical information on trade and economic structure circa 1965 was gathered for a carefully selected group of twenty-four countries, contributing some 90 per cent of the manufactured exports from nonsocialist countries. The twenty-four nations are listed in Table 2. Eliminated in the selection process were nations with relatively small (and hence probably erratic) manufactured exports;[3] nations belonging to the socialist camp (because of closely regulated trade and lack of data);[4] and nations specializing in manufactured exports requiring nontransportable natural resources.[5] Because of this preselection process, the

[3] The following countries were excluded because of the small size of their manufactured exports (million dollars of 1965 manufactured exports and percentage of total exports in parentheses): Greece ($44.4; 14 per cent); Brazil ($124.3; 8 per cent); Colombia ($34.8; 6 per cent); Ghana ($3.3; 1 per cent); Iraq ($6.4; 1 per cent).

[4] Although a member of the socialist camp, Yugoslavia is included.

[5] The following nations were excluded because of their specialization in resource-intensive manufactures (product and percentage of country's manufac-

trade theories perform better than if applied to a more haphazard collection of nations.[6] Furthermore, each theory receives, in the alternative, the benefit of one ad hoc exclusion: the one country most at variance with the predictions of each theory is dropped in order to obtain an alternative evaluation of the twenty-three "best" nations.

Commodities were classified both according to the 28 two-digit divisions and the 102 three-digit categories identified in sections 5, 6, 7, and 8 of the revised Standard International Trade Classification (SITC) [63]. (See Appendix Table 2.) The three-digit classification was preferred for analytic purposes. Import and export statistics were generally taken from United Nations sources [64, 80].

SITC sections 5, 6, 7, and 8 exclude many goods, such as processed foods, which are defined as manufactures in the United Nations International Standard Industrial Classification (ISIC). Most such exclusions relate to products with a large, nontransportable, natural resource content.[7]

Table A-2 (Appendix Table 2) presents characteristics for the commodities enumerated in the two-digit and three-digit SITC. Many hazards surround these estimates. Difficulties associated with particular qualities are touched upon later, but certain common problems deserve mention here.

To begin with, the qualities, with the exception of the "consumer goods ratio," were estimated from American experience, an expedient but potentially risky procedure.[8] A frequently mounted theoretical objec-

tured exports are given in parentheses): Finland (wood, paper, 60 per cent); South Africa (assorted metals, minerals, 65 per cent); Turkey (nonferrous metals, 61 per cent); Chile (nonferrous metals, 94 per cent); Malaya-Singapore (nonferrous metals, 67 per cent); Kenya-Uganda-Tanganyika (nonferrous metals, 36 per cent); Nigeria (nonferrous metals, 84 per cent).

[6] This statement mainly applies to evaluation on the basis of Spearman rank correlations. If export-weighted rank correlations are used, then the deviations of the excluded countries become less troublesome, since their role in world manufactures trade is typically much smaller than the included countries.

[7] Even so, the manufactures portion of the SITC includes some highly resource-intensive goods, for example group 68, primary nonferrous metals, while it wrongly excludes both synthetic rubber and man-made fiber. For practical reasons, we have taken the SITC manufactures definition as it stands. The addition of man-made fiber and synthetic rubber and the deletion of nonferrous metals were contemplated too late for incorporation in the calculations.

[8] Furthermore, U.S. 1965 export values were used as weights to convert three-digit characteristics to a two-digit basis. (Two-digit data on skill ratios were estimated directly from United States experience.) However, since two-digit

tion to the use of American coefficients is that widespread "factor intensity reversals" or, more generally, "product characteristic reversals," may mark a world of vastly different factor prices and production circumstances. I happen not to believe this ingenious theoretical objection, but I do not intend to reexamine the controversy here. My skeptical views on capital-labor reversals were stated in 1963,[9] and the work published since then confirms my original suspicion. With regard to the other product characteristics of Table A-2, I am predisposed to an equally skeptical view. Keesing's cross-country analysis of skill coefficients [28; also see 48] and the cross-country examination of wage rates carried out later in this paper both suggest that "skill reversals" are relatively unimportant. Since innovation is a unique event, reversals become theoretically irrelevant in the case of first trade dates; the main difficulty there lies in obtaining the true dates. Japanese-American evidence, mentioned later, indicates that consumer goods ratios are not susceptible to the reversal phenomenon, while, from an a priori standpoint, product differentiation reversals seem most unlikely. A more agnostic attitude is perhaps warranted for scale economies.

The almost total reliance on American coefficients raises, it seems to me, more practical dangers than the reversal threat. Owing to statistical inadequacies and aberrations, some of the characteristics may be improperly measured. Furthermore, the range of values for a particular characteristic may differ somewhat between nations. If coefficients from various nations had been calculated on the three-digit SITC basis, it might be possible to spot the obvious national discrepancies, and also to estimate a set of characteristic coefficients representing the "average" exporting nation.

The dangers of relying on American coefficients are self-evident. Moreover, most characteristics were derived from industry data, not commodity data, even though only an approximate correspondence exists between industrial and commodity classification schemes. A rough-and-ready key developed here for matching the two classification

SITC characteristics are barely used in the statistical analysis, and since collateral experiments with Japanese export weights yield much the same two-digit coefficients, this feature seems comparatively unimportant.

[9] See G. C. Hufbauer [21]. The Cambridge University thesis underlying this book was written in 1963, and Appendix B was independently circulated at that time.

TABLE 2

Characteristics Embodied in 1965 Exports

	Capital per Man	Skill Ratio	Wages per Man	Scale Economies	Consumer Goods Ratio[a]	First Trade Date	Product Differentiation
Canada	17,529	.0811	6,583	.0439	.1957	1947.6	.8068
United States	11,441	.1062	6,506	.0596	.2748	1948.4	.9558
Austria	12,423	.0732	5,926	.0372	.2846	1947.1	.8680
Belgium	14,043	.0762	6,202	.0366	.2488	1946.3	.7645
Denmark	8,832	.0932	5,901	.0380	.2993	1948.0	.9849
France	12,480	.0891	6,176	.0455	.2965	1947.2	.8385
Germany	11,734	.1011	6,410	.0430	.2260	1947.8	.9166
Italy	10,379	.0828	5,801	.0333	.3465	1946.8	.8243
Netherlands	11,768	.0969	6,007	.0456	.3327	1947.5	.9116
Norway	16,693	.0860	6,396	.0200	.1665	1946.5	.8593
Sweden	12,873	.0883	6,460	.0463	.2002	1948.3	.9291
United Kingdom	10,868	.0962	6,264	.0435	.2556	1947.9	.8815
Australia	15,181	.0891	6,458	.0242	.1971	1946.8	.7997
Japan	11,006	.0830	5,887	.0313	.3067	1947.4	.8624
Israel	6,317	.0608	4,860	.0282	.3144	1946.6	.7910
Portugal	7,862	.0514	4,777	.0130	.4858	1945.5	.7489
Spain	11,353	.0847	5,735	.0209	.3257	1944.9	.8508
Yugoslavia	10,030	.0826	5,741	,0120	.2799	1945.9	.8498
Mexico	17,926	.0799	6,149	-.0236	.2512	1945.8	.7518
Hong Kong	4,315	.0431	4,049	-.0162	.6624	1946.0	.6701
India	7,339	.0330	4,493	-.0157	.6195	1945.8	.6020
Korea	8,004	.0354	4,761	.0011	.4614	1946.5	.6271
Pakistan	5,725	.0298	4,238	-.0036	.6476	1946.0	.5925
Taiwan	11,697	.0557	5,018	.0200	.4748	1947.2	.6829

Notes to Table 2

Note: Embodied characteristics for 1965 exports were generally found by applying 1965 three-digit SITC export values to the three-digit commodity characteristics in Table A-2. Since three-digit data on skill ratios were not available, two-digit export values were used in that case. For certain countries, 1965 export data was not available in time for the analysis, and 1964 data was used instead. Embodied characteristic j for country i is given as $\sum_n c_{jn} \cdot x_{in}$, where c_{in} is is characteristic j as it appears in commodity n, and x_{in} is the percentage of country i's exports accounted for by commodity n.

[a]Calculated with uncorrected values; see note (f) to Table A-2.

schemes is produced in Table A-1 (Appendix Table 1). Another difficulty is that although manufactured goods embody characteristics acquired by purchased supplies drawn from ancillary industries, our analysis runs entirely in terms of "immediate" characteristics.[10]

The qualities enumerated in Table A-2, when applied to each nation's trade composition for 1965, yield the mosaic of embodied characteristics given in Tables 2 and 3.[11] These tables, together with

[10] An input-output distinction divides "immediate," "direct," and "total" characteristics. Immediate characteristics are qualities of the product itself; direct characteristics are qualites of the product plus qualities of its direct inputs. Total characteristics are qualities of the product plus qualities of its direct and indirect inputs. Whether immediate, direct, or total characteristics best suit the needs of trade theory depends on the import content of domestic manufactures. "Domestic" characteristics constitute the ideal analytic tool: all characteristics except those inherited from imported inputs. Domestic characteristics must, of course, fall somewhere between immediate and total characteristics. To the extent domestic characteristics are correlated with immediate characteristics, the use of immediate characteristics is not so bad. High correlations are suggested by the following matrices which show the connection between immediate (I), direct (D), and total (T) capital and wages per man according to 1963 American experience, using the 1958 input-output table; the data are based on the sources enumerated in Table 12.

Rank Correlations

	Capital per man				Wages per man		
	I	*D*	*T*		*I*	*D*	*T*
I	1.000			*I*	1.000		
D	.973	1.000		*D*	.993	1.000	
T	.955	.992	1.000	*T*	.988	.955	1.000

[11] An embodied characteristic is found by multiplying the trade characteristics vector by the export or import percentage composition vector and summing the result.

TABLE 3

Characteristics Embodied in 1965 Imports

	Capital per Man	Skill Ratio	Wages per Man	Scale Economies	Consumer Goods Ratio[a]	First Trade Date	Product Differentiation
Canada	11,051	.0976	6,404	.0464	.2517	1948.2	.8980
United States	13,139	.0771	6,023	.0306	.2913	1946.6	.7995
Austria	11,284	.0937	6,127	.0356	.2758	1947.7	.8684
Belgium	11,462	.0902	6,121	.0345	.2681	1947.2	.8466
Denmark	12,366	.0894	6,155	.0418	.2738	1947.4	.8559
France	13,290	.0930	6,317	.0381	.2404	1947.1	.8825
Germany	13,161	.0779	6,006	.0276	.3074	1946.4	.8061
Italy	13,815	.0982	6,412	.0380	.2584	1947.1	.8985
Netherlands	11,706	.0896	6,057	.0387	.2994	1947.3	.8698
Norway	10,476	.0983	6,199	.0276	.2337	1947.7	.9580
Sweden	11,373	.0923	6,147	.0358	.2795	1947.3	.8674
United Kingdom	12,832	.0832	6,000	.0224	.2739	1946.4	.8591
Australia	11,552	.0951	6,294	.0495	.2803	1948.1	.8763
Japan	14,010	.1033	6,445	.0399	.2589	1946.3	.9148
Israel	10,172	.0886	6,052	.0438	.2228	1948.0	.9107
Portugal	12,039	.0976	6,311	.0467	.2306	1947.7	.8852
Spain	14,162	.0979	6,497	.0418	.1897	1947.6	.9312
Yugoslavia	13,285	.0950	6,451	.0464	.2028	1947.5	.9156
Mexico	12,745	.1119	6,603	.0465	.2105	1948.4	.9729
Hong Kong	10,780	.0770	5,618	.0272	.3625	1947.1	.8442
India	12,019	.1028	6,553	.0513	.1692	1948.1	1.0122
Korea	14,900	.1112	5,887	.0520	.2239	1944.0	.8068
Pakistan	12,371	.0989	6,419	.0448	.1837	1947.1	.9380
Taiwan	13,062	.1066	6,467	.0505	.2102	1947.4	.9175

Notes to Table 3

Note: Embodied characteristics for 1965 imports were generally found by applying 1965 three-digit SITC import values to the three-digit commodity characteristics in Table A-2. The exceptions mentioned in the note to Table 2 pertain here as well. The arithmetic formulation is identical to that given in the note to Table 2, except that import percentages are used instead of export percentages.

[a]Calculated with uncorrected values; see note (f) to Table A-2.

Table 4 on national attributes, furnish the statistical foundation for assessing the first six "orthodox" nature-of-trade theories enumerated in Table 1. In evaluating the product cycle theories, it might have been preferable to use time series data rather than trade for a single year, but this would have required a far more ambitious undertaking. It should be mentioned that certain national attributes—particularly fixed capital per man for several less developed countries and availability of skilled employees in France, Germany, the United Kingdom, and Australia—were "estimated" from "similar" countries. These estimates, marked by note e in Table 4, may be biased in favor of the pertinent theories.

A better procedure, in finding national export characteristics, would have been to use export *value added* (preferably at world prices) for each commodity, rather than export *receipts* for that commodity, as the ingredient of national export composition. As M. Michaely and P. T. Knight observe, export receipts *minus* the world market cost of purchased inputs should ideally serve as the export composition vector. The use of straight export receipts would not be so bad for large countries (which import relatively few inputs), if commodity characteristics had been measured on a "total" rather than an "immediate" basis. Thus, if commodity characteristics had included the characteristics acquired from ancillary industries, both the characteristics of a commodity and the receipts from its sale by big nations would be placed on approximately the same footing. As it happens, the analysis here includes many small countries, and commodity characteristics are measured on an "immediate" basis. The best reconciliation, therefore, would be the employment of export value-added weights in aggregating export characteristics derived from different commodities. To the extent value-added ratios differ between commodities, the use of export receipts in deriving the embodied characteristics of Table 2 produces a distorted image.

TABLE 4

National Attributes

	Fixed Capital per Manufacturing Employee[a]	Skilled Employees as Per Cent of Total[b]	Total Manufacturing Output[c]	GDP per Capita[d]
Canada	8,850	.106	10.55	2,110
United States	7,950	.108	173.04	3,000
Austria	4,000	.068	2.90	1,030
Belgium	4,400	.080	4.11	1,460
Denmark	2,850	.078	2.38	1,680
France	4,900	.083[e]	27.53	1,580
Germany	4,250	.100[e]	40.61	1,770
Italy	2,600	.046	17.40	1,030
Netherlands	4,750	.092	5.55	1,430
Norway	6,100	.080	1.81	1,880
Sweden	5,400	.129	5.62	2,100
United Kingdom	4,000	.095[e]	32.22	1,710
Australia	5,300	.103[e]	5.63	1,810
Japan	3,100	.049	21.56	720
Israel	3,900	.114	0.67	1,090
Portugal	1,500	.027	1.56	420
Spain	1,700	.041	4.44	550
Yugoslavia	2,500	.056	1.95	250
Mexico	2,000	.036	4.75	430
Hong Kong	1,200[e]	.046	0.37[e]	200[e]
India	500[e]	.017	6.84	80
Korea	850	.022	0.51	140
Pakistan	500[e]	.014	0.78	80
Taiwan	1,150	.031	0.32	130

[a]Fixed capital per manufacturing employee, expressed in U.S. dollars of approximately 1958 vintage, was estimated by summing current outlays for gross manufacturing investment between 1953 and 1964 inclusive, and dividing by 1964 manufacturing employment. No explicit allowance was made for depreciation or inflation. Local monetary units were converted to U.S. dollars using mid-period (generally 1958) exchange rates. Among other ad hoc corrections, the United Kingdom figure was arbitrarily increased from an original estimate of $3,150 per man, and the Yugoslavian figure was arbi-

(continued)

Notes to Table 4 (concluded)

trarily decreased from an original estimate of $4,050 per man, both on grounds of "reasonableness." Obviously all estimates must be regarded as crude orders of magnitude. The underlying data was taken from United Nations Statistical Office [66]. Fixed capital per manufacturing employee is used to evaluate the simplistic factor proportions theory.

[b]Skilled employees as a per cent of total employees represent the fraction of the economically active population belonging to Group O of the ILO classification scheme, that is, professional, scientific, and technical personnel. The data come from International Labour Office [22]. (The skilled employee ratio is used to assess the human skills thesis.)

[c]Manufacturing output, expressed in billions of U.S. dollars, was found by applying the United Nations estimates of percentage of gross domestic product originating in the manufacturing sector to the GDP figures. The source for both sets is the United Nations Statistical Office [66]. Total manufacturing output is used to assess the scale economy and stage of production theories.

[d]Gross domestic product figures, expressed in thousands of U.S. dollars, generally apply to the year 1964, but some pertain to 1963. Purchasing power exchange rates, as estimated by the United Nations, were employed for conversion purposes. The data source is [66]. GDP per capita is used to evaluate both the technological gap and product cycle theories.

[e]Values represent arbitrary extrapolation from "similar" countries.

The basic statistical tool employed to assess the impact of structure on trade is the correlation coefficient: the more influence an aspect of economic structure exercises on commerce, the better should be the correlation between the particular national attribute and the trade-embodied characteristic. Both rank and simple correlations are presented. The rank correlation does not depend on the assumptions of normality required for the simple correlation; it avoids high coefficients based solely on a "dumbbell" effect between India and Pakistan at the one extreme, and the United States, Canada, and Sweden at the other. On the other hand, the rank correlation is a less efficient tool; it sacrifices part of the information contained in the underlying data.

The Spearman rank correlation takes no notice of the relative trading importance of different countries, so the danger exists in using this measure that well or badly behaved small countries may contribute

TABLE 5

Rank Correlations Between Commodity Characteristics and Associated National Attributes

	Commodity Characteristics Embodied in Exports[a]													
	Capital per Man		Skill Ratio		Wages per Man		Scale Economies		Consumer Goods Ratio		First Trade Date		Product Differentiation	
	R	*W*	*R*	*W*	*R*	*W*	*R*	*W*	*R*	*W*	*R*	*W*	*R*	*W*
Fixed capital:														
24 nations	.704	.736												
23 nations[c]	.814(Mexico)													
Skilled employees:														
24 nations			.695	.822	.784	.960								
23 nations[c]			.796(Israel)		.912(Israel)									
Manufacturing output:														
24 nations							.627	.778						
23 nations[c]							.710(India)							
GDP per capita:														
24 nations									.818	.801	.698	.864	.724	.763
23 nations[c]									.864(Mexico)		.764(Taiwan)		.788(Canada)	

Notes To Table 5

Sources: Tables 2 and 4.

[a]R is the Spearman correlation coefficient:

$$R = 1 - \left(\frac{6 \sum d_i^2}{n^3 - n} \right).$$

W is the weighted rank correlation coefficient:

$$W = 1 - \left(\frac{6 \sum d_i^2 w_i}{n^2 - 1} \right).$$

where d_i is the difference in rank orderings for country i; w_i is the percentage of 1965 manufacturing exports contributed by country i; n is the number of countries. When two or more observations were tied, they were assigned an average of the relevant ranks.

[b]The signs of the consumer-goods-ratio rank correlations have been reversed, so a positive correlation indicates agreement with theoretical predictions. The correlations here reflect the uncorrected ratio values; see note (f) to Table A-2.

[c]The country excluded in the twenty-three-nation Spearman rank correlation analysis is named in parenthesis.

more weight to the total impression than they are entitled to do. Therefore, "weighted" rank correlations are also presented, where 1965 national export values furnish the weights.[12]

Spearman and weighted rank correlations between characteristics embodied in exports and the associated national attributes, for the full sample of twenty-four nations and (for Spearman only) allowing each theory "one cut," are given in Table 5. (All the figures are statistically significant at the 1 per cent level, using the Student's t test [49].) Simple correlations between each characteristic and all the national attributes appear in Table 6.

It must be acknowledged that the chosen statistical tools afford little

[12] The weighted rank correlation formula is given in the notes to Table 5. The weighted rank correlation, unlike the Spearman coefficient, is not symmetrical about the value zero. If one rank list is reversed, the new coefficient will not necessarily have the same absolute value as the original coefficient. Furthermore, the weighted correlation can take on values less than −1.0.

TABLE 6

Simple Correlations Between Commodity Characteristics and National Attributes of Twenty-Four Nations

	Capital Per Man	Skill Ratio	Wages Per Man	Scale Economies	Consumer Goods Ratio[a]	First Trade Date	Product Differentiation
				Commodity Characteristics Embodied in Exports			
Fixed capital	**.625**	.696	.789	.739	.748	.657	.633
Skilled employees	.396*	**.714**	**.700**	.760	.736	.725	.717
Manufacturing output	.067*	.437*	.345*	**.457***	.192*	.480*	.392*
GDP per capita	.500*	.777	.799	.809	**.727**	**.765**	**.749**
				Commodity Characteristics Embodied in Imports			
Fixed capital	**-.353***	-.409*	-.171*	-.383*	-.414*	.166*	-.321*
Skilled employees	-.429*	**-.604**	**-.375***	-.463*	-.535	.139*	-.436*
Manufacturing output	.232*	-.476*	-.193*	**-.374**	-.274*	-.229*	-.428*
GDP per capita	-.257*	-.552	-.283*	-.516	**-.505***	**.054***	**-.458***

Note: Values in boldface represent the simple correlations comparable to the twenty-four-nation Spearman correlations of Table 5.

Sources: Tables 2, 3, and 4.

[a]The signs of the consumer-goods-ratio simple correlations have been reversed, so a positive correlation indicates agreement with theoretical predictions on the export side, and a negative correlation indicates theoretical agreement on the import side. The correlations here reflect the uncorrected ratio values; see note (f) to Table A-2.

*Not statistically significant at the 1 per cent confidence level, using the Student's *t* test.

more than a crude screen for eliminating unsatisfactory theories. No real attempt can be made, using such measures, to say which of several closely competing theories is "best." Nor can any definitive statements be made about the welfare aspects of trade. These exercises would require rather more sophisticated analysis, possibly cast in terms of Bruno's work on dynamic comparative advantage.[13]

The analysis here focuses on exports because exports are typically less distorted by domestic policies than imports. Even so, as a guide to comparative advantage, exports suffer from at least three difficulties. First, tariffs and quotas severely limit certain international markets, for example, cotton textiles. Textile characteristics are accordingly understated in the exports of nations with a textile advantage. Second, a nation's own import restrictions affect its export composition by drawing resources directly and indirectly from the export industries. If a skill-intensive activity enjoys high domestic protection, that will retard those exports also dependent on skills. Third, Linnemann has shown that geographical and psychological distance adversely affect trade [45]. By implication, Country A will export a different menu of commodities if located in Region I than if located in Region II. Because it would multiply the analytic task many times, location has been ignored in the present statistical work. However, as Bhagwati has rightly stressed, the bilateral dimension can hardly be overlooked in evaluating the nature of trade [5]. Occasional qualitative references are made here to bilateral trade relations on the sound presumption that location affects overall export composition. But it is clear that future scholars should explicitly incorporate the bilateral variable in their analysis.

NATURE OF TRADE

The same elephant?

Table 1 enumerates six supposedly distinct, "orthodox" trade theories. But perhaps these accounts merely provide alternative glimpses of the same elephant. To the extent of intercorrelation between the

[13] M. Bruno, "Development Policy and Dynamic Comparative Advantage," this volume.

characteristics listed in Table A-2, the six theories—or at least our presentations of them—differ more in degree than in kind.

Table 7 presents Spearman rank correlations between commodities ordered according to different characteristics. The argument has been suggested that the unimportant groups among the 102 three-digit SITC commodities may, however, unduly influence these Spearman correlations. Therefore, Table 8 presents weighted rank correlations between the commodity characteristics. The weights are 1965 exports, so the weighted correlations give less emphasis to rank differences between small traded commodities than between big ones. As it happens, the Spearman and the weighted rank correlations yield roughly the same impression.

Both Tables 7 and 8 reveal some significant interrelationships between the commodity characteristics. Skill ratios and wages per man show a positive correlation ranging between .579 and .642. The surprising thing, perhaps, is that the relationship is not more robust. Data compiled by Waehrer yield a correlation of about 0.78 between an occupational index and annual earnings by industry [39, pp. 36–37]. A major difference between her results and ours seems to stem from the more comprehensive character of her occupational index. Her index includes professional and technical workers; managers, officials, and proprietors; clerical workers; sales workers; craftsmen and foremen; and service workers—in other words, virtually all high-earning employees. Our skill ratio, by contrast, relates only to professional and technical workers, because Keesing found that the other categories of "skilled employees," with the possible exception of craftsmen and foremen, contribute little to an understanding of trade flows.[14]

Capital per man shows a strong correlation with both indices of "human capital." At the same time, physical and human capital are related to the stage of production. In other words, the consumer-producer goods dichotomy (reflecting "stage of production") overlaps a good deal with the light-heavy industry dichotomy. The overlap applies

[14] Keesing discovered that the proportion of managerial labor embodied in exports changes little between nations, and concluded that professional, technical, and craft labor taken by themselves were better indications of skills embodied in trade [26]. Our analysis likewise excludes managerial labor both from the skill ratio (Table A-2) and the measure of national skill endowments (Table 4).

TABLE 7

Spearman Correlations Between Commodity Characteristics

	Capital per Man	Skill Ratio[a]	Wages per Man	Scale Econ-omies	Con-sumer Goods Ratio[b]	First Trade Date	Prod-uct Differ-enti-ation
Capital per man	1.000						
Skill ratio[a]	.590	1.000					
Wages per man	.695	.642	1.000				
Scale economies	-.058*	.165*	.094*	1.000			
Consumer goods ratio[b]	.479	.204*	.418	-.150*	1.000		
First trade date	.105*	.236*	.220*	.157*	.123*	1.000	
Product differentiation	-.119*	.547	.199*	.061*	.039*	.169*	1.000

Note: Commodity characteristics were ranked as follows: capital per man – highest capital-labor ratio to lowest; scale economies – largest increasing returns to scale to smallest; consumer goods ratio – lowest proportion of output going for final consumption to highest; skill ratio – greatest use of technical labor to smallest; wages per man – highest wages to lowest; first trade date – newest products to oldest; product differentiation – most differentiated products to least differentiated products.

The correlations are derived using the Spearman formula. When two or more observations were tied, they were assigned an average of the relevant ranks.

Source: Table A-2.

[a]The correlations between skill ratio and other characteristics are based on the two-digit SITC, since three-digit skill data was not available. All other correlations are based on the three-digit SITC.

[b]See note (f) to Table A-2.

*Not significantly different from zero at the 1 per cent confidence level.

not only to industries light and heavy in machine power, but also to industries light and heavy in brain power. The same trading patterns that confirm or deny the factor proportions theory will thus also tend

TABLE 8

Weighted Rank Correlations Between Commodity Characteristics

	Capital per Man	Skill Ratio[a]	Wages per Man	Scale Econ-omies	Con-sumer Goods Ratio[b]	First Trade Date	Prod-uct Differ-enti-ation
Capital per man	1.000						
Skill ratio[a]	.547	1.000					
Wages per man	.655	.579	1.000				
Scale economies	.298	.501	.374	1.000			
Consumer goods ratio[b]	.505	.234*	.513	.191*	1.000		
First trade date	.111*	.377*	.349	.366	.086	1.000	
Product differentiation	-.173*	.686	.018*	.077*	.054*	.011*	1.000

Note: Commodity characteristics were ranked as in Table 7, note. The weighted rank correlation formula is described in note a to Table 5. The weights are total 1965 exports of each three-digit SITC commodity by the twenty-four countries listed in Table 2.

Source: Table A-2.

[a]See Table 7, note a.

[b]See Table A-2, note f.

*Not significantly different from zero at the 1 per cent confidence level, using the same test as for Spearman correlations.

to support or undermine the human skills argument and the stage of production thesis.

Differentiated commodities seem to require skilled labor, so from the outset these two theories have an area of overlap. Scale economies are also linked with skill ratios, judging from the weighted rank correlations. Among the other bilateral characteristic pairs, some correlations are significant, but none is very strong.

Whenever strong intercorrelation appears between two characteristics, the question may arise: does theory X owe its good performance to theory Y, or vice versa? To this question, probably the best answer is: a confluence of theory makes for good results. At any rate, we have not attempted here to resolve such disputes. The question, if it must be answered in "either-or" fashion, demands more than a search for the marginally higher correlation coefficient.

So much for interrelationships between commodity characteristics. What about attributes of economic structure? Table 9 presents a matrix of intercorrelations between the four attributes used here: fixed capital per man in manufacturing industry; skilled employees as a per cent of labor force; total manufacturing output; and gross domestic product

TABLE 9

Spearman and Simple Correlations Between National Attributes

	Fixed Capital per Man in Manufacturing Industry		Skilled Employees as Per Cent of Labor Force		Total Manufacturing Output		Gross GDP per Capita	
	R	*S*	*R*	*S*	*R*	*S*	*R*	*S*
Fixed capital per man in manufacturing industry	1.000	1.000						
Skilled employees as per cent of labor force	.889	.848	1.000	1.000				
Total manufacturing output	.545	.480*	.469*	.334*	1.000	1.000		
GDP per capita	.947	.914	.892	.879	.579	.581	1.000	1.000

Note: *R* is the Spearman correlation; *S* is the simple correlation. All attributes are ordered from largest to smallest. In the rank correlations, when two or more observations were tied, they were assigned an average of the relevant ranks.

Source: Table 4.

*Not significantly different from zero at the 1 per cent confidence level.

per capita. Total manufacturing output presumably influences scale economies in exports. Gross domestic product per capita serves as a catch-all measure of technological sophistication, thereby influencing the age, standardization, and consumer-producer mix of exports. Six trade theories are thus evaluated against four national attributes, one of which does triple duty.

With the exception of total manufacturing output, the attributes show considerable interrelationship, either on a rank or a simple correlation basis. For practical purposes a composite attribute might perform almost as well, or as poorly, in explaining different export characteristics.

Finally, it deserves mention that the commodity export patterns of the largest, richest industrial nations display great similarity. Indeed, as a general proposition, the richer a pair of countries, the greater the coincidence between their export patterns (Table A-4 and the analysis in Table 13 below). Thus, the cosines between U.S., U.K., and German export vectors all exceed 0.9, although these are the extreme cases.[15] The theories that "work" for the United States will "work" for Germany and the United Kingdom, and vice versa. The coincidence of cosine vectors points to the origin of theoretical success at the rich end of the country scale: a similar pattern of commodity exports rather than different patterns embodying the same characteristics.

FACTOR PROPORTIONS

In 1969, the factor proportions account celebrates its fiftieth birthday. The subject of as many scholarly papers since 1919, the theory in its present form can claim an academic parentage resembling a Burke's Peerage of Economists. It deserves special notice that the theory, as enunciated by Ohlin, was a very much more complex and realistic account than the truncated oversimplified two-factor version later employed by its adaptors and critics (including myself). For expositional purposes, nevertheless, we shall consider only the two-factor "parody" and not the more realistic thesis set forth by Ohlin.

Leontief's findings [41, 42] dealt an apparently telling blow to the simplistic two-factor version. Various authorities have sought to repair

[15] The cosine analysis of trade vectors is explained in the penultimate section of this paper. The discussion there refers to national import vs. export vectors; the application here is to national export vectors.

the damage; their work in some respects resembles the tortured efforts of pre-Copernican astronomers.[16] "Factor-intensity reversals," for example, are an ingenious but doubtful sort of patching plaster.[17] Other explanations, emphasizing the resource content of American trade [39] and the perverse structure of American tariffs,[18] are a good deal more persuasive.

Leontief's original report was based on the 1947 capital position of U.S. industries, the 1947 U.S. transactions table, and 1947 U.S. trade flows; subsequently he examined 1951 trade flows as well. Conceivably World War II might have distorted the American economy and world trade patterns so as to give unrepresentative results. Before examining the twenty-four-nation data, therefore, I checked Leontief's findings against more recent data, limiting myself, however, to manufactures variously defined.

The confirmation exercise made use of 1963 U.S. fixed capital data, the 1958 U.S. transactions table, and 1963 trade flows. The most questionable statistics are those for fixed capital. To derive these figures, capital outlays between 1947 and 1963 were added to the 1947 Leontief estimates, after correcting for inflation and depreciation. The resulting capital-per-man estimates differ substantially in absolute value from Leontief's figures, and also from the Census Bureau's 1958 "book value" figures [67]. Nevertheless, Spearman rank correlations between the three sets of figures for the industries concerned all exceed 0.88.

Table 10 presents results from the confirmation exercise. The conclusions for 1963 are broadly similar to Leontief's original findings. American imports embody approximately the same quantum of capital

[16] Advocates of the Ptolemaic System used epicycles and deferents to square fact with theory. T. S. Kuhn [37].

[17] International empirical evidence against the factor-intensity reversal proposition has been marshalled by H. B. Lary [39]. J. R. Moroney also shows, on interregional evidence, that reversals are something of a red herring [50]. See also the discussion in the addendum to J. Bhagwati's survey [5].

[18] W. P. Travis [60]. B. Balassa found no correlation between effective tariff rates and labor-intensity [3]. However, he used an inappropriate measure of labor-intensity—share of wage payments (direct and indirect) in value of output. This measure confuses skilled labor with crude labor power: an industry may have a large wage proportion owing not to the *numbers* of men employed but rather to the *high* wages per man. If industries are instead ranked according to wages per man, the rank correlation between effective tariffs and wages is −.568. Cf. D. S. Ball [4]. However, for present purposes, a conceptually superior approach would be to rank industries by capital per man.

TABLE 10

Fixed Capital Per Man Embodied in U.S. Manufactures Trade

Year[a]	Definition[b]	Requirements[c]	U.S. Exports[d]	U.S. Imports[d]
1947	para-ISIC	Total	9,048	11,306
1947	para-SITC	Total	10,127	9,287
1951	para-ISIC	Total	9,256	12,412
1951	para-SITC	Total	11,493	10,129
1963	ISIC	Immediate	12,235	14,892
1963	ISIC	Direct	12,292	14,461
1963	ISIC	Total	12,051	13,396
1963	SITC	Immediate	10,632	11,253
1963	SITC	Direct	10,900	11,480
1963	SITC	Total	11,467	11,399

Sources: W. W. Leontief [42, 43]; U.S. Bureau of the Census [69, 74]; H.B. Lary [40].

[a]The date refers to the calendar year for which trade is analyzed, not necessarily the input-output table year or the year for which capital estimates were made.

[b]This column refers to whether manufactures are defined in accordance with the ISIC, Sections 20 through 39, or the more restrictive SITC, Sections 5, 6, 7, and 8. The para-ISIC definition refers to Leontief [42], p. 397, row C4, which encompasses ISIC Sections 20 through 39 plus mining. The para-SITC definition refers to Leontief [42], p. 398, row D, which encompasses SITC sections 5, 6, 7, and 8, plus certain types of mining, food products, and petroleum products. This para-SITC definition consciously excludes certain resource-intensive products that are prominent in imports but not those that are prominent in exports. Hence the comparison is artificially biased toward a high capital figure in exports.

[c]The requirements column indicates whether capital per man is measured only according to what is used in the industry, according to what is used in the industry plus its direct suppliers, or according to what is used in the industry plus its direct and indirect suppliers.

[d]Embodied capital in exports and imports is measured in dollars of 1947 vintage for both 1947 and 1951, and 1963 vintage for 1963.

as American exports. If manufactures are defined according to the SITC, rather than the resource-inclusive ISIC, or if "total" rather than "immediate" requirements are examined, exports take on a more capital-intensive hue. If allowance could be made for the bias of American tariff and quota policy, an orthodox capital intensity differential might even emerge. Nevertheless, it is difficult to believe that variations in fixed capital per man provide the mainspring for American commerce. Many authors have manipulated the figures, but no one has yet shown that U.S. exports enjoy a *pronounced* capital-intensity lead over imports.[19]

In a similar vein, Tatemoto and Ichimura found that 1951 Japanese exports were more capital-intensive than 1951 imports, while Roskamp discovered just the opposite for 1954 West German trade.[20] Given the position of Japan and Germany in any world league of capital endowments, the authors conclude that Leontief's paradox is not confined to U.S. commerce.

To be sure, these single-nation export-versus-import results can be rationalized by introducing new variables. The perverse Japanese findings turn on the difference between exporting "up" and "down"—to Europe and North America and to regions less developed than Japan. "Downward" sales comprised 75 per cent of 1951 Japanese exports, so a capital-intensive bias may be attributed to regional considerations and might disappear if the analysis were conducted in terms of bilateral trade flows.[21] Indeed, Tatemoto and Ichimura found that 1951 Japanese exports to the United States were, in orthodox fashion, more capital-intensive than imports from that country. Germany's Leontief paradox was "resolved" in 1968 by Roskamp and McMeekin through the introduction of a human capital variable, along the lines applied earlier to the Leontief paradox in United States trade.[22] A bilateral dimension, although not introduced in the Roskamp-McMeekin analysis, might shed further light on the German paradox.

[19] See the thorough analysis by H. B. Lary [40].

[20] M. Tatemoto and S. Ichimura [59], and K. W. Roskamp [53]. Other single-country studies of the Leontief paradox, not considered here, are: R. Bharadwaj [7, 8] (Leontief paradox refuted for Indian trade); W. Stolper and K. W. Roskamp [58] (Leontief paradox refuted, considering the bilateral direction of East German trade); and D. F. Wahl [79] (Leontief paradox refuted for Canadian-U.K. trade, and confirmed—ignoring the role of natural resources—for Canadian-U.S. trade).

[21] The important distinction between "upward" and "downward" exports, a distinction which needs to be generally incorporated in trade theory, was emphasized by W. P. Travis [60, pp. 194–96].

[22] See K. W. Roskamp and G. C. McMeekin [54] and the work of Kravis, Keesing, and others cited in Table 1.

By contrast with these single-nation results, which require ad hoc explanation, it is interesting that the simplistic factor proportions theory performs surprisingly well when applied to the exports *alone* of the twenty-four-nation sample. The Spearman rank correlation between national fixed capital per man [23] and capital embodied in national exports is .704; the weighted correlation is .736 (Table 5). The simple correlation between fixed capital and capital in exports is .625 (Table 6). Removed from the country sample, of course, have been developing nations with large nonferrous metals exports such as Turkey, Chile, Malaya-Singapore, Kenya-Uganda-Tanganyika, and Nigeria. Nonferrous metals are both highly capital-intensive and closely tied to ore bodies; hence their presence in the exports of capital-poor countries gives an unwarranted impression of capital-intensity.

Indeed, on much the same grounds, Mexico should also be excluded, since nonferrous metal goods comprise 35 per cent of Mexico's manufactured exports. When Mexico is dropped under the "one-cut" rule, the Spearman correlation rises to .814. After Mexico has been excluded, Taiwan, the United States, and Israel deviate most from the predictions of the simple theory. The United States and Israel have much less capital embodied in their exports than the size of their capital stocks would indicate, while Taiwan has much more.

Although the foregoing analysis ignores imports, it might be mentioned that, using United States coefficients, 1965 Japanese exports appear considerably less capital-intensive than imports ($11,006 vs. $14,010 capital per man, cf. Tables 2 and 3). These results, while seemingly contrary to the 1951 Tatemoto-Ichimura results, are nevertheless consistent with their findings: by 1965, more than 50 per cent of Japanese exports were destined "upward" to the advanced nations, compared with only 25 per cent in 1951. On the other hand, Roskamp's 1954 German results (making no allowance for a bilateral dimension)

[23] Rank correlations between fixed capital per man in manufactures (*F*), horsepower per man in manufactures (*H*), and total capital per capita (*T*), all circa 1958–63, are as follows:

	F	*H*	*T*
F	1.000		
H	.979	1.000	
T	.958	.924	1.000

Horsepower estimates could be made for only sixteen nations, while crude total capital estimates were available for thirty-one countries.

still apply: as with American experience, 1965 German exports are less capital-intensive than her imports ($11,734 vs. $13,161).[24] Furthermore, although Table 6 shows a negative correlation between fixed capital endowments and capital embodied in imports, the relationship is not very strong.

The simplistic theory fares poorly in accounting for the trade composition of the Western world's two largest manufacturing nations, and sheds little light on over-all import patterns. Even so, Heckscher-Ohlin find surprising corroboration when the export patterns of twenty-four nations are examined as a group. The corroboration may partly result from intercorrelation between capital-intensity and skill-intensity on a commodity basis (Tables 7, 8), given the correspondence between national fixed capital endowments and skills embodied in exports (Table 6). But no persuasive theoretical arguments have been advanced for ascribing the good Heckscher-Ohlin performance to the cross-correlation with human skills, rather than vice versa.

HUMAN SKILLS

More than a decade ago Kravis discovered that high-wage industries furnish the bulk of American exports, and that American imports compete with low-wage industries. These findings could have been rationalized in one of two ways. Wages in the import-competing sectors might be temporarily depressed, and wages in the export sectors temporarily inflated, as a disequilibrium result of expanded international commerce. This rationalization cannot be pushed very hard, however, partly because higher export industry wages have persisted since 1899, partly because more impressive evidence has been offered for the alternative explanation.

The second explanation holds that wage differentials are the product of skill differences, and that trade flows reflect the differential application of education and training to human labor. As a matter of fact, in his original article, Leontief proposed a "labor efficiency" resolution of the famous paradox. Somewhat later, Bhagwati suggested that human

[24] Numerous differences of data and methodology separate the Tatemoto-Ichimura and Roskamp-McMeekin analyses from the work presented here. To mention only one example: Roskamp and McMeekin impute the size of factor contributions from the size of income flows. Hence, no exact correspondence can be expected between the various results.

capital should be treated as a factor input, like physical capital, in evaluating trade patterns.[25]

In recent years the skill theme has found able empirical advocates at Columbia University. These advocates have advanced two different "proofs"—Keesing relates trade flows to skill differentials as reflected in inter-industry employment of different kinds of labor; Kenen-Yudin and Waehrer have followed Kravis's lead in relating trade flows to skill differentials as reflected in inter-industry wage differentials. The Kenen-Yudin approach, also employed by Bharadwaj and Bhagwati in evaluating Indian trade,[26] essentially consists of treating the difference between skilled labor wage and unskilled labor wage as an approximate measure of the return to human capital, and capitalizing this rental at appropriate rates to secure estimates of the human capital employed in average exports and imports. A similar method, without the capitalization element, was used by Roskamp and McMeekin in their resolution of the West German Leontief paradox.

The wage-differential school has concentrated on single nation import-export trading patterns, while Keesing has examined the trade of several nations. Both advocates have achieved plausible results. American exports require more skills than American imports, whether skills are measured by wage differentials or occupational categories. The same is true of West German trade. In other words, the presence of human skills appears to compensate for, if not explain, the absence of physical capital in American and German exports. Furthermore, Keesing's rank ordering of the United States and eight other nations according to occupational skills embodied in exports seems eminently plausible,[27] and this ordering is virtually reversed by skills embodied in imports.

Despite the impressive weight of evidence, two loose ends remain in the Columbia School's empirical analysis. First, to what extent are inter-

[25] J. Bhagwati [5]. Bhagwati's addendum reviews the human skill hypothesis at some length.

[26] Bharadwaj and Bhagwati [6] conclude that Indian exports embody marginally more human capital than Indian import-replacing activities. The finding, in contrast to our own orthodox results in Tables 3 and 4, pertains to all trade, not just manufactures, and may turn on the skill intensity of plantation and mineral exports.

[27] The rank ordering is: United States, Sweden, West Germany, United Kingdom, Netherlands, France, Italy, Belgium, and Japan. D. B. Keesing [25]. Keesing also remarks that Hong Kong's exports embody even fewer skills than Japan's.

industry skill differences the same elsewhere as in the United States? Second, what link is there between skill embodied in trade flows and relative national abundance of trained manpower?

To determine whether "skill reversals" loom as an important feature of the economic landscape, I compared the circa 1958 wage rankings of thirteen industry groups in twenty-three nations (data was not available for Hong Kong) [65]. The Kendall coefficient of concordance was .638, easily significant at the 1 per cent level [30]. Of the 253 individual Spearman coefficients, 182 exceeded .500, a value significant at the 1 per cent level. These findings are confirmed by the Arrow-Chenery-Minhas-Solow data [2] on approximately twenty-three industries in eight industrial nations for the early 1950's.[28] The Spearman rank correlation, on an annual earnings basis, between the United States and the seven other countries exceeded in every instance .600, and the average was .724. Keesing's recent work also refutes the skill-reversal hypothesis [28]. Broadly speaking, inter-industry skill differentials are similar the world over, especially as between important manufacturing nations.

In assessing the link between trade flows and skill endowments, the first task was to measure the skill embodied in different manufactured exports. The second task was to measure relative national abundance of trained manpower. Following the Columbia School, Table A-2 gives two indices of skills embodied in traded goods: American wage rates and American professional and technical manpower ratios by industry. Table 4 gives figures on the percentage of national workforces belonging to International Labor Office category O, "professional, technical, and related workers." Unfortunately, the ILO data is not particularly good: the figures are dominated by "service" professionals, a category whose definition is internationally inconsistent and whose presence may be less relevant than professionals directly connected with manufacturing activity.[29]

Despite these limitations, both interpretations yield good results, and the Waehrer-Kenen-Yudin version gives particularly high coefficients. When professional labor force percentages are matched with skill ratios

[28] Data analyzed by D. S. Ball [4].

[29] If a country has a disproportionate number of service professionals, certain questions arise. Why has human capital not moved into manufacturing? If human capital is not fungible, what factor is? Where is the explanatory power of a trade theory that must distinguish between types of human capital?

in trade, the Spearman correlation is .695, and the weighted correlation is .822; when the match is with wage rates, the correlations are .784 and .960 respectively. In deriving these correlations, professional labor force percentages for four important countries—France, Germany, the United Kingdom, and Australia—were estimated from the experience of "similar" nations. The estimates may be biased towards a favorable evaluation of the skill theory.

Whether wage rates or skill ratios are used in the analysis of exports, Israel stands out as the deviant country. Israel has the second highest professional labor force percentage, but ranks eighteenth or nineteenth in terms of wages and skills embodied in exports. A similar relationship marks her experience with physical capital. The Israeli phenomenon has attracted explanations from Michaely and others. One line of argument holds that the embodied characteristics of Table 2, derived by using export sales as weights, exaggerate the absence of human and physical capital. If the weights were based, more properly, on export value added at world prices, cut diamonds (a relatively low skill, low capital activity) would be much less prominent. Likewise textiles, a sector particularly favored by the complex system of export incentives, would shrink in importance. Beyond these considerations, however, it could be that Israel has yet to digest the great influx of trained immigrants and the sudden buildup of capital stock. If the "slow digestion" argument has any relevance, it implies that rapid accumulation of skills or capital may take years before "upgrading" the composition of exports.

In any event, weighted correlations between national attributes and embodied export skills give better results than Spearman correlations, primarily because Israeli exports constitute only a small proportion of world manufactures trade; likewise, exclusion of Israel raises the Spearman coefficients to .796 (skills in trade) and .912 (wages in trade).

The physical capital and human skill theories produce enviable results with little ad hoc empirical manipulation or theoretical amplification. Better results might emerge if nonferrous metals were excluded and man-made fibers and synthetic rubbers were included in the definition of manufactured goods. If somehow the biases of commercial policy could be taken into account, the results should further improve. In short, a distressingly simple and orthodox formulation goes a long way to explain trade among manufactured goods.

Since skill-intensive commodities overlap with capital-intensive commodities, while the acquisition of human skills and physical capital both involve acts of saving, there is no reason not to join forces by combining human skills and physical capital into a single measure of man-made resources. Indeed, Bhagwati and Kenen have advocated this approach on a theoretical plane, some of the earlier cited authors have used it in their empirical work, and Lary has put it to fruitful use in examining the export prospects of developing countries [5, 32, 39].[30] The only substantial criticism of this "new" factor proportions explanation of trade is that national acquisition of human skills or physical capital need not necessarily *precede* or *presage* the emergence of these qualities in export sales. Israel illustrates the case in which export composition may lag behind the accumulation of skills and capital; Hong Kong too has rather more human resources than her export composition would indicate. On the other hand, Taiwan's exports lead her manufacturing sector with respect to capital intensity. Apart from this line of criticism, however, the main question is whether any role remains for other explanations of trade.

SCALE ECONOMIES

According to a simplistic version of the scale economy thesis, the large nation, because of an assured home market, will specialize in goods produced with increasing returns to industry size. A small nation might occasionally develop a scale economy industry, relying on export sales to justify production. But geographic and psychological distance, not to mention tariff and quota barriers, restrict that possibility. The presumption is made that large industries are usually the property of large nations. And with specialized production of scale economy goods come certain advantages: easier productivity gains and greater market control.

Jacques Drèze has amplified the scale economy thesis as it applies to small nations [11, 12].[31] In the process, he has modified the ingredients and enriched the final story. The Drèze account, set forth as early as 1960, emphasizes interaction between long production runs and extent

[30] Also see Kenen-Yudin [33], Bharadwaj-Bhagwati [6], and Roskamp-McMeekin [54] (notes to Table 1), where, generally speaking, human capital has been superimposed on physical capital.

[31] The work of Drèze was brought to my attention by C. P. Kindleberger in his comments based on the conference version of this paper.

of product differentiation between national markets. In Drèze's framework, industry or firm size is not the key to scale economies so much as number of items turned off a given production line. Furthermore, the differentiation that counts is not so much differentiation *within* a group of goods as differentiation *between* national suppliers. A small industrial power like Belgium can exert little influence over the tastes of its neighbors. For this reason, Belgium is handicapped when exporting goods characterized by "brand" differences between national markets. On the other hand, goods manufactured to international standards, even though manufactured in many varieties, are susceptible to Belgian competition. With these items, Belgium can enjoy long enough production runs to reap the full harvest of scale economies and sell much of the output abroad.

According to Drèze, technical leather goods and plywood are Belgian exports, while domestic leather wares and furniture are not. The plywood industry per se might exhibit greater scale economies than the furniture industry. And, by any objective test, there may exist more varieties of technical leather goods than household leather items. But the interaction between potential production runs and distinctive national tastes renders the technical leather and plywood markets more amenable to Belgian penetration.[32]

The "hypothesis of standardization," as Drèze calls it, may explain not only the concentration of Belgian exports among semifinished industrial goods, but also the export structure of other small European nations. Whether it sheds light generally on the trade of small nations must, in this paper, remain an unexplored issue. For in the analysis here, I attempt to examine scale and standardization as separate rather than interacting influences. Furthermore, my modus operandi is to link characteristics with specific products. Thus, I have not developed a tool to examine Drèze's "assembly line" view of scale economies, nor to evaluate his interesting contentions about differentiation between national markets.[33] In dealing with the scale economy theory here and with the

[32] As a matter of fact, Drèze does not consider intrinsic variations in the scale economy potential of different industries, nor does he much dwell on standardization as a product characteristic apart from the market environment.

[33] Drèze's own statistical work, contained in his second article [12], shows that Belgian industrial exports are concentrated, group by group, in the lower stages

product cycle theory later, I have selected simpler versions than those ingeniously proffered by Drèze.

The simplistic scale economy thesis, taken by itself, depends on size advantages which are internal to the industry, whatever their relationship to the firm or plant. Lacking alternative data, the empirical work here deals only with economies internal to the plant. These economies were estimated from 1963 United States experience.

The 1963 Census of Manufactures, like earlier censuses, gives value-added statistics by size class of establishment for each four-digit industry. The statistics were rearranged according to the three-digit SITC. Value added per man was then compared with establishment size,[34] using the regression equation:

$$v = kn^{\alpha}. \tag{1}$$

In this equation, v represents the *ratio* between value added per man for a given size class of plant and the average value added per man for all establishments in the four-digit industry;[35] n represents the average number of men employed per establishment in the given size class; k is a constant; and α represents the scale elasticity parameter. An α value of .06, for example, indicates that a doubling of plant size increases output per man by roughly 6 per cent.

Scale economies are usually measured, not in the manner of (1), but in terms of "plant factors" and "labor factors."[36] These "factors" are exponential expressions of the relationship either between inputs and

of fabrication. Perhaps these products are also standardized according to the unit value coefficient developed later in this paper, even though that coefficient does not measure differentiation between national markets.

[34] Establishments belonging to the smallest size class, 1–4 men, were excluded from the regression analysis. In 70 per cent of the industries, these small establishments had greater output per man than establishments belonging to the next larger size class. Presumably, they carry on specialty trades, quite different from the ordinary plant, and should be excluded on account of product differentiation. Interestingly enough, in about 40 per cent of the industries for which observations were available, for 1,000–2,499 men establishments and those exceeding 2,500 men, the penultimate establishments had larger outputs per man—confirming the familiar phenomenon of inefficient giants.

[35] v was expressed as a ratio because several four-digit industries were pooled to obtain each three-digit SITC parameter. Output per man differs between industries for reasons unrelated to scale; the ratio approach is meant to mitigate these extraneous differences.

[36] There is also the "survival" approach used by G. J. Stigler [56].

output or between inputs and capacity. The typical labor factor formulation is:

$$(2) \qquad n = kQ^z, 0 < z < 1,$$

where n represents the number of men, Q represents the physical output or capacity, k is a constant, and z is the labor factor.

If labor and plant factors are identical, it can be shown that the relationship between α of (1) and z of (2) is: [37]

$$(3) \qquad \alpha = \frac{1}{z} - 1.$$

Elsewhere I have investigated scale economy conditions in the synthetic materials industry [21]. Alan Manne has recently published scale economy data on aluminum smelting, cement, nitrogenous fertilizer, and caustic soda [46, 17, 77]. These studies, relying on engineering data, come up with plant factors in the 0.6–0.8 range. Labor factors are less certain, but values as low as 0.2 have been suggested for some industries. If both plant and labor factors were 0.8, then alpha would be .25 by virtue of (3). As it happens, scarcely any of the alpha values in the main part of Table A-2 are as large as .25; most are a good deal smaller, and some are even negative.

Of course there is nothing sacrosanct about scale economies estimated from engineering data. Even when available, which is not very often, the engineering estimates are fairly speculative. And they seldom cover

[37] Besides the notation in the text, let p represent the proportion (assumed constant) of output required for purchased inputs, and k_1, k_2, etc. represent various constants. Suppose that labor is the only factor of production (it makes no difference if each laborer is joined, regardless of scale of output, by the *same* amount of machinery). Starting with relation (2) in the text:

(i)	$n = kQ^z$	Text equation (2).
(ii)	$v = k_1 \frac{Q(1-p)}{n}$	Definition of value added per man. (In the text, v is defined as a ratio, so k_1 represents the inverse of average value added per man for the four-digit industry.)
(iii)	$n^{\frac{1}{z}} = k_2Q$	From (i).
(iv)	$v = k_3n^{\frac{1}{z}-1}$	Substituting (iii) in (ii), remembering that p is a constant.
(v)	$\alpha = \frac{1}{z} - 1$	By analogy with text equation (1).

the *range* of plant sizes encompassed by the value added data.[38] Nevertheless, the discrepancy between engineering estimates and Table A-2 estimates provokes at least some mention of potential biases in the present data:

(a) Different factories within a given four-digit industry may make quite distinct products. If products requiring much skilled labor and physical capital are manufactured by large plants, then the alpha coefficients would exaggerate the extent of scale economies; in the opposite case, they would understate the extent of scale economies.

(b) Factories making the same product may nevertheless employ different qualities of labor and different amounts of machinery per man, and these differences may systematically vary with size. A glance at wages by size of establishment for total U.S. industry in fact reveals a monotonically increasing relationship.[39] Part of the statistically estimated scale economies, therefore, probably reflect the use of more highly skilled labor as plant size gets larger. (Note the positive correlation between scale economies and skill ratios, Table 8.) Another part may possibly reflect increasing capital intensity with size.

(c) Competitive forces could serve to concentrate factory sizes around the optimum scale. Under certain circumstances, this might impart a downward bias in estimates of scale economies. On the other hand, some correlation may exist between optimum plant size and plant age. Larger plants may also be newer plants. Alpha would then reflect improved technology as well as larger size, thus overstating the scale element.

(d) Since market power usually accompanies size, alpha could also reflect an element of monopoly profit.

On the whole, these biases point toward alpha estimates which exaggerate the true scope of scale economies. The discrepancy with

[38] For example, the data in G. C. Hufbauer [21], Tables C-21, C-22, and C-23, cover about a tenfold range of plant sizes, a range of unusual magnitude for engineering data. By contrast, the value added data of the present analysis cover establishments of 5 to 2,500 men or more. To be sure, for a given four-digit industry, the range would usually be smaller, but still larger than most available engineering data.

[39] See, for example, U.S. Bureau of the Census [67, p. 767]. Average 1958 wages in establishments of the 1–4 man class were about $3,400; wages increased regularly until, at the 2,500+ man class, they exceeded $6,000. Wage differentials are probably not so great for the typical four-digit industry taken by itself.

engineering estimates thus becomes all the more curious. I bequeath this mystery to future scholars!

With the shortcomings of alpha in mind, Table 5 gives rank correlations between scale economies embodied in exports and national economic size, as measured by national manufacturing output.[40] The Spearman correlation is .627 and rises to .710 when India is eliminated; the weighted correlation is .778. The relevance of the scale economy account is buttressed by Keesing's recent work which found, through cross-country regression analysis, significant size effects for commerce in thirty-six out of forty major groups of manufactured goods [29].

On a simple correlation basis, however, the twenty-four nation correspondence between manufacturing output and export scale economies is only .457, a value not significantly different from zero (Table 6). On the other hand, the simple correlation between GDP per capita and export scale economies is .809. Apparently the benefits of scale economy specialization are distributed not entirely according to the dictates of national economic size, but also with some regard to economic sophistication. Small, rich countries, especially those in Europe with ready access to large markets, sometimes export scale economy products whereas bigger but less affluent countries infrequently specialize in these goods. In part the phenomenon could reflect the connection noted earlier between scale economies and skilled labor. At any rate, the exports of Japan, Mexico, and India show fewer scale economies than sheer size would warrant, while Denmark, the Netherlands, and Sweden specialize more in scale economy goods than their manufacturing output alone would justify.[41]

STAGE OF PRODUCTION

Theories of import substitution often presuppose that a stage of production sequence underlies trade. The newly developing country, so the argument runs, will produce for itself and may even export consumers' goods, while the advanced nation will specialize in exporting

[40] Much the same results emerge if gross domestic product, rather than national manufacturing output, is used to measure economic size. However, GDP per capita gives different findings, as the subsequent text reveals.

[41] As C. P. Kindleberger notes in his comment on this paper, and as I suggested in [21, p. 72], the specialization of Denmark, the Netherlands, and Sweden (possibly also Switzerland) in scale economy goods may also be explained by their role as industrial style-setters, achieving scale economies through exports.

producers' goods. This sequence supposedly results from the "natural" practice of industrializing via backward integration.

The trade implications of import substitution are often pressed no further than to "explain" why poor countries export textiles and import machinery. But this elementary rendition adds nothing to trade accounts which emphasize product sophistication, human skills, and labor intensity. To discover whether the stage of production hypothesis enjoys any independent explanatory power, the backward integration theme must be extended beyond the obvious commodities and reach the whole range of manufactured goods.

In evaluating this extended theme, a quantitative measure is needed which differentiates, by degrees, consumers' goods from producers' goods. Input-output analysis can be of assistance. The measure devised to reflect commodity differences is:

$$(4) \qquad \text{Consumer Goods Ratio} = \frac{s^{kh} + \sum_n s^{kn} \cdot \frac{s^{nh}}{s^n}}{s^k}.$$

In this statistic, s^{kh} and s^{nh} represent, respectively, sales by industry k and sales by industry n to households and government bodies acting as consumers; s^{kn} represents sales by industry k to industry n on current account; and s^k and s^n represent, respectively, total sales (including imports) of k and n except export and inventory accumulation sales.[42] The ratio thus reflects the percentage of total sales appearing as consumer goods directly and indirectly after the first and second rounds.[43]

Another version of the stage of production argument was peripherally suggested by Jacques Drèze. In his version, the argument is interpreted so that its key variable reflects not how close the item is to the final consumer, but the degree of fabrication. Thus, following tariff practice and the Brussels Tariff Nomenclature, Drèze divides manufactured products into some twenty-eight groups according to the primary material (e.g., wood, copper, inorganic chemicals), and then subdivides

[42] Export and inventory accumulation sales are excluded on the grounds that, ultimately, they are distributed between consumer and producer uses in the same ratio as other sales.

[43] A more comprehensive statistic might reflect the number of "rounds" required for sales on consumption account to reach, for example, 95 per cent of total sales. This more comprehensive statistic would require data on the rate of transformation, through depreciation, of capital goods to consumer goods.

each group into six degrees of fabrication. The interpretation of the stage of production as a degree of fabrication thesis was not examined here. But an examination would probably take the same analytic path pursued later, and for different reasons, in looking at the product cycle theory.

The 1960 Japanese input-output table was employed to calculate the concept (4) ratio values appearing in Table A-2. Certain errors crept into the calculations, but they were not large enough to affect the conclusions materially.[44] Despite the errors and statistical peculiarities, the two-digit Japanese ratios show a rank correlation of about 0.8 with their two-digit American counterparts (given in parentheses), derived from the 1958 U.S. input-output table.[45] Nevertheless, the ratio values may occasionally suggest that the theory itself—or at least the version tested here—has little promise. For example, an apparently small portion of pottery sales (SITC 666) goes to final consumers, a partly misleading result because of the importance of industrial ceramics in the particular input-output industry. On the other hand, a seemingly large share of scientific, medical, and optical instruments (SITC 861) is consumed by the public, probably because the group includes cameras. Among these SITC groups, factors beside the stage of production will clearly exert greater influence on the pattern of trade. Generally speaking, since producers' goods have been defined as anything not quickly reaching the consumer, the category embraces semiprecious stones, fertilizer, wood products, paper goods, and other "unlikely" advanced country exports. Thus from the outset the hypothesis may appear none too promising.

The stage of production theory can be tested by comparing statistic (4) either with national manufacturing output or with GDP per capita. The comparison with manufacturing output presumes that sheer indus-

[44] Well after the statistical work was completed, I discovered that the ratio values were calculated neglecting imports and with some classification errors. The Table A-2 values were partially corrected for these errors (which were usually small) but no attempt was made to recompute the embodied characteristics or the various correlation coefficients. See note (f) to Table A-2.

[45] The 1958 input-output table was used to calculate consumer goods ratios on a two-digit SITC basis, but the U.S. table was not sufficiently detailed for three-digit SITC values. The U.S.-Japanese correlation would be better except for (a) the Japanese practice of treating automobile sales as capital formation; and (b) the use of Japanese export weights in calculating the two-digit Japanese values.

trial size determines specialization in consumer or producer goods. The comparison with GDP per capita places more emphasis on sophistication.

As it happens, the comparison with manufacturing output turns out poorly, but the comparison with GDP per capita turns out extremely well. The Spearman and weighted rank correlations for the latter comparison are .818 and .801 respectively, while the simple correlation is .727, despite the sometimes peculiar consumer goods ratios. If backward integration is seen as the concomitant of economic development, rather than sheer size, then trade patterns emerge in quite logical fashion. But it must be remembered that this "logic" overlaps a good deal with the logic of the Heckscher-Ohlin and human skill theories.

TECHNOLOGICAL GAP

The sequence of innovation and imitation vitally affects export patterns, or so I and others have contended. Early producers enjoy easy access to foreign markets, access which is reinforced by technical and managerial leadership;[46] later producers must rely on some factor cost advantage (e.g., low wages) to secure a share of foreign sales. Furthermore, production history may determine whether overseas commitments by leading firms take the form of licensing arrangements, joint ventures, or solely owned corporations.

Technological gap and product cycle analyses of trade have lately enjoyed a certain vogue. It is interesting to note that Reverend Josiah Tucker enunciated the major elements of this theme as early as 1758. In a remarkable essay, "The great Question resolved, Whether a rich Country can stand a Competition with a poor Country (of equal natural Advantages) in raising of Provisions, and Cheapness of Manufacturers?" [61], Tucker opened with the observation:

> It has been a Notion universally received, That Trade and Manufactures, if left at full Liberty, will always descend from a richer to a poorer State; somewhat in the same Manner as a Stream of Water falls from higher to lower Grounds; . . . It is likewise inferred, very consistently with this first Principle, that when the poor Country, in Process of Time, and by this Influx of Trade and Manufactures, is become relatively richer, the Course of Traffic will turn again. . . .

[46] J. Diebold contends [9] (without offering any evidence) that the gap is not technological but managerial. What this really means is that alert, technologically oriented managers, with a flair for marketing new products, are as vital as good scientists in the research laboratory—a perfectly unobjectionable contention.

Tucker then posed the great question, apparently a matter of some concern during the mid-eighteenth century:

This being the Case, can it be denied, that every poor Country is the natural and unavoidable Enemy of a rich one; especially if it should happen to be adjoining it? And are not we sure beforehand that it will never cease from draining it of its Trade and Commerce, Industry and Manufactures, 'till it has at least so far reduced it, as to be on a Level and Quality with itself? Therefore the rich Country, if it regards its own Interest, is obliged by a Kind of Self-defence to make War on the poor one, and to endeavour to extirpate all its Inhabitants. . . .

Reverend Tucker, distressed by the apparent conflict between self-interest and Divine Providence, denied this pessimistic outcome, at least for the rich country which had acquired wealth by industrious pursuits rather than gold mines (the distinction between England and Spain). The artisan nation would enjoy, said Tucker, seven advantages over its poorer competitor: (1) a larger stock of direct and infrastructure capital and better organized institutions; (2) superior human skills; (3) bigger capacity for investment; (4) an ability to attract the best talent from the poor country; (5) greater division of labor; (6) more internal competition; (7) lower interest rates. Given these advantages: ". . . it may be laid down as a general Proposition, which very seldom fails, That *operose* or *complicated Manufactures* are cheapest in rich Countries;—and raw *Materials* in poor ones. . . ."

Corn, wheat, and garden-stuff were cited by Tucker as agricultural produce suited to the environs of well-to-do London, while cattle, sheep, and timber were assigned to poorer Scotland. Wooden products, woolen clothes, horn combs, ink-horns, powder-flasks, leather shoes and boots invariably moved from England to Scotland, not vice versa. Even more remarkable was the English import of Swedish raw iron ("and surely Sweden is a country poor enough") and the return export of metal articles to Sweden, despite heavy duties at nearly every border crossing.

In a polemical postcript, addressed to a critic who asked whether ". . . according to this Hypothesis, Improvements, Industry, and Riches, may be advanced and encreased *ad infinitum;* which is a Position too extravagant to be admitted," Tucker dismissed the man with eighteenth century optimism: "No Man can set Bounds to Improvements even in Imagination; and therefore, we may still be allowed to assert, that the richer manufacturing Nation will maintain its Superiority over the poorer one, notwithstanding this latter may be likewise advancing towards Perfection."

Tucker, of course, was forgotten in the Ricardian and neoclassical ascendancy. Today, when continuous technological progress has become an article of faith, no one worries much about the consequences of "spread" for the rich nation. Otherwise, many ingredients of the technology-trade story remain the same.

Several latter day studies of technological gaps and their influence on trade and overseas investment have explored developments among specific high technology products, though at least one investigator promises to look at the low technology end.[47] Another quite different approach, successfully pursued by Gruber, Mehta, and Vernon [16] and Keesing [27], and by Gruber and Vernon in the present volume, is to measure technological sophistication by research expenditure. This approach, by contrast with individual product studies, can quickly encompass a wide range of manufactures trade. But it requires an examination of trade flows on an *industry* basis. In this and the next section, we prefer measures more closely identified with *commodities.* The industry and commodity results are of course reconcilable, and it may well be that, after the reconciliation, R&D offers the statistically superior tool for examining the whole "bundle" of product cycle characteristics.

Nevertheless, in the present section, our preferred tool would be a product date measure readily available for a broad range of commodities. The tentative foundations for this tool are supplied by the U.S. Census Bureau's export classification list, "Schedule B."

Editions of Schedule B were published in 1909, 1915, 1917, 1919, 1921, 1922, 1925, 1928, 1929, 1930, 1931, 1932, 1933, 1938, 1939, 1941, 1944, 1949, 1952, 1955, 1958, and 1965. Each new edition expanded the list of commodity headings, both by subdividing existing

[47] Cf. the notes to Table 1: G. C. Hufbauer (plastics, synthetic rubbers, and man-made fibers), G. K. Douglass (motion pictures), R. B. Stobaugh (selected chemicals). J. Tilton of the Brookings Institution has a study underway on diffusion of the semiconductor industry. W. A. Chudson at the Columbia University School of Business is looking at the efficiency with which petrochemical technology is transferred to developing countries. D. R. Sherk of Boston College will examine the postwar Japanese transition from low technology standardized exports to higher technology, more differentiated goods.

groups and by breaking new groups from basket categories. This expansion, which magnified Schedule B from a small pamphlet of one hundred pages in 1909 to a heavy volume of one thousand pages in 1965, provides the basis for dating the arrival of new products to the status of internationally traded goods. The mechanical steps of deriving "first trade dates" from successive editions of Schedule B, and the shortcomings of the data listed in Table A-2, are summarized in the paragraphs that follow.

To begin with, the seven-digit 1965 SITC classification, containing some 2,000 manufactured items, was related to the old six-digit 1964 Schedule B, containing an approximately equal number of headings [71]. Ordinarily, more than one "old" Schedule B group contributed to the commodities under each "new" SITC Schedule B heading. Hence, after obtaining the first trade date for each "old" SITC group (as explained below), an unweighted mean of the contributing groups was used to represent the first trade date for each "new" seven-digit SITC group.

The 1958 edition of Schedule B (reprinted and revised as of January 1, 1962) gave first establishment dates for all six-digit export groups inaugurated after 1939 [68]. The great majority of first trade dates for the old six-digit Schedule B were taken directly from the 1962 volume. For those categories established before 1939, a search was made of earlier Schedule B editions to discover their first appearance. Even so, the first trade dates for certain kinds of six-digit groups could not be determined. For example, basket categories rarely have definitive inception dates. Similarly, groups formed by the combination of two or more groups often had untraceable antecedents. These six-digit Schedule B groups were ignored in finding the first trade date for each seven-digit SITC group.

Commodities which trade in big volume probably get broken out from basket categories sooner than small volume items. First trade dates at a seven-digit level are thus weighted by American export experience, apart from the fact that Schedule B takes no cognizance of new export items shipped from other countries.

Once an unweighted average was obtained for each seven-digit SITC group, two different methods were employed to obtain first trade dates on a three-digit SITC basis. First, the seven-digit values belonging to each three-digit group were weighted according to 1965 United States exports in order to find a value for that three-digit group. Second, an unweighted average of the seven-digit values was taken. In 60 out of 102 cases, the weighted values were more recent than the unweighted values (in 5 cases they were identical), confirming that U.S. exports are concentrated among newer goods. Because of this concentration, it seemed better to use unweighted values in the trade analysis. Unweighted values thus appear in Table A-2.

The dates in Table A-2, ranging from 1927.7 to 1954.6, are not always compatible with a priori expectations. For example, textile yarn and thread (SITC 651) and cotton fabrics (SITC 652) have dates more recent than 1950, although electrical apparatus for medical purposes (SITC 726) has a date of 1944.7. Whether these aberrations reflect mere nuances in the compilation of Schedule B, vagaries in the attempted link between "old" and "new" Schedule B, or in some sense genuine patterns of innovation, we have not investigated. It seems likely that American exports of cotton textiles exhibit an altogether different composition than the bulk of world trade. But even allowing for such ad hoc explanations, the first trade dates very inadequately reflect the commodity characteristic which they purport to measure. These dates surely stand out as the least satisfactory statistic presented in this paper.

Furthermore, as Kindleberger notes in his criticism of the conference version of this paper, an examination of the embodied first trade dates of Table 2 shows that no country has an average composition of 1965 exports dating earlier than 1944, while the latest average comes only to 1948. Kindleberger adds that it is hard to conclude very much about the technological gap theory of trade with data which average out most of the technological differences between countries, and produce sixteen out of twenty-four averages in the two years 1946 and 1947.

To determine whether these (inadequate) first trade dates are linked with economic structure when embodied in exports, some measure of "industrial sophistication" is required. Gross domestic product per capita meets this need in a crude way. As Table 5 shows, the Spearman correlation between first trade dates embodied in exports and GDP per capita is .698, while the weighted correlation is .864. The main deviant nations are Norway and Taiwan—the former with a much older export composition and the latter with a much younger set of exports than their respective levels of per capita GDP would suggest. Both these nations are comparatively small exporters. Hence the weighted correlation is larger than the Spearman coefficient. The exclusion of Taiwan raises the Spearman coefficient to .764.

GDP per capita is highly correlated with both fixed capital per capita and skilled employees as a percentage of the labor force. As we have seen, the resource endowment theories of trade perform quite well. Therefore, it would be reasonable to expect that first trade dates embodied in exports would correspond with GDP per capita only to the extent that commodity first trade dates correspond with commodity physical capital and human skill requirements. But in fact, the weighted rank correspondence between first trade dates and physical capital is only .111, while the correspondence between first trade dates and skill requirements is .377 (Table 8). The successful performance of the first trade date measure is not entirely attributable to the overlap with physical and human capital.

PRODUCT CYCLE

Successive stages of standardization, argues Vernon, characterize the product cycle. Initially a new good is made in small lots, each firm with its own variety. Manufacturing processes are highly experimental; many different techniques are given a try. But as markets grow, changes take place; national and international specifications are agreed upon. Simultaneously, the number of processing technologies decreases as inferior methods are weeded out. The surviving techniques grow more familiar and marketing channels become better established. The expansion of output transforms the items from "sideline" to "mainline" status.

In the early stages, production and export advantages lie with sophisticated firms in advanced nations. As the product cycle unfolds, however, firms and nations with less technical expertise begin making and exporting the item. Standardization aids and abets this migration of industry in two ways—longer production runs and proven production technology bring industry within the technical grasp of more nations; standardized goods are more easily marketed, both because sales channels have been established and because feedback problems are less severe.

The product cycle accounts and the technological gap accounts clearly belong to the same family. Both stress the sequential development of production history. But while technological gap emphasizes *time,* product cycle emphasizes the transition from product *differentiation* to product *standardization.*[48] Hence the two theories merit separate examination.

"Differentiation" and "standardization" convey different meanings in different contexts. For his purposes, Drèze used the six degrees of fabrication distinguished in tariff schedules.[49] For the present context, a measure is needed which compares the homogeneity of a great many products at a given moment in time (assuming that standardized products imply standardized processes).[50] The coefficient of variation in unit export values roughly serves this need:

$$\text{(5)} \qquad \text{Product Differentiation} = U_n/V_n.$$

In this expression, U_n denotes the standard deviation of U.S. export unit values for shipments of product n to different countries; V_n denotes the unweighted mean of these unit values. The use of country destination for distinguishing between shipments was dictated by available data. If a product is standardized, presumably the unit values of different shipments will be similar. However, as P. T. Knight points out, cyclical market variations and discriminatory export practices will, to some unknown degree, distort statistic (5) as a measure of differentiation.

The United States Census Bureau, using 1965 export data, computed differentiation coefficients for each seven-digit SITC category on which quantity figures were available. Quantity figures, however, were not

[48] On a somewhat different tack involving the same variable, B. Kit, J. Yurow, and H. Millie [34] have examined the impact of international standards on national exports. Much trade, they claim, turns on the adoption of national specifications for international practice. General Electric, for example, says it has foregone bids on overseas TV equipment amounting to some $11 million during recent years, thanks to the adoption of European rather than American standards ("Case History No. 6," p. 51). When national standards become international practice, the country renders its home market more accessible to foreign imports but at the same time gains broader entry to foreign markets.

[49] For another example, S. A. N. Smith-Gavine [55] develops a statistic suitable for measuring the complexity of a firm's output, with respect to both components and processes.

[50] This assumption is not necessarily correct. There are many goods, such as handicrafts and apparel, which are not themselves standardized but which are made by highly standardized processes. Conversely, new industrial materials may be manufactured in very different fashion by different firms.

available for highly individualistic goods: for example, complex machinery, scientific apparatus, and parts of all description. For purposes of estimating three-digit SITC differentiation coefficients, these "nonquantity" seven-digit groups were treated in two ways. In the first instance, they were ignored. The coefficients given in Table A-2 were estimated following this procedure. In the second instance, the "nonquantity" groups were assigned values equal to the largest coefficients (on a seven-digit basis) directly estimated for the three-digit group. The three-digit coefficients estimated in this way were more widely dispersed than those obtained by the first procedure. But the rank order of commodities was much the same, while the ultimate analytic results were slightly inferior using these assigned value coefficients. The second approach was therefore not pursued.

The three-digit coefficients in Table A-2 represent simple averages of the underlying seven-digit values. Alternatively, the seven-digit values might have been weighted by 1965 U.S. export experience. Weighted coefficients were in fact obtained on a trial basis, but simple averages were preferred for comparability with first trade dates. Interestingly, the weighted coefficients (unlike the weighted first trade dates) were not noticeably biased towards differentiated products. In 51 out of 102 instances, the weighted coefficients were larger than the simple averages (in 4 cases the values were identical), a proportion no greater than random weights would give. As between seven-digit SITC commodities, the United States shows no strong tendency towards differentiated goods.[51]

At a three-digit level, reasonable coefficients seem to emerge, at least in some instances. The SITC categories 652 ("cotton fabrics"), 673 ("iron or steel bars, rods, angles, etc."), and 715 ("metalworking machinery"), for example, yield a plausible sequence of coefficients: .4774, .6916, and 1.3156.

However, it is perhaps surprising that the rank correlation between first trade dates and product differentiation is no higher than .169. But the commodities that detract from a better correspondence are not altogether unexpected. Some goods are intrinsically differentiated, what-

[51] The comparison does not reflect "nonquantity" SITC items. If such items were included, U.S. exports might show a bias.

ever their age. Among the commodities that have much older dates than the high degree of differentiation might suggest:

533 Pigments, paints, varnishes
571 Explosives and pyrotechnics
679 Iron and steel castings, forgings, etc.
694 Nails, screws, nuts, bolts, etc.
717 Textile and leather machinery
842 Fur clothing and fur articles

Other goods are very young, but nevertheless highly standardized. Two separate cases seem to appear: goods which are genuinely new, but naturally standardized, and standardized goods whose newness, if not a quirk of the dating method, can only be explained by changing industrial or consumer fashions. In addition, there are some commodities, for example nickel and tin, which are not at all new but which have been *exported* only very recently by the United States. Among those commodities which have younger dates than the high degree of standardization would indicate are:

651 Textile yarn and thread
652 Cotton fabrics
672 Ingots, other primary forms
674 Universals, plates, sheets
683 Nickel
687 Tin
688 Uranium, thorium, etc.
712 Agricultural machinery
725 Domestic electrical equipment
732 Road motor vehicles
733 Bicycles, trailers, invalid carriages
893 Plastic articles

Without these eighteen items, the rank correlation between product age and standardization would improve, perhaps to about 0.5. Even this correspondence is not terribly large. It must be recognized that different goods start their lives with different intrinsic degrees of standardization. Over the product cycle any given good may become more standardized, but, because of differences at birth, there will never be an exact correspondence between product age and product standardization.

Indeed, as measured by coefficient (5), goods may never change their degree of differentiation very much. Production techniques could well become more familiar and standardized with time, but no correspondence need exist between product age and product standardization. In that event, the success of coefficient (5) would reflect the arguments put up by Drèze rather than a temporal sequence. Drèze contended that small and less developed nations would concentrate on internationally standardized goods because such nations cannot achieve long runs making differentiated items. Drèze might also have noted that differentiated goods require more skills in manufacture and for this reason tend to be the province of developed countries. True, Drèze emphasized international standardization while coefficient (5) measures product group standardization, but some similarity probably marks the two concepts.

Given the existence of these possible explanations, what luck does differentiation have as an explanatory characteristic? As with first trade dates, gross domestic product per capita is the national attribute assumed to determine differentiation in exports. Table 5 shows a Spearman correlation of .724 between this attribute and the trade characteristic. Canada and Australia, "new" rich countries with highly standardized exports, are the principal deviant nations. Elimination of Canada raises the Spearman coefficient to .788. The weighted rank coefficient for twenty-four nations is .763, and the simple correlation is .749.

These coefficients bear out the Vernon-Drèze hypothesis that advanced nations specialize in differentiated exports. Whether the hypothesis owes its success to a product cycle thesis, or to the intrinsic difficulties of making and marketing differentiated goods, is not a question that can be answered from static cross-section analysis.

SUMMARY

What can be said about an evaluation which finds virtue everywhere? Considering the unlikely, indeed almost improbable, statistics used in certain instances, the discovery of little truths in every nook is perhaps surprising. Much better to pour academic hot oil on two or three accounts than to broadcast olive branches!

Had the analysis been extended to more countries, and had a broader definition of manufactures been employed, less sympathetic findings might have emerged. But distinctions based on the experience of small exporting countries or on commodities with a large natural resource component would scarcely convince anyone. If a theory is to be condemned, it must be condemned after sympathetic examination.

In retrospect, it must be conceded that many different characteristics express themselves in export patterns. No one theory monopolizes the explanation of manufactures trade.

This seemingly prosaic finding is not altogether commonplace. The characteristics themselves, when matched against the 102 SITC commodities on a weighted rank correlation basis, show five strong intercorrelations: the expected coincidence between wages and human skills; the correspondence between human and physical capital; the overlap between the consumer-producer goods dichotomy and the light-heavy industry dichotomy; the match between standardized and skilled goods; and the correspondence between scale economy and skilled goods. To a certain extent, therefore, the "different" characteristics do nothing more than catch different glimpses of the sophistication that accompanies economic development.

But the seven commodity characteristics, when applied to national export patterns, yield much more similar country rankings than the underlying correspondence between characteristics themselves might lead us to expect. The Kendall coefficient of concordance between country rankings exceeds .700, a value which is easily significant at the 1 per cent level. When the export-embodied characteristics of twenty-four nations are compared on a simple correlation basis, the same picture emerges. Out of the twenty-one bilateral correlations between the export-embodied characteristics of the twenty-four-nation sample, all are significant but 4 (Table 11). The average value of the twenty-one bilateral correlations is .683, whereas the average value of the twenty-one weighted rank correlations between commodity characteristics per se (Table 8) is only .303. Export patterns exercise an intriguing kind of selectivity. Commodities are favored which contain several characteristics suitable to the nation's economic structure. The composite trading pattern thereby agrees with various theoretical predictions.

TABLE 11

Simple Correlations Between the Export-Embodied Characteristics of Twenty-Four Nations

	Capital per Man	Skill Ratio	Wages per Man	Scale Economies	Consumer Goods Ratio[a]	First Trade Date	Product Differentiation
Capital per man	1.000						
Skill ratio	.597	1.000					
Wages per man	.826	.911	1.000				
Scale economies	.308*	.744	.695	1.000			
Consumer goods ratio[a]	.782	.849	.938	.645	1.000		
First trade date	.261*	.636	.588	.777	.481*	1.000	
Product differentiation	.382*	.923	.783	.786	.766	.674	1.000

Note: In this exercise the correlations between national values for different export-embodied characteristics are compared with one another.

Source: Table 2.

[a]The signs of the consumer goods ratio correlations have been reversed. Also see note (f) to Table A-2.

*Not significantly different from zero at the 1 per cent confidence level.

Earlier it was said that the neofactor proportions account, combining human and physical capital, performed so well that the role for other theories was doubtful. It is now apparent that another cluster of explanations—shall we call it the neotechnology account?—emerges as an equally strong contender.

The neofactor proportions story emphasizes tangible factors of production—physical capital and labor of different qualities—operating in a basically competitive world economy. This stress permits easy assimilation to the grand body of neoclassical economic reasoning. Questions of income distribution, international migration, savings, capital formation, and so forth, are easily handled starting from national endow-

TABLE 12

Simple Correlations Between the Import-Embodied Characteristics of Twenty-Four Nations

	Capital per Man	Skill Ratio	Wages per Man	Scale Economies	Consumer Goods Ratio[a]	First Trade Date	Product Differentiation
Capital per man	1.000						
Skill ratio	.317*	1.000					
Wages per man	.261*	.668	1.000				
Scale economies	.197*	.740	.577	1.000			
Consumer goods ratio[a]	.267*	.719	.749	.654	1.000		
First trade date	-.608	.026*	.483*	.162*	.184*	1.000	
Product differentiation	-.141*	.596	.761	.416*	.720	.604	1.000

Note: In this exercise, the correlations between national values for different import embodied characteristics are compared with one another.

Source: Table 3.

[a]The signs of the consumer goods ratio correlations have been reversed. See also note (f) to Table A-2.

*Not significantly different from zero at the 1 per cent confidence level.

ments of productive resources. And the dichotomy between consumer and producer goods can be accompanied as a minor garnish.

The neotechnology account, however, points to production "conditions" in a setting of monopolistic competition: [52] economic returns to scale, product age, and product differentiation. If this trilogy were somehow combined into a single characteristic, that characteristic might prove as powerful as Lary's single measure (value added per man) of human and physical capital in explaining trade flows.[53]

[52] For the distinction between perfect and monopolistic competition as an underlying presupposition of international trade theory, see H. G. Johnson [24].

[53] For results of correlations incorporating value added per man as the dependant variable, see the note by Lary in this volume.

But the neotechnology approach is not geared to answering the traditional questions of economic inquiry. It can as yet offer little to compare with Samuelson's magnificent (if misleading) factor-price-equalization theorem. The theoreticians may remedy this shortcoming. In the meantime, the technology approach has illuminated some new fields of inquiry. For example, it helps explain the composition of direct investment flows [76]. And it provides the foundation for understanding why trade refuses to wither and die when nations grow more similar.

GAINS FROM TRADE

Orthodoxy vs. Linder

According to the prevalent orthodoxy, international trade makes possible greater output by reallocating resources among substantially different activities. *Dissimilar* goods, so the argument runs, are the mainspring of exchange. Maximum benefit accrues when each nation concentrates on its own, relatively efficient, lines of production. The first six theories enumerated in Table 1 presuppose this basic orthodoxy.

S. B. Linder offers a different story, at least for commerce in manufactured goods [44, pp. 86–109]. In Linder's version, the qualities and kinds of manufactured goods consumed by a nation are peculiar to its own industrial structure and level of per capita income. Exports of manufactures are an outgrowth of a home production which caters to majority dictates, while imports accommodate the slightly different needs of the minority.[54] The factor proportions approach may adequately explain commerce in primary goods, but international trade in manufactures must be seen as an extension of the internal market.

Linder's core hypothesis yields various suggestive insights. Flavored with ingredients from the theory of monopolistic competition, it rationalizes the flourishing exchange between Renaults and Fiats, between Budweiser and Loewenbrau. It explains the creation and extinction of trade as a function of each partner's travelling speed through its income zone. An empirical corollary which Linder casually examined is the connection between bilateral trade intensity and per capita income; but,

[54] H. G. Grubel finds confirmation of Linder's commodity composition argument in the *growth* of European Common Market trade [15].

as Linnemann subsequently demonstrated, the intensity of bilateral trade can hardly be evaluated without explicit reference to distance. Here we examine another Linder corollary relating to the commodity composition of trade in manufactured goods.

The assertion tested is that the composition of nation *i*'s manufactured exports will be more similar to the composition of nation *j*'s imports as *i* and *j* more closely resemble each other in per capita income and economic structure. In the extreme case, the export and import menus for a given country should be highly similar. As Linder himself says [44, p. 91]: ". . . the range of potential exports [of a country] is identical to, or included in, the range of potential imports." And, somewhat later [44, p. 138]: "Potential exports and imports are—when they are manufactures—the same products. An *actual import* product today is a *potential export* product today and may be an *actual export* product tomorrow." The gains from this sort of exchange stem from the marginal satisfaction which differentiated consumption brings to the buyer, from the reduction of monopoly returns to labor and capital, and from the elimination of economic rents on technological know-how.

The assertions of the orthodox school as opposed to those of Linder regarding export-import similarity can be interpreted at two levels. They can mean that dissimilarity (similarity) should exist between actual *commodities* imported and exported by a given nation. Or they can mean that dissimilarity (similarity) should exist between commodity *characteristics* embodied in imports and exports. Both interpretations are examined in the following sections.

Before proceeding to the numerical exercises, it must be admitted that the Linder-orthodoxy distinction has been phrased too strongly, at least so far as the "orthodox" scale economy and product cycle theories are concerned. In a few offhand remarks, Linder allows these latter explanations a role in accounting for trade among manufactured goods [44, pp. 102, 103, 129]. The remarks afford Linder a potential escape hatch for explaining commodity specialization, so long as that specialization is based, not on "tangible" factor endowments (including human skills), but on "ephemeral" production conditions, like innovation and scale. Since Linder's text spends very little time developing this escape hatch, we are perhaps justified in giving it only editorial notice.

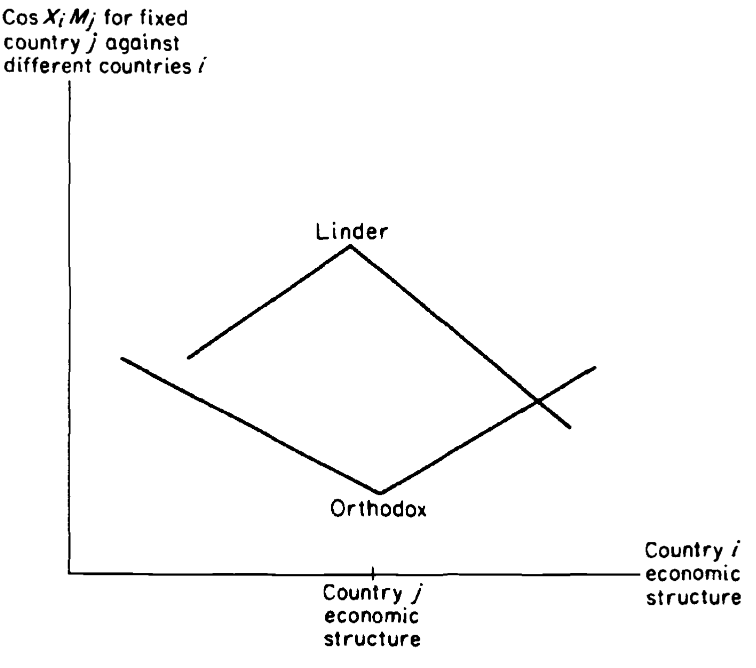
SIMILAR COMMODITIES?

Country i's commodity composition of exports may be expressed by vector X_i, where each element, x_{in}, represents exports of commodity n as a percentage of that country's total manufactures exports. Country j's commodity composition of imports may be expressed by vector M_j, where each element, m_{jn}, represents imports of commodity n as a percentage of its total manufactures imports. The cosine of vectors X_i and M_j provides an index of trade similarity: [55]

$$\text{(6)} \qquad \operatorname{Cos} X_i M_j = \frac{\sum_n x_{in} \cdot m_{jn}}{\sqrt{\sum_n x_{in}^2 \cdot \sum_n m_{jn}^2}}$$

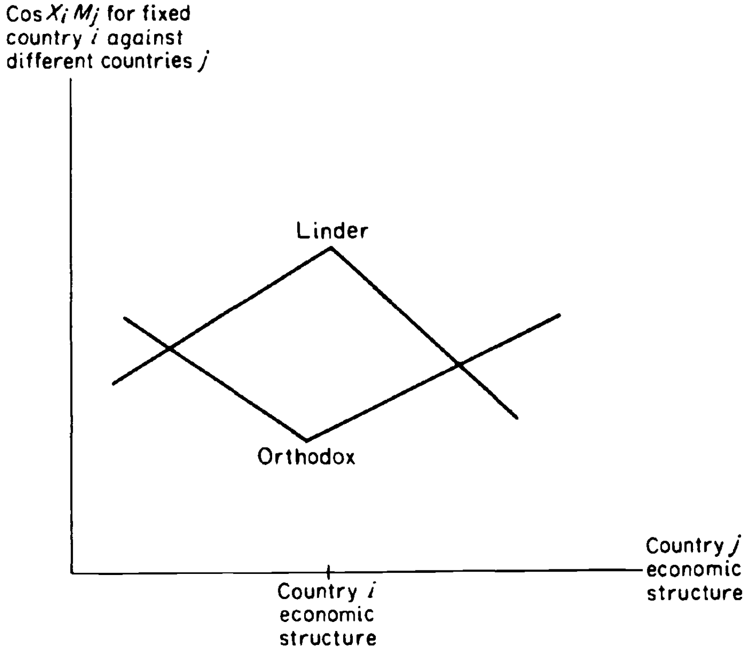
When Cos X_iM_j equals one, the two vectors are identical: when the cosine equals zero, they are completely dissimilar.

FIGURE 2



[55] This measure is presented in R. G. D. Allen [1, p. 381] and critically examined by H. Linnemann [45, pp. 140–143].

FIGURE 3



By extension of Linder's argument, the Cos X_iM_j values, when graphed for a given country's *import* vector, should resemble the tent shape depicted in Figure 2; for the same country's *export* vector, the Cos X_iM_j values should resemble the tent shape of Figure 3. This extension depends on the assumption that a country's actual *trade* with all countries represents the range of its *potential* trade with any given country. Thus, actual total imports of country i will be more similar to actual total exports of country j as i and j more closely resemble each other in economic structure; and the same statement applies to total exports of country i when compared with total imports of country j.

Conversely, orthodox theory suggests that imports of countries in a given economic zone will not match their exports, because trade, rather than merely extending the internal market, compensates for international economic differences. The orthodox position yields the expectation, depicted in Figures 2 and 3, of a "V" shaped distribution of Cos X_iM_j values. Table A-3 sets forth the matrix of Cos X_iM_j values derived from the 1965 three-digit trade statistics for manufactured goods. Whether the matrix in Table A-3 reflects a tent or a "V" can be suggested by application of the following regression equations, where A_i and A_j measure economic structure.

(7) $$\text{Cos}\, X_iM_j = c_1 + a_1A_j + b_1A_i, \text{ when } A_j \leq A_{ij};$$

and

(8) $$\text{Cos}\, X_iM_j = c_2 + a_2A_j + b_2A_i, \text{ when } A_j \geq A_i.$$

If Linder's argument is correct, then c_1 should be less than c_2, a_1 should be positive, b_1 should be negative, a_2 should be negative, and b_2 should be positive. The converse relationships would support the orthodox position.

In estimating the parameters of (7) and (8), per capita GDP has been used as the sole measure of economic structure. Since GDP per capita offers a well correlated proxy for most other aspects of economic structure (Table 9), this restriction should not prove fatal.

The parametric results from (7) and (8) support neither Linder nor orthodoxy. The shape of export-import cosines represents neither a tent nor a "V." Instead, as Table 13 shows, the typical export vector grows *continuously* more similar to the import vector of an opposing nation, as the importing nation is more developed. This holds not only for manufactures exports from the United Kingdom and Sweden, but also for exports from Portugal and Hong Kong: export vectors mesh better with import vectors when the importing country is a richer nation. Likewise, the typical import vector grows continuously more similar to the opposing export vector, as the exporting nation is more developed. The United States and Germany offer a wider selection of exports than Mexico and India.

Broadly speaking, these findings represent nothing more than the diversification of exports and imports which accompanies greater affluence. Owing to concentration, especially export concentration, the opposing trade vectors of two poor countries, say Hong Kong and Portugal, will substantially differ, while thanks to diversification the import-export vectors of two rich nations, for example the United Kingdom and Sweden, will roughly coincide.

Thus, as Table 13 shows, a_1, b_1, a_2, and b_2 all are positive, and to

TABLE 13

Similarity of Import and Export Vectors

I. National Import vs. Export Vectors

	Constant	Parameter of A_j	Parameter of A_i	R^2
Present results[a]				
$\mathrm{Cos}X_iM_j =$				
$c_1+a_1A_j+b_1A_i$,	.30331	.00006	.00012	.235
when $A_j \leq A_i$	(±.20183)	(±.00002)	(±.00002)	
$\mathrm{Cos}X_iM_j =$				
$c_2+a_2A_j+b_2A_i$,	.17781	.00004	.00026	.503
when $A_j \geq A_i$	(±.17442)	(±.00002)	(±.00002)	
Linnemann results[b]				
$\log\mathrm{Cos}X_iM_j =$				
$c_3+a_3\log A_j+b_3\log A_i$	c	.18	.35	

II. National Export Vectors[a]

	Constant	Parameter of $\|A_i - A_j\|$	Parameter of $\sqrt{A_iA_j}$	R^2
Linnemann results[b]				
$\mathrm{Cos}X_iX_j = c_4 +$	.33517	-.00011	.00015	.318
$a_4\|A_i-A_j\| + b_4\sqrt{A_iA_j}$	(±.18400)	(±.00002)	(±.00002)	

Note: Symbols are
X = Export vector for the three-digit SITC classification, expressed as per cent of total country exports.
M = Import vector for the three-digit SITC classification, expressed as per cent of total country imports.
A = Per capita gross domestic product or gross national product.
i, j = Country subscripts.
a, b, c = Parameters and constants to be estimated.

[a]The present results are based on the cosine values reported in Tables A-3 (national import vs. export) and A-4 (national export vs. export). These cosine values pertain only to trade in manufactured goods.

(continued)

[b]The Linnemann results are based on H. Linnemann [45], Case AC 1, p. 82 and Case AC 29, p. 150. The equation in Case AC 29 was rearranged to make log C_{ij} (C_{ij} = Cos X_iM_j) appear on the left side as the dependent variable. The Case AC 1 value for log X_{ij} was then substituted in the rearranged Case AC 29 equation. The parametric relationship between C_{ij} and per capita income of importing country j is consequently found as the difference between the Case AC 1 and Case AC 29 values of ϕ_3, divided by ϕ_{16}. In our notation:

$$a_3 = \frac{\phi_3 \text{ (AC 1)} - \phi_3 \text{ (AC 29)}}{\phi_{16} \text{ (AC 29)}}.$$

Similarly:

$$b_3 = \frac{\phi_1 \text{ (AC 1)} - \phi_1 \text{ (AC 29)}}{\phi_{16} \text{ (AC 29)}}.$$

Five features should be observed about the implied relationships. First, Cases AC 1 and AC 29 are not based on exactly the same trade flows, and for this reason slight distortions are introduced. Second, parameters ϕ_1 and ϕ_3 are attached, in Linnemann's equations, to gross national product. The assumption that these parameters also describe the impact of cross-sectional changes in per capita gross national product depends on the tautology:

$$\phi_1 \log \text{(GNP)} \equiv \phi_1 \log \text{(per capita GNP)} + \phi_1 \log \text{(population)}.$$

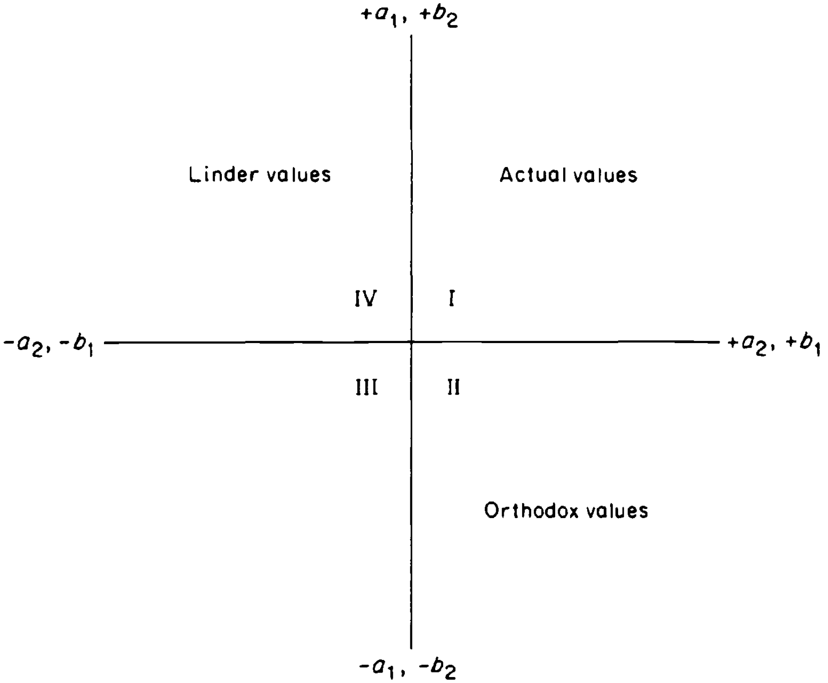
Third, interactions between the commodity composition vector and terms other than per capita income have been ignored. Fourth, for all the foregoing reasons, the implied values of a_3 and b_3 probably differ somewhat from those that would be obtained by direct estimation. Fifth, the Linnemann results apply to all trade, not just manufactures trade.

[c]Not derived.

a much greater extent than their standard errors. To be sure, the explanatory powers of (7) and (8), as measured by R^2, are limited. But the positive parameter signs are unmistakable. Furthermore, the standard errors of c_1 and c_2 are so large that these coefficients cannot be statistically distinguished from one another.

If c_1 definitely exceeded c_2, then in terms of Figure 4 the orthodox position would receive support provided the other parameters fell in quadrant II. If c_2 exceeded c_1, Linder would get a boost provided the other parameters fell in quadrant IV. As it happens, c_1 and c_2 are indistinguishable, while the other parameters all land in quadrant I.

FIGURE 4



These results are obliquely confirmed by Linnemann's econometric work. Linnemann applied various "gravity" models on a cross-sectional basis to explain the size of 1959 bilateral trade flows (total trade, not just manufactures). Most of the models contain GNP and population of the trading partners, distance between them, and a dummy preference term (e.g., for Commonwealth trade) as explanatory variables. One model also includes the cosine between export and import commodity composition vectors as an independent variable. Assuming that commodity composition is a *dependent* rather than an independent variable, the results of this model—when contrasted with the results from a model without the cosine variable—imply certain parametric values for the impact of cross-sectional income changes on commodity composition. Table 13 performs and explains this exercise. The implied parameters indicate that import and export composition grow more similar with an increase in the per capita income of either partner.

For those who like theoretical admixtures, the parametric results of our own work, indirectly confirmed by Linnemann, may be rationalized by assigning orthodoxy and Linder each its own "sphere of influence." Judging solely from the cosine exercise, Linder—perhaps supplemented by product cycle and scale economy theory—works best in accounting for trade *within* the rich country zone. By the same token, orthodoxy—perhaps in the narrow tangible factor sense (including factors of nature)—does better at explaining the commodity composition of manufactures *within* the poor country zone. As for trade between zones, the cosine results agree with Linder if the zones are close together, and with orthodoxy when the zones are widely separated.

The "spheres-of-influence" reconciliation is at least compatible with a finding from the cross-sectional Gruber-Vernon work on the size of bilateral trade flows. Invoking a concept which dates from Tatemoto and Ichimura, Gruber and Vernon distinguish between "upstream" and "downstream" trade flows. Gruber and Vernon find that, as a country gets richer, its upstream exports increase about as rapidly as its downstream exports.[56] As Linder might predict, trading relations do not particularly wither with those areas which the exporting country comes more to resemble.

Nevertheless the "spheres of influence" reconciliation critically depends on one assumption: that tangible orthodox considerations govern a

[56] W. H. Gruber and R. Vernon, "The Technology Factor in a World Trade Matrix," this volume, Table 10. The results quoted are derived by comparing the parameters for the group in which $H_i > H_j$ with the group $H_i < H_j$. H_j, used to distinguish between upstream and downstream trade, is the Harbison-Myers index of human resource development. Using the Gruber-Vernon notation, and heroically assuming that variables not mentioned in the formulation below are independent of per capita income, the elasticity of exports from i to j with respect to a change in the per capita income of i is given by:

$$\frac{\partial E_{ij}}{\partial PC_i} \cdot \frac{PC_i}{E_{ij}} = b_1 + b_3 \pm b_7 \left\{ \frac{PC_i}{|PC_i - PC_j|} \right\}$$

The range of per capita GNP covered in the Gruber-Vernon sample runs from about \$100 to about \$3000. For downstream exports, therefore, the average value of the term in braces applied to b_7, taking into account the range of possible trading partners j, is about 2; for upstream exports, it gets larger as the country gets richer. The sign of b_7 is positive for downstream sales, negative for upstream sales. Thus, for a country with per capita income of \$1,000, the elasticity of exports with respect to an increment in per capita income is about 1.2 for both upstream and downstream trade. This elasticity reflects the mean experience of eight high technology industries and sixteen other industries, giving each industry equal weight.

rather smaller segment of manufactures trade than the neotechnological considerations of Linder. For as a country gets richer, its export menu becomes rapidly more diversified. If Linder explains the trade between rich nations, then his arguments necessarily apply to a wider range and larger volume of goods.

Putting the matter in Linder's own phraseology, the range of potential imports expands somewhat with economic development, but the range of potential manufactured exports expands *very much more.*[57] Pakistan *already* imports a wide spectrum of manufactures, but its exports are virtually limited to textiles and leather goods. Judging from cross-section data, however, affluence diversifies the poor country export menu, rendering it more similar to world import menus. Affluence also diversifies the poor country import menu, but at a slower rate. Thus, in Table 13, parameters a_1, a_2, and a_3, representing the impact on cosine values of an increment in importing country income, are all significantly smaller than respectively b_1, b_2, and b_3, the parameters reflecting a change in exporting country income.

Obviously the proffered reconciliation demands an econometric investigation of bilateral trade composition. The reconciliation requires, among other things, that the cosines of bilateral trade become more similar as trading partners become richer. Trade vector analysis without this bilateral dimension can yield only speculation on the kinds of gain which characterize trade in manufactures.

SIMILAR CHARACTERISTICS?

What about the characteristics embodied in trade flows? Do export and import characteristics make up each other's deficiencies, or do they merely duplicate one another's qualities? Table 14 attempts to answer this question in a preliminary way by contrasting national export and import rank lists with respect to commodity characteristics. If trade compensates for national deficiencies, as each orthodox theory contends, then negative rank correlations should appear. Linder himself

[57] See M. Michaely [47, pp. 11–18]. Michaely's results cover all trade, not just manufactures. Similar results, however, should emerge from a comparative analysis of Cos X_iX_j and CosM_iM_j vectors limited to manufactured goods. See also the work of Gruber and Vernon, reported in this volume, which finds that an increase in the exporting nation's per capita income exercises a far more favorable impact on bilateral trading intensity than an increase in the importing country's income.

TABLE 14

Spearman Correlations Between Export Characteristics and Import Characteristics

Commodity Characteristic	Spearman Correlations Between Nations Ordered According to Characteristic Embodied in Exports and Characteristic Embodied in Imports
Capital per man	-.162*
Skill ratio	-.503*
Wages per man	-.183*
Scale economies	-.490*
Consumer goods ratio[a]	-.337*
First trade date	-.380*
Product differentiation	-.404*

Sources: Tables 2 and 3.

[a]See note (f) to Table A-2.

*Not significantly different from zero at the 1 per cent confidence level. With twenty-four observations, however, any coefficient greater than 0.342 in absolute value significantly differs from zero at the 10 per cent confidence level.

might agree that trade compensates for product cycle and scale economy characteristics, but he is reluctant to see either an exchange of physical capital for crude labor or an exchange of human skills [44, p. 86].

As a matter of fact, the Spearman correlations are all negative. Although none significantly differs from zero at the 1 per cent level, it is hardly coincidental that they all agree with the orthodox argument. Either through the selective workings of the marketplace, or through the deliberate imposition of trade barriers, exports and imports substantially compensate each other for skills, for scale economies, for product age, and for standardization, while the exchange of physical capital for crude labor power is limited.[58] The comparatively weak showing of Heck-

[58] Weighted rank correlations, not presented in Table 14, reinforce these conclusions. For big trading nations, there is virtually no exchange of crude capital and crude labor power, and the trade between producers' and consumers' goods is not at all robust.

TABLE A-1

Concordance between United Nations Standard International Trade Classification (SITC)[a] and United States Standard Industrial Classification (SIC)

SITC	SIC
512	2818
513	2812, 2813, 2895
514	2819
515	nil
521	2814, 2815
531	2818
532	nil
533	2816, 2851, 2893
541	2831, 2833, 2834
551	2087
553	2844
554	2841, 2842, 2843
561	2871, 2872, 2879
571	2892
581	2821
599	2861, 2891, 2899
611	3111
612	3121, 3131
613	3992
621	nil
629	3011, 3069
631	2431, 2432, 2433
632	2441, 2442, 2443, 2445, 2499, 2541
633	nil
641	2621, 2631
642	2641, 2642, 2643, 2644, 2645, 2646, 2647, 2649, 2651, 2652, 2653, 2654, 2655, 2661
651	2281, 2282, 2283, 2284
652	2211, 2261
653	2221, 2231, 2262, 2269, 2296
654	2241, 2292
655	2291, 2295, 2298, 3987
656	2299, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2399
657	2271, 2272, 2279, 3982
661	3241, 3274, 3281
662	3251, 3253, 3255, 3259
663	3271, 3272, 3291, 3292, 3293, 3295, 3296, 3297, 3299
664	3211
665	3221, 3229
666	3262, 3263
667	nil
671	3312, 3313, 3321, 3322
672	3312, 3323
673	3312
674	3312, 3316
675	3312, 3316
676	3312
677	3312, 3315
678	3317
679	3391
681	3339
682	3331, 3341, 3351, 3399
683	3339, 3399
684	3334, 3352, 3399, 3497
685	3332

(continued)

TABLE A-1 (continued)

3356 3399 **686** 3333 3356 3399 **687** 3339 3356 3399 **688** 3339 **689** 3339 **691** 3441 3442 3444 3446 3449 2542 **692** 3443 3491 **693** 3357 3481 **694** 3452 **695** 3423 3425 3429	**696** 3421 **697** nil **698** 3411 3392 3361 3362 3369 3492 3493 3496 3499 2591 3993 3964 **711** 3511 3519 **712** 3522 **714** 3571 3572 3576 3579 **715** 3541 3542 3544 3545 3548 **717** 3552	**718** 3531 3532 3533 3534 3535 3536 3537 3551 3554 3555 3559 2794 **719** 3553 3561 3562 3564 3566 3567 3569 3581 3582 3585 3586 3589 3599 **722** 3612 3613 3621 **723** 3643 3644 **724** 3651 3652 3661	3662 3671 3672 3673 3674 3679 **725** 3631 3632 3633 3634 3635 3636 3639 **726** 3693 **729** 3622 3623 3624 3629 3611 3641 3642 3691 3692 3693 3694 3699 **731** 3741 3742 **732** 3713 3715 3717	**733** 3751 3791 3799 **734** 3721 3722 3723 3729 **735** 3731 3732 **812** 3231 3261 3264 3269 3431 3432 3433 3494 3498 **821** 2511 2512 2514 2515 2519 2521 2522 2531 2599 **831** 3161 3171 3172	**841** 2251 2252 2253 2254 2256 2259 2311 2321 2322 2323 2327 2328 2329 2331 2335 2337 2339 2341 2342 2351 2352 2361 2363 2369 2381 2384 2385 2386 2387 2389 3151 **842** 2371 **851** 3021 3141 3142

(continued)

TABLE A-1 (concluded)

861	3861	**892**	**893**	3953	**899**
3811		2711	3079	3955	3199
3821	**863**	2721			3962
3822	nil	2731	**894**	**896**	3963
3831		2732	3941	nil	3981
3841	**864**	2751	3942		3983
3842	3871	2752	3943	**897**	3984
3843	3872	2753	3949	3911	3995
3851		2761		3912	
	891	2771	**895**	3913	
862	3931	2782	3951	3914	
2793		2789	3952	3961	

Note: There is no one-to-one correspondence between the two schemes. The same four-digit SIC industry frequently contributes to more than one three-digit SITC commodity, while some three-digit SITC groups find no counterpart four-digit industry. This concordance was used in estimating capital per man, wages per man, and scale economies for four-digit SITC groups. Other concordances were devised for converting the Japanese input-output data on consumer ratios, and the Census Bureau data on occupational skills, to the SITC basis. The input-output data was converted with the partial assistance of the United Nations concordance [62].

[a] SITC figures are bold face.

scher-Ohlin might be interpreted either as a modest triumph for Linder or as the inevitable outcome of restrictive tariffs and quotas. The major point, though, is that trade *does* involve some exchange of characteristics.

It would be interesting to quantify the characteristics exchanged on a bilateral basis, distinguishing between upstream and downstream trade. The speculation of the previous section, for what it is worth, suggests a shift from "tangible" factor proportions trade to "ephemeral" product cycle and scale economy commerce as the trading partners become richer and more similar.

Even a bilateral exercise, however, would leave open the question whether an exchange of "ephemeral" characteristics contributes much to welfare. Emile Despres, for example, argues that the important segment of commerce is Heckscher-Ohlin trade, and that other trade, large as it may be in volume, makes a much smaller welfare contribution per dollar of traffic.[59] Whether product cycle, scale economy, and other forms of interstitial commerce have redeeming qualities in spurring the diffusion of techniques, enhancing productivity, and curbing the power of local monopolies, is a question that might be debated for a very long time.

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[59] This view was offered by Professor Despres at a Stanford Seminar, October 1968. S. B. Linder takes a similar position [44, p. 140].

TABLE A-2

Characteristics of Traded Goods

SITC Two-Digit Division or Three-Digit Group[a]		Capital per Man[b]	Skill Ratio[c]	Wages per Man[d]	Scale Econ-omies[e]	Consumer Goods Ratio[f]	First Trade Date[g]	Product Differen-tiation[h]
51	**Chemical elements and compounds**	**36,213**	**.1564**	**7,684**	**.041**	**.105(.293)**	**1946.4**	**.8934**
512	Organic chemicals	40,058		7,921	.086	.136	1947.2	.9175
513	Inorganic chemicals: elements, etc.	26,166		6,913	-.074	.035	1943.0	.7741
514	Other inorganic chemicals	26,371		7,318	-.058	.035	1943.2	1.1162
515	Radioactive materials	26,371*		7,318*	.000*	.035*	1953.4	2.4360
52	**Mineral tar and crude chemicals from coal, petroleum, natural gas**	**24,188**	**.1564**	**7,287**	**.027**	**.301(.293)**	**1940.0**	**.8008**
521	Mineral tar and crude chemicals from coal, petroleum, natural gas	24,188		7,287	.027	.301	1940.0	.8008
53	**Dyeing, tanning, coloring materials**	**13,395**	**.1075**	**7,031**	**.060**	**.091(.291)**	**1938.8**	**.9122**
531	Synthetic organic dyestuffs, etc.	13,395*		7,921	.086	.048	1945.7	.9505
532	Dyeing and tanning extracts	13,385*		6,563*	.047*	.048*	1945.1	.4875
533	Pigments, paints, varnishes	13,395		6,563	.047	.138	1935.3	.9093
54	**Medicinal and pharmaceutical products**	**13,646**	**.1926**	**6,806**	**.083**	**.804(.854)**	**1950.5**	**1.4745**
541	Medicinal and pharmaceutical products	13,646		6,806	.083	.804	1950.5	1.4745

55	**Essential oils, perfume materials, toilet and cleansing goods**	**19,506**	**.1564**	**6,273**	**.185**	**.804*(.854)**	**1940.5**	**.7488**
551	Essential oils, perfume, flavor materials	42,967		6,217	.194	.804*	1948.6	.7454
553	Perfumery and cosmetics	10,000		5,342	.240	.804*	1930.1	.2990
554	Soaps, cleansing, polishing preparations	8,223		6,692	.158	.804*	1943.0	.7618
56	Manufactured fertilizers	**17,103**	**.1564**	**4,980**	**.076**	**.141(.293)**	**1933.2**	**.4791**
561		17,103		4,980	.076	.141	1933.2	.4791
57	Explosives and pyrotechnic products	**7,703**	**.1564**	**6,190**	**-.079**	**.170(.293)**	**1942.6**	**1.2713**
571		7,703		6,190	-.079	.170	1942.6	1.2713
58	Plastic materials, regenerated cellulose and artificial resins	**24,788**	**.1564**	**7,126**	**.009**	**.257(.212)**	**1954.6**	**.9093**
581		24,788		7,126	.009	.257	1954.6	.9093
59	Chemical materials and products, n.e.s.	**19,489**	**.1564**	**6,094**	**.059**	**.505(.293)**	**1945.5**	**.7512**
599		19,489		6,094	.059	.505	1945.5	.7512
61	**Leather, leather mfg., and dressed fur**	**5,195**	**.0171**	**5,907**	**.104**	**.841(.691)**	**1934.9**	**.5898**
611	Leather	4,586		5,201	-.058	.767	1935.3	.5896
612	Manufactures of leather	3,081		4,030	.060	.860	1931.9	.5896*
613	Fur skins	6,923		7,728	.400	.860*	1935.0	.5903

(continued)

TABLE A-2 (continued)

SITC Two-Digit Division or Three-Digit Group[a]		Capital per Man[b]	Skill Ratio[c]	Wages per Man[d]	Scale Economies[e]	Consumer Goods Ratio[f]	First Trade Date[g]	Product Differentiation[h]
62	**Rubber manufacturers, n.e.s.**	**9,361**	**.0604**	**6,356**	**.011**	**.316(.506)**	**1947.8**	**.7467**
621	Materials of rubber	9,361*		6,356*	.011*	.316*	1949.0	.8769
629	Articles of rubber	9,361		6,356	.011	.316	1947.5	.7106
63	**Wood and cork manufacturers**	**4,086**	**.0149**	**4,525**	**.013**	**.201(.223)**	**1946.1**	**.8468**
631	Veneers, plywood boards, etc.	4,087		4,933	.029	.058	1947.9	.6834
632	Wood manufactures, n.e.s.	4,086		4,340	.006	.482	1946.2	.9511
633	Cork manufactures	4,086*		4,340*	.006*	.482*	1934.3	.8320
64	**Paper, paperboard, and manufactured paper products**	**23,383**	**.0390**	**6,541**	**.088**	**.229(.285)**	**1948.8**	**.8487**
641	Paper and paperboard	26,456		6,740	.101	.215	1949.2	.8279
642	Articles made of paper pulp, paper or paperboard	7,558		5,516	.018	.272	1946.5	.9943
65	**Textile yarn, tabrics, made-up goods**	**6,437**	**.0208**	**4,083**	**-.001**	**.604(.603)**	**1948.1**	**.5367**
651	Textile yarn and thread	6,452		3,500	.066	.677	1950.9	.4592
652	Cotton fabrics, woven	6,077		3,832	-.050	.677*	1952.6	.4774
653	Other textile fabrics, woven	7,178		4,325	-.034	.677*	1946.9	.5954

654	Tulle, lace, embroidery, etc.	5,018		3,972	-.004	.677*	1941.4	.6057
655	Special textile fabrics	7,097		5,218	.011	.440	1945.9	.6167
656	Made-up textile articles	2,903		3,940	-.014	.634	1943.6	.5873
657	Floor coverings, tapestries, etc.	12,925		4,566	.052	.449	1936.9	.5132
66	**Nonmetallic mineral manufactures, n.e.s.**	**14,561**	**.0500**	**5,163**	**.048**	**.142(.380)**	**1945.6**	**.7826**
661	Lime, cement, building materials	41,009		6,401	-.055	.022	1936.1	.6718
662	Clay construction materials	8,862		4,937	.023	.008	1945.3	.7651
663	Mineral manufactures, n.e.s.	8,851		5,660	.051	.043	1945.2	.7681
664	Glass	21,623		7,553	.039	.209	1946.4	.9109
665	Glassware	9,724		5,462	.112	.242*	1945.9	.6279
666	Pottery	2,206		4,498	.034	.242	1944.7	.6015
667	Pearls, precious, semiprecious stones	2,206*		4,498*	.034*	.242*	1947.7	.8435
67	**Iron and steel**	**22,547**	**.0502**	**7,188**	**.069**	**.027(.125)**	**1948.5**	**.6959**
671	Pig iron, sponge iron, ferro-alloys, etc.	20,541		7,116	.082	.004	1942.2	.6917
672	Ingots and other primary forms	22,722		7,307	.035	.027	1949.4	.5479
673	Bars, rods, angles, shapes	24,455		7,414	.058	.027	1941.5	.6916
674	Universals, plates, and sheets	24,581		7,410	.124	.027	1951.0	.5159
675	Hoop and strip	24,581		7,410	.124	.027	1949.3	.6101
676	Rails and track construction material	24,455		7,414	.058	.027	1945.2	.5494

(continued)

TABLE A-2 (continued)

SITC Two-Digit Division or Three-Digit Group[a]		Capital per Man[b]	Skill Ratio[c]	Wages per Man[d]	Scale Economies[e]	Consumer Goods Ratio[f]	First Trade Date[g]	Product Differentiation[h]
677	Wire, excluding wire rod	24,189		7,371	.019	.027	1941.6	.6908
678	Tubes, pipes, and fittings	20,000		6,688	.039	.027	1950.4	.8713
679	Castings and forgings, unworked	16,777		7,157	-.004	.027	1939.5	1.3266
68	**Nonferrous metals**	**20,915**	**.0735**	**6,634**	**-.079**	**.092(.152)**	**1942.3**	**.6360**
681	Silver, platinum	29,216		6,825	-.298	.042	1938.6	.3357
682	Copper	18,743		6,494	-.067	.101	1938.6	.5589
683	Nickel	29,300		6,476	-.104	.042	1951.1	.6729
684	Aluminum	20,607		6,911	-.032	.142	1947.0	.7498
685	Lead	21,261		6,509	-.022	.042	1945.7	.6040
686	Zinc	20,545		6,434	-.024	.042	1946.9	.7365
687	Tin	23,235		6,603	-.068	.042	1947.8	.3390
688	Uranium and thorium	29,216		6,825	-.298	.042	1958.1	.2650
689	Miscellaneous nonferrous metals	29,216		6,825	-.298	.042	1951.3	.9489
69	**Manufactures of metals, n.e.s.**	**6,974**	**.0966**	**5,935**	**.028**	**.288(.378)**	**1945.6**	**1.1631**
691	Finished structural parts and structures	4,917		5,786	.005	.017	1944.2	.8109
692	Metal containers for storage, transport	5,602		6,222	.041	.017	1948.6	1.3287

693	Wire products and fencing grilles	10,402		5,698	-.008	.334	1945.4	.8969
694	Nails, screws, nuts, bolts, rivets	8,160		6,441	-.023	.334	1931.3	2.0906
695	Tools for hand or machine	6,425		5,890	.071	.334	1949.2	1.2815
696	Cutlery	13,475		5,448	.174	.334	1941.9	.5900
697	Household equipment	8,823*		5,448*	.011*	.334	1941.3	.5870
698	Metal manufactures, n.e.s.	8,823		5,925	.011	.334	1946.5	1.0341
71	**Machinery, other than electric**	**7,595**	**.0913**	**6,485**	**.044**	**.116(.112)**	**1948.6**	**1.0199**
711	Power generating machinery	77,702		7,036	.084	.039	1949.8	.9855
712	Agricultural machinery	9,867		6,120	.062	.039*	1950.7	.5654
714	Office machines	7,894		6,889	.030	.039*	1946.1	.5958
715	Metalworking machinery	7,247		7,111	.031	.003	1948.6	1.3156
717	Textile and leather machinery	5,222		5,455	.003	.026	1939.0	1.1986
718	Machines for special industries	6,738		6,598	.030	.018	1948.3	1.2200
719	Machinery and appliances, n.e.s.	7,362		6,216	.036	.245	1950.8	1.2075
72	**Electrical machinery, appliances**	**5,627**	**.1523**	**6,068**	**.063**	**.061(.494)**	**1947.8**	**1.3671**
722	Electric power machinery, switchgear	6,586		6,231	.081	.033	1951.4	1.7492
723	Equipment for distributing electricity	4,865		5,364	.031	.033	1948.1	.8825
724	Telecommunications apparatus	3,868		6,294	.031	.033	1948.7	.9608
725	Domestic electrical equipment	5,894		5,922	.096	.527	1948.8	.5320
726	Electrical apparatus for medical purposes	6,613		7,064	.073	.071	1944.7	.5320*

(continued)

TABLE A-2 (continued)

SITC Two-Digit Division or Three-Digit Group[a]		Capital per Man[b]	Skill Ratio[c]	Wages per Man[d]	Scale Econ-omies[e]	Consumer Goods Ratio[f]	First Trade Date[g]	Product Differen-tiation[h]
729	Other electrical machinery, apparatus	5,839		5,874	.064	.071	1945.6	1.5192
73	**Transport equipment**	**9,328**	**.1218**	**7,399**	**.137**	**.099(.338)**	**1951.1**	**.7886**
731	Railway vehicles	8,182		6,689	.011	.118	1948.6	.8476
732	Road motor vehicles	12,264		7,486	.058	.077	1951.1	.5504
733	Road vehicles, nonmotor	2,811		4,861	.110	.236	1948.5	.5108
734	Aircraft	4,460		7,469	.304	.086	1951.7	1.0225
735	Ships and boats	5,305		6,440	.006	.106	1949.5	1.3093
81	Sanitary, plumbing, heating and lighting fixtures	**9,593**	**.0455**	**5,827**	**.065**	**.242(.256)**	**1946.0**	**.9592**
812		9,593		5,827	.065	.242	1946.0	.9592
82	Furniture	**3,470**	**.0197**	**4,408**	**.032**	**.326(.556)**	**1947.3**	**.5360**
821		3,470		4,408	.032	.326	1947.3	.5360
83	Travel goods, handbags, and similar articles	**1,217**	**.0138**	**3,720**	**.031**	**.860(.957)**	**1936.6**	**.6300**
831		1,217		3,720	.031	.860	1936.6	.6300

84	**Clothing**	**1,329**	**.0102**	**3,098**	**-.096**	**.878(.945)**	**1945.5**	**.5273**
841	Clothing except fur	1,316		3,051	-.097	.878	1945.7	.5137
842	Fur clothing	2,151		6,017	-.032	.834	1928.8	1.0717
85	Footwear	**1,443**	**.0066**	**3,653**	**.052**	**.985(.957)**	**1927.7**	**.6060**
851		1,443		3,653	.052	.985	1927.7	.6060
86	**Instruments, photographic goods, watches**	**6,619**	**.1622**	**6,300**	**.038**	**.689(.444)**	**1948.8**	**1.6355**
861	Scientific, medical, optical instruments	5,982		5,958	.034	.689	1948.7	1.2224
862	Photographic supplies	10,308		7,674	.060	.800*	1948.6	1.9434
863	Developed cinema film	10,308*		7,674*	.060*	.800*	1958.1	1.0325
864	Watches and clocks	5,354		5,306	-.013	.662	1943.8	1.1907
89	**Miscellaneous manufactures,n.e.s.**	**4,845**	**.0730**	**5,004**	**.060**	**.526**	**1947.9**	**1.3152**
891	Musical instruments, sound recorders	3,731		5,126	.089	.527	1950.9	1.5929
892	Printed matter	5,681		6,039	.034	.512	1947.1	1.3470
893	Plastic articles	6,314		5,037	.078	.527	1950.6	.5983
894	Perambulators, toys, sporting goods	3,988		4,076	.090	.527	1947.5	.7867
895	Office and stationery supplies	4,620		5,056	.066	.527	1944.4	.9424
896	Works of art, collectors' pieces	2,824*		4,798*	.032*	.527	1941.6	.9424*
897	Jewelry, goldsmiths' wares	2,824		4,798	.032	.527	1950.6	.9424*
899	Manufactured articles, n.e.s.	6,989		4,359	.055	.527	1944.2	.7360

(continued)

TABLE A-2 (concluded)

SITC Two-Digit Division or Three-Digit Group[a]		Capital per Man[b]	Skill Skill Ratio[c]	Wages per Man[d]	Scale Econ-omies[e]	Consumer Goods Ratio[f]	First Trade Date[g]	Product Differen-tiation[h]
Selected Products Not Included In the Statistical Analysis								
013	Canned, prepared meat	7,840	.0179	5,955	.027	.996	1940.8	.4205
032	Canned, prepared fish	6,012	.0330	3,837	.081	.995	1943.9	.3576
046	Meal, flour, of wheat, maslin	11,588	.0180	6,183	.170	.976	1933.9	.2198
047	Meal, flour, of cereals, n.e.s.	13,256	.0180*	4,759	.244	.976	1938.9	.2620
048	Cereal preparations	7,529	.0180*	5,507	.135	.976	1934.5	.4364
053	Preserved fruit	7,937	.0330	3,993	.121	1.000	1941.3	.2617
055	Preserved vegetables	7,986	.0330	4,045	.119	1.000	1938.8	.4571
061	Sugar and honey	22,625	.0156	5,913	-.135	.715	1937.7	.4667
062	Sugar confectionery	5,498	.0156*	4,345	.144	1.000	1924.4	.6005
091	Margarine, shortening	19,852	.0452	6,558	-.039	1.000*	1943.6	.2640
111	Nonalcoholic beverages	7,428	.0277*	5,033	.089	.999	1939.3	.3705
112	Alcoholic beverages	18,869	.0277	7,101	.142	.996	1925.6	.4948
122	Tobacco manufactures	9,735	.0221	4,463	.153	1.000	1935.3	.1780
231.2	Synthetic rubber	35,683	.1564	7,733	na	.252	1954.6	.4298
242	Wood shaped, worked roughly	10,629	.0122	3,880	.081	.042	1948.3	.4511
251	Pulp, waste paper	36,821	.0620	7,099	na	.038	1942.2	.2267
266	Synthetic, regenerated fibers	24,867	.1124	6,193	.491	.462	1952.1	.3834
332	Petroleum products	21,374	.1468	6,185	-.014	.335	1939.2	.4583
421	Fixed vegetable oils, soft	18,512	.0532	5,331	.077	na	1951.2	.1889

Notes to Table A-2

[a]The descriptions here are somewhat abbreviated. Consult *Commodity Indexes for the Standard International Trade Classification, Revised* [63] for a complete description.

[b]Capital per man, measured in U.S. dollars of approximately 1963 vintage, refers to fixed plant and equipment immediately employed in making the commodity, as produced in the United States. The labor estimates represent total manufacturing employment. The capital estimates were synthesized from Leontief's 1947 estimates and the capital expenditure figures reported in various editions of *Census of Manufactures* [69]. Annual 2 1/2 per cent depreciation and 3 1/2 per cent inflation factors (both straight line) were applied to structures. Annual 5 per cent depreciation and 2 1/2 per cent inflation factors (again, straight line) were applied to equipment. The depreciation factor was first applied and the surviving plant and equipment was then inflated to 1963 values. It was assumed that the capital stock in 1947 was composed of 37 per cent structures and 63 per cent equipment; hence, given the stipulated depreciation and inflation factors, 38.3 per cent of the 1947 capital outfit was assumed to exist in 1963. Depreciation factors were based on data in Treasury Department, *Tables of Useful Lives of Depreciable Property* [75]. Inflation factors were based on indices appearing in *Statistical Abstract of the United States: 1965* [67]. The capital expenditures series were not always continuous from one year to the next, owing both to inadequate data received by the Census Bureau and to the reclassification of industries in 1958. Accordingly it was often necessary to interpolate figures and to reconstruct the series. Once labor and capital estimates were obtained, the data was reclassified according to the three-digit SITC. The two-digit estimates were obtained by weighting the three-digit estimates (excluding asterisked values) by the 1965 United States export pattern.

[c]Skill ratios refer to the percentage of the industry's labor force accounted for, in the United States, by professional, technical, and scientific personnel, The data was derived on a two-digit SITC basis, after appropriate reclassification. The basic statistics come from *U.S. Census of Population, 1960: Occupation by Industry* [70].

[d]Wages per man, measured in 1963 U.S. dollars, were derived from U.S. data by dividing the wage bill by total employees immediately occupied in making the commodity. The data was taken from the *Census of Manufactures: 1963* [69] and reclassified according to the three-digit SITC. The two-digit SITC estimates were obtained by weighting the three-digit estimates (excluding asterisked values) by the 1965 United States export pattern.

[e]Scale economies were equated with the exponent in the regression equation, $v = kn^{\alpha}$, where v is the 1963 ratio between value added in plants employing n persons and average value added for the four-

digit U.S. Census Bureau industry, and *k* is a constant. The data was taken from the *Census of Manufactures: 1963* (69). Four-digit industries were reclassified according to the three-digit SITC prior to running the regression analysis. The two-digit SITC estimates were obtained by weighting the three-digit estimates (excluding asterisked values) by the 1965 United States export pattern.

[f]After the statistical work was complete, I discovered that imports had been erroneously neglected in calculating the Japanese consumer goods ratios, and that some errors of classification had crept into the work. These shortcomings were partially remedied on an ad hoc for those three-digit SITC groups most affected, namely 512, 521, 531, 533, 541, 551, 553, 554, 561, 581, 599, 612, 613, 681, 683, 685-689, 715, 718, 719, 724, 725, 734, 812, 861, 862, 863, 892. The corrected values appear in Table A-2. However, no attempt was made to recompute the embodied characteristics appearing in Tables 2 and 3, or the subsequent statistical analyses, using the corrected values. These values would not materially alter the conclusions reached in the text. In principle, the consumer-goods ratio is measured as the percentage of commodity output and imports purchased, in Japan, by "final consumers" directly and on the "second round." "Final consumers" are defined as households plus government bodies, except when government bodies are clearly purchasing for investment purposes (as in the acquisition of transport equipment and machinery). Inventory changes and exports were netted out of total deliveries by each sector on the ground that they are divided between consumption goods and investment goods in the same ratio as other sales. The "second round" refers to the percentage of intermediate goods which find their way to final consumption after one pass through the input-output table. The consumer goods ratios were estimated from the 1960 Japanese input-output table, reclassified according to the three-digit SITC (see notes to Table A-1). The two-digit SITC estimates were obtained by weighting the three-digit estimates (excluding asterisked values) by the 1965 Japanese export pattern. Two-digit U.S. consumer-goods ratios, based on the 1958 input-output table, appear in parentheses. These were not used in the subsequent calculations. The figures in the last section of the table for "selected products not included in the statistical analysis" are approximate estimates, based on Japanese experience. The Japanese data came from *1960 Table of Industrial Relations* [23]. The United States data are based on "The Transactions Table of the 1958 United States Input-Output Table" [43].

[g]First trade dates are expressed in a decimal version of the Christian calendar. The dates were found by examining successive issues (beginning in 1917) of United States Census Bureau *Schedule B* (the detailed schedule of exportable goods) for the first appearance of specific commodities. The three-digit SITC estimates represent a simple average of all seven-digit commodities belonging to the three-digit group. The two-digit SITC estimates were obtained by weighting the three-digit estimates by the 1965 United States export pattern.

[h]Product differentiation is measured as the coefficient of variation in unit values of 1965 United States exports destined to different countries. Differentiated goods are marked by higher coefficients of variation. Coefficients on a seven-digit SITC basis were derived from *United States Exports Commodity by Country* [72]. A simple average of the seven-digit coefficients is used for the three-digit SITC estimates. The two-digit SITC coefficients were obtained by weighting the three-digit estimates by the 1965 United States export pattern.

*Asterisked values represent arbitrary extrapolation from a ''similar'' commodity group.

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TABLE A-3

Cosine Coefficients[a] between National Export and Import Vectors, Three-Digit SITC Basis

Importing Country	Exporting Country: Canada	U. S.	Austria	Belgium	Denmark	France	Germany	Italy	Nether-lands	Norway	Sweden	U. K.
Canada	.4308	.9280	.5160	.6746	.5627	.8807	.9564	.7938	.5637	.1905	.6379	.9611
United States	.7316	.6551	.6871	.8016	.3804	.7915	.6952	.7378	.6042	.4524	.6869	.7506
Austria	.3995	.8811	.5811	.6655	.6342	.8918	.9487	.8694	.6523	.2345	.6543	.9186
Belgium	.5044	.8264	.5431	.7924	.5028	.8456	.8829	.7934	.5972	.2936	.6338	.9316
Denmark	.5545	.8483	.7466	.7891	.6633	.9464	.8986	.8773	.7691	.4427	.7940	.8787
France	.4941	.8771	.7627	.7333	.7231	.8653	.8639	.8046	.7498	.3441	.7229	.8242
Germany	.5626	.7092	.8046	.7921	.5777	.8349	.7065	.8353	.7525	.3969	.6671	.7126
Italy	.4826	.8449	.7209	.6774	.6785	.8159	.8180	.7293	.7858	.3510	.6753	.7820
Netherlands	.4824	.8622	.7260	.7637	.6528	.9235	.9004	.9106	.7928	.2979	.6998	.8799
Norway	.2131	.4533	.4174	.4053	.6777	.5525	.5108	.5191	.5643	.6085	.7080	.4834
Sweden	.4229	.8797	.6512	.7604	.6533	.9410	.9454	.8994	.7093	.3083	.6907	.9177
United Kingdom	.5674	.6127	.6073	.6155	.5196	.5853	.5565	.5782	.6098	.4571	.5976	.6245
Australia	.5461	.9233	.5493	.6704	.5237	.8708	.8961	.7816	.6448	.2521	.6711	.9203
Japan	.3088	.6914	.4852	.4189	.5968	.5767	.5795	.5509	.6243	.3749	.4882	.5657
Israel	.2815	.5245	.4076	.6301	.4542	.5523	.5599	.4653	.4801	.2815	.5117	.6860
Portugal	.4145	.8188	.5727	.7793	.5422	.8673	.8938	.7617	.6262	.2233	.6137	.9184
Spain	.3450	.7757	.7420	.5450	.7409	.7166	.7539	.6578	.6675	.2917	.6304	.6729

Yugoslavia	.3663	.8015	.7374	.6828	.6874	.8543	.8464	.7485	.7083	.3360	.6627	.7836
Mexico	.4111	.9242	.5279	.5586	.6671	.8256	.9581	.7637	.5863	.2231	.6870	.8991
Hong Kong	.3388	.4956	.6029	.6472	.4472	.6330	.5285	.6091	.6495	.2425	.4593	.5963
India	.3646	.8171	.6825	.5836	.7371	.7460	.7935	.6656	.6289	.3169	.6783	.7421
Korea	.1960	.3010	.3139	.3754	.3024	.3920	.3223	.3701	.4534	.3867	.2469	.2698
Pakistan	.3403	.7603	.6479	.6026	.6757	.7666	.8034	.6766	.6752	.2995	.6481	.7403
Taiwan	.3212	.5847	.4765	.6196	.4719	.6960	.6288	.5623	.6129	.3782	.5416	.6591

	Australia	Japan	Israel	Portugal	Spain	Yugo-slavia	Mexico	Hong Kong	India	Korea	Pakistan	Taiwan
Canada	.5549	.5495	.0521	.1915	.4586	.3421	.1851	.1185	.1189	.1860	.1193	.1600
United States	.5849	.6551	.2563	.3784	.4859	.4592	.2601	.3499	.2639	.4689	.1991	.3759
Austria	.5532	.5786	.0756	.2940	.5690	.4060	.3043	.1699	.2185	.2210	.2230	.2744
Belgium	.6243	.5531	.3724	.3688	.5196	.4158	.2532	.1750	.1957	.2320	.1623	.2307
Denmark	.5896	.7563	.1031	.3396	.5669	.5352	.3137	.2206	.2476	.3456	.2462	.3428
France	.6014	.6162	.1008	.2556	.5471	.4494	.3329	.1700	.1365	.2602	.1341	.2391
Germany	.6031	.6707	.1761	.4238	.5567	.5252	.4066	.3728	.3184	.4847	.2963	.4403
Italy	.6139	.6094	.0785	.2489	.5010	.4288	.3577	.1354	.1624	.2265	.1524	.2161
Netherlands	.5669	.6998	.1213	.3756	.5189	.4909	.2891	.3401	.2393	.3765	.2412	.3948
Norway	.3158	.7783	.0580	.1749	.5572	.7611	.1912	.1704	.0970	.2031	.1037	.1757
Sweden	.6105	.6929	.0903	.3032	.5602	.4972	.2898	.2654	.1974	.3401	.1935	.2956
United Kingdom	.5569	.4677	.5361	.4647	.4893	.4663	.3313	.2209	.2139	.3133	.1760	.3533
Australia	.5535	.5640	.0698	.2826	.5015	.3751	.1952	.1497	.2059	.2174	.2406	.2494
Japan	.4267	.3765	.1879	.2368	.4752	.3533	.3334	.0741	.1364	.1082	.0842	.1382
Israel	.4095	.5052	.7998	.4322	.3222	.3474	.1787	.0498	.1133	.1158	.0660	.1356

(continued)

TABLE A-3 (concluded)

Importing Country	Exporting Country: Australia	Japan	Israel	Portugal	Spain	Yugo-slavia	Mexico	Hong Kong	India	Korea	Pakistan	Taiwan
Portugal	.6070	.6052	.3073	.3046	.4376	.3222	.2983	.0917	.1099	.2056	.1281	.2102
Spain	.4564	.5122	.0619	.1866	.3955	.3354	.2876	.0630	.0474	.1665	.0667	.1863
Yugoslavia	.5191	.6588	.0640	.2330	.4686	.3763	.2846	.0746	.1575	.2461	.1485	.2081
Mexico	.5020	.4856	.0396	.1455	.4573	.3406	.2130	.0596	.0214	.0814	.0376	.1218
Hong Kong	.3661	.5846	.4853	.6857	.4029	.4215	.2646	.4423	.2919	.4437	.3985	.5622
India	.4796	.5487	.0776	.1523	.4317	.4439	.2513	.0337	.0252	.1362	.0471	.1401
Korea	.1905	.3601	.1193	.2472	.4061	.2222	.2065	.0424	.0977	.1166	.1324	.2427
Pakistan	.4598	.5991	.0496	.1840	.4480	.4340	.2798	.0715	.0286	.1524	.0654	.1626
Taiwan	.4771	.7113	.0673	.1682	.5072	.4595	.3065	.0491	.0643	.2093	.0887	.1897

[a]The cosine coefficient is defined as:

$$\mathrm{Cos} X_i M_j = \frac{\sum_n x_{in} \cdot m_{jn}}{\sqrt{\sum_n x_{in}^2 \cdot \sum_n m_{jn}^2}},$$

where x_{in} represents exports of commodity n as a percentage of country i's total manufactures exports, and m_{jn} represents imports of commodity n as a percentage of country j's total manufactures imports.

TABLE A-4

Cosine Coefficients[a] between National Export Vectors, Three-Digit SITC Basis

	Canada	U.S.	Austria	Belgium	Denmark	France	Germany	Italy	Netherlands	Norway	Sweden	U.K.
Canada	1.0000											
United States	.4776	1.0000										
Austria	.5013	.5704	1.0000									
Belgium	.3932	.5892	.6157	1.0000								
Denmark	.2106	.6718	.6537	.3485	1.0000							
France	.4264	.8389	.7099	.8173	.5985	1.0000						
Germany	.3851	.9107	.5723	.6884	.6375	.9016	1.0000					
Italy	.3379	.7738	.6973	.6839	.6558	.8884	.8272	1.0000				
Netherlands	.3821	.6766	.6984	.5561	.6671	.7381	.6190	.7024	1.0000			
Norway	.6627	.2441	.4410	.2642	.4000	.3198	.2264	.2603	.3910	1.0000		
Sweden	.6790	.6739	.6785	.5044	.7063	.6621	.6921	.6079	.5969	.6435	1.0000	
United Kingdom	.4263	.9063	.5228	.7313	.5727	.8851	.9415	.8024	.6139	.2080	.6370	1.0000
Australia	.3960	.5271	.3909	.6166	.3011	.5917	.5629	.4681	.3969	.2255	.4215	.5846
Japan	.2515	.4942	.6356	.6611	.5724	.7434	.6025	.6929	.7426	.4463	.6276	.5913
Israel	.0402	.0632	.0829	.3329	.0584	.0992	.0593	.1083	.1335	.0562	.0402	.2559
Portugal	.1009	.1867	.3606	.3741	.2506	.3445	.1939	.4082	.4296	.1172	.1525	.3003
Spain	.2553	.4430	.4191	.4577	.4336	.5578	.4711	.5733	.5087	.3858	.4293	.4693
Yugoslavia	.2918	.3549	.4663	.3895	.5792	.4817	.3813	.5392	.4955	.5771	.5696	.3858
Mexico	.1480	.2064	.3021	.3014	.2377	.3257	.2208	.2732	.3136	.1083	.1786	.2429
Hong Kong	.0327	.0970	.3838	.2086	.2390	.2595	.1075	.4528	.2691	.0611	.0928	.1171
India	.0212	.0656	.2234	.2379	.0932	.2261	.0964	.3303	.3096	.0392	.0409	.1807
Korea	.1028	.1272	.4643	.3764	.2223	.3800	.1719	.4890	.3299	.0725	.1362	.1951
Pakistan	.0317	.0814	.2168	.2214	.0980	.2372	.0926	.2878	.3113	.0319	.0457	.1516
Taiwan	.1825	.1542	.3827	.3134	.2250	.3583	.1612	.4254	.4051	.1780	.1521	.1752

(continued

TABLE A-4 (concluded)

	Aus-tralia	Japan	Israel	Port-ugal	Spain	Yugo-slavia	Mexico	Hong Kong	India	Korea	Paki-stan	Taiwan
Australia	1.0000											
Japan	.4143	1.0000										
Israel	.1248	.1205	1.0000									
Portugal	.1538	.3899	.4864	1.0000								
Spain	.3627	.5387	.1027	.3936	1.0000							
Yugoslavia	.3949	.6449	.0806	.3328	.6039	1.0000						
Mexico	.6211	.2374	.0805	.2191	.3917	.2946	1.0000					
Hong Kong	.0627	.3322	.1049	.4910	.2793	.4025	.0748	1.0000				
India	.0669	.3976	.1257	.4409	.2384	.1373	.0687	.1321	1.0000			
Korea	.1684	.4892	.1111	.4813	.2783	.3864	.1623	.7090	.3694	1.0000		
Pakistan	.0688	.3316	.0570	.4890	.2746	.1603	.1333	.2128	.7444	.3202	1.0000	
Taiwan	.1170	.3920	.1410	.5312	.3244	.3821	.2189	.5492	.2372	.7589	.3486	1.0000

[a]The cosine coefficient is defined as in note (a) to Table A-3, except that x_{jn} replaces m_{jn}, where x_{jn} represents exports of commodity n as a percentage of country j's total manufactures exports.

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