Hitotsubashi Journal of Economics 29 (1988) 59-71. © The Hitotsubashi Academy

TRADE AND INVESTMENT BEHAVIOR IN U.S. AND JAPANESE MANUFACTURING INDUSTRIES: 1962-1981

LAWRENCE S.T. TAI AND DILEEP R. MEHTA

I. *Introduction*

Since the end of World War II, there has been an enormous growth in foreign direct investment by multinational firms. In this regard, numerous theories have been advanced to explain the existence of multinational firms. The currency premium theory [Aliber (1970)] and the risk diversification theory [(advanced by Grubel (1968), Lessard (1976), Rugman (1975), and Solnik (1974)] emphasized financial market imperfection as the motive for foreign direct investment. At the other extreme, the industrial organization theory [Hymer (1976)] and the product life cycle theory [Vernon (1966)] focused on product market imperfection as the determinant of foreign direct investment activities. Recently, the internalization theory [Dunning (1979) and Rugman (1980)] has provided a generalized framework of foreign direct investment by combining both financial market and product market imperfections.

Undoubtedly, the theory that has received the most empirical support so far is the product life cycle theory. This theory has been applied successfully to the electronics industry by Hirsch (1965), to the synthetic materials industry by Hufbauer (1966), to petrochemical products by Stobaugh (1971), and to consumer products by Wells (1969). All the studies have found that international trade patterns in these products follow those predicted by the product life cycle theory.

Despite the fact that many empirical studies concerning the validity of the product life cycle model have been conducted, these investigations were mainly concentrated on either some of the industries or even a particular industry in a certain country. The present study, on the other hand, is aimed at finding empirical evidence to substantiate the existence of trade-investment cycles of manufactured goods in different industries within a bilateral trade and investment case. Such trade-investment cycles can provide information regarding when a country switches from the position of a net exporter to that of a net importer and the lengths of the cycles. From this information, factors accounting for inter-industry differences in the lengths of the cycles can be identified.

The United States and Japan are selected as the two countries from which the trade and investment behavior are examined. The main reasons for selecting these two countries are that they are industrialized and technologically advanced, and the trade and direct investment flows between these two countries are significant.

II. *Measures of Intra-Industry Trade Patterns*

To substantiate the existence of trade-investment cycles between the United States and Japan, intra-industry trade indices are calculated. Intra-industry trade is a country's simultaneous export and import of the "same" commodity. Various methods of calculation have been proposed in analyzing trade flows.

In the present study, a modified intra-industry trade index is employed. This measure was initially suggested by Grubel and Lloyd (1975) and has subsequently been adopted by others in doing relevant empirical studies on trade flows. The original expression was

$$B_t = \frac{(X_t + M_t) - |X_t - M_t|}{X_t + M_t} \cdot 100$$

This is a systematic way in revealing total trade, where B_t lies between 0 (either $X_t=0$ or $M_t=0$) and 100 (when $X_t=M_t$). Since the main interest of this paper rests on both the magnitude and direction of commodity trade flows, this index is inadequate in meeting the requirement. In other words, if an index of $B_t=0$ is obtained, the country's position of trade flow cannot be identified; it simply does not indicate whether the country concerned is a net exporter or a net importer, because either $X_t=0$ or $M_t=0$ would result in $B_t=0$. In order that the position of a country's trade flow can clearly be indicated, some modifications on the formula of this index are necessary so that its merits in measuring trade flows can be retained while its shortcomings are eliminated.

After removing the absolute sign, we have

$$T_t = \frac{(X_t + M_t) - (X_t - M_t)}{X_t + M_t} \cdot 100$$

$$= \frac{200 M_t}{X_t + M_t}$$

By scaling the index from 200 to 100, we have

$$T_t = \frac{M_t}{X_t + M_t} \cdot 100$$

Now T_t lies in the closed interval of 0 (when $M_t=0$) and 100 (when $X_t=0$). The corresponding trade flow positions are shown below.

$T_t=0$		$T_t=50$		$T_t=100$
$M_t=0$	$X_t>M_t$	$X_t=M_t$	$X_t<M_t$	$X_t=0$

Thus, the value of the intra-industry trade index can indicate the trade position of each country at each stage of the cycle. If $T_t=0$, the United States is the sole exporter of the product; when $0<T_t<50$, Japan begins exporting to the United States, but its export is less than its import from the United States; when $50<T_t<100$, the United States' export to Japan declines steadily and is less than its import from Japan. Finally, when $T_t=100$, Japan becomes the sole exporter of the product. Hence, the trade-investment cycle begins when $T_t=0$ and ends when $T_t=100$. When $T_t=50$, this is the time that the United States switches from the position of a net exporter to that of a net importer.

III. *The SITC Two-Digit and Three-Digit Intra-Industry Trade Indices, 1962–1977*

In conducting trade flow analysis, it is usually recommended to use statistical data of exports and imports both in free on board (f.o.b.) values or both in cost, insurance and freight (c.i.f.) values so that bias can be avoided. Of the two, f.o.b. valuation is preferable since it measures the value of trade produced by manufacturers in each industry, while excluding the value added by transporters and traders. Unfortunately, trade data available are generally prepared by a country in f.o.b. values for its exports but c.i.f. values for its imports. In this respect, the measures may be biased upwards or downwards, depending upon whether exports are greater or less than imports in the aggregate.

Concerning this case, since U.S. trade data are employed, U.S. imports from Japan would somehow be overstated. However, it can be argued that the use of f.o.b. values for exports and c.i.f. values for imports is justified because the costs of insurance and transportation are usually a small percentage of the cost of goods and moreover, c.i.f. values would give the same magnitude as f.o.b. values when the margins for costs of insurance and transportation are the same for export and import goods.

The product life cycle model has been developed with a focus on manufactured goods. Thus, the following empirical analysis is applied to goods classified under SITC sections 5 through 8. There are 28 two-digit divisions and 102 three-digit groups in SITC sections 5 through 8. Due to the revisions of SITC numbers in 1962 and again in 1978, the period of analysis covers 1962 through 1977. Export and import statistics are taken from United Nations sources.

The intra-industry trade indices for each SITC division and group for the period 1962–1977 are calculated. As has been discussed earlier in this paper, to substantiate the existence of a complete trade cycle for a manufactured good, the intra-industry trade indices for each product have to start from a value of 0 and end with a value of 100. However, the period of analysis covers only 16 years; hence it cannot be expected that all products start from a value of 0 in 1962 and end with a value of 100 in 1977.

To substantiate the existence of trade cycles in manufactured goods in different industries between the United States and Japan, regression analysis is used to test for the existence of a trend line of intra-industry trade indices from 1962 to 1977. If the trade cycle model is valid, then intra-industry trade indices would show an upward trend between 1962 and 1977. Thus, the null hypothesis of a random pattern of intra-industry trade indices against the alternative hypothesis of an upward trend of these indices is tested. For each SITC two-digit group, regression of the form $T_t=b_0+b_1t$ is run, where b_0 is the intercept and b_1 is the slope coefficient of the equation. The null hypothesis will be rejected if b_1 is significantly positive. The regression results are summarized in Table 1.

TABLE 1. REGRESSION RESULTS ON SITC TWO-DIGIT INTRA-INDUSTRY TRADE INDICES

	SITC Two-Digit Division	t Value	R^2
51	Chemical Elements and Compounds	2.56*	0.32
52	Mineral Tar and Crude Chemicals	1.12	0.08
53	Dyeing, Tanning, Coloring Materials	10.10**	0.88
54	Medicinal and Pharmaceutical Products	− 3.23**	0.43
55	Essential Oils, Perfume Materials	8.53**	0.84
56	Manufactured Fertilizers	1.67	0.17
57	Explosives and Pyrotechnic Products	− 9.42**	0.86
58	Plastic Materials	4.29**	0.57
59	Chemical Materials and Products	7.22**	0.79
61	Leather, Leather Manufactures	− 0.25	0.00
62	Rubber Manufactures	2.29*	0.27
63	Wood and Cork Manufactures	−16.45**	0.95
64	Paper, Paperboard, Paper Products	− 3.77**	0.50
65	Textile Yarn, Fabrics	− 4.17**	0.55
66	Nonmetallic Mineral Manufactures	− 6.30**	0.74
67	Iron and Steel	2.43*	0.30
68	Nonferrous Metals	0.85	0.05
69	Manufactures of Metals	3.09**	6.41
71	Machinery, other than Electric	17.58**	0.97
72	Electrical Machinery, Appliances	0.74	0.04
73	Transport Equipment	12.93**	0.92
81	Sanitary, Plumbing, Heating Fixtures	− 0.84	0.05
82	Furniture	− 3.37**	0.45
83	Travel Goods, Handbags	− 2.35*	0.28
84	Clothing	− 5.11**	0.65
85	Footwear	− 5.12**	0.65
86	Instruments, Photographic Goods, Watches	3.17**	0.42
89	Miscellaneous Manufactures	− 2.63*	0.33

* significant at five percent level (3 positive and 2 negative).
** significant at one percent level (8 positive and 9 negative).

As can be seen from Table 1, the t value of b_1 is positively significant in 11 (out of 28) SITC two-digit industries. Thus, it can be concluded that trade cycles do exist in some industries but the results cannot be generalized to all industries.

To provide for an alternative way of testing the existence of trade cycles in SITC two-digit industries, the above regression analysis is again employed. However, in this case, instead of using intra-industry trade indices as the dependent variable, U.S. exports to Japan as a proportion of U.S. total trade with Japan is used. If the existence of trade cycles is supported, then the export proportions of all industries with $T_t<50$ would show a downward trend and the export proportions of all industries with $T_t>50$ would show an upward trend. Thus, for all industries with $T_t<50$ the null hypothesis of a random pattern of export proportions against the alternative hypothesis of a declining trend of these proportions is tested; and for all industries with $T_t>50$ the null hypothesis of a random pattern of export proportions against the alternative hypothesis of a rising trend of these proportions is tested. The export proportions are shown in Table 2.

The regression results indicate that for all two-digit industries with $T_t<50$, b_1 is significantly negative (t value is -7.44 which is significant at the one percent level and R^2 is 0.80) and for all two-digit industries with $T_t>50$, b_1 is significantly positive (t value is 4.12 which is significant at the one percent level and R^2 is 0.55). Hence, both null hypotheses are

TABLE 2. U.S. EXPORTS TO JAPAN AS A PROPORTION OF U.S. TOTAL TRADE WITH JAPAN, 1962–1977

Year	$T_t < 50$	$T_t > 50$
1962	0.2588	0.0632
1963	0.2344	0.0664
1964	0.2010	0.0890
1965	0.1286	0.1155
1966	0.1134	0.1180
1967	0.1572	0.1056
1968	0.1287	0.1065
1969	0.1423	0.1063
1970	0.1311	0.1276
1971	0.0775	0.1377
1972	0.0243	0.1799
1973	0.0781	0.1757
1974	0.0405	0.2102
1975	0.0388	0.1868
1976	0.0584	0.1352
1977	0.0550	0.1134

TABLE 3. RANKINGS OF TIME AND U.S. EXPORTS TO JAPAN AS A PROPORTION OF U.S. TOTAL TRADE WITH JAPAN, 1962–1977

Year	Time	$T_t < 50$	Ranking	$T_t > 50$	Ranking
1962	1	0.2588	16	0.0632	1
1963	2	0.2344	15	0.0664	2
1964	3	0.2010	14	0.0890	3
1965	4	0.1286	9	0.1155	8
1966	5	0.1134	8	0.1180	9
1967	6	0.1572	13	0.1056	4
1968	7	0.1287	10	0.1065	6
1969	8	0.1423	12	0.1063	5
1970	9	0.1311	11	0.1276	10
1971	10	0.0775	6	0.1377	12
1972	11	0.0243	1	0.1799	14
1973	12	0.0781	7	0.1757	13
1974	13	0.0405	3	0.2102	16
1975	14	0.0388	2	0.1868	15
1976	15	0.0584	5	0.1352	11
1977	16	0.0550	4	0.1134	7

rejected and it can be concluded that for industries with $T_t < 50$, U.S. export proportions showed a declining trend and for industries with $T_t > 50$, U.S. export proportions showed a rising trend, thus providing support for the existence of trade cycles in SITC two-digit manufactured goods.

To provide further evidence on the existence of trade cycles in SITC two-digit industries, Spearman rank correlation coefficients are computed for the ranking of time and the ranking of U.S. export proportions. If the existence of trade cycles is supported, then the coefficient for the ranking of time and the ranking of export proportions of all industries with $T_t < 50$ would be significantly negative and the coefficient between the ranking of time and the ranking of export proportions of all industries with $T_t > 50$ would be significantly positive. Thus, for all industries with $T_t < 50$ the null hypothesis of independent rankings between time and export proportions against the alternative hypothesis of a negative correlation of the rankings between time and export proportions is tested; and for industries with $T_t > 50$ the null hypothesis of independent rankings between time and export proportions against the alternative hypothesis of a positive correlation of the rankings between time and export proportions is tested. The rankings are shown in Table 3.

The Spearman rank correlation coefficient for the ranking of time and the ranking of export proportions of all industries with $T_t < 50$ is -0.8471 and that for the ranking of time and the ranking of export proportions of all industries with $T_t > 50$ is 0.7529. Both coefficients are significant at the one percent level. Hence, both null hypotheses are rejected and it can be concluded that for industries with $T_t < 50$ the rankings between time and U.S. export proportions are negative while for industries with $T_t > 50$ the rankings between time and U.S. export proportions are positive, thus providing further support for the existence of trade cycles in SITC two-digit manufactured goods.

IV. *The Intra-Industry Trade Indices, 1962–1977 and the Intra-Industry Direct Investment Indices, 1973–1981*

Unlike the trade statistics which provide export and import data at the SITC two-digit and three-digit levels, direct investment statistics are not given at these levels. Starting from 1973, the U.S. Department of Commerce publishes in the *Survey of Current Business* statistics of U.S. direct investment abroad and foreign direct investment in the United States, classified by country and by industry. The seven industries with direct investment data are food and kindred products, chemicals and allied products, primary and fabricated metals, nonelectrical machinery, electric and electronic equipment, transportation equipment, and other manufacturing. Food and kindred products are not considered here due to the emphasis of this study on manufactured goods, and other manufacturing are ignored because it is difficult to identify the products included in this section. Hence, direct investment data are available only for five industries which are relevent to this study.

To obtain comparable trade data, again the United Nations sources are consulted. After detailed examination it is believed that chemicals and allied products correspond to SITC section 5; primary and fabricated metals correspond to SITC divisions 67, 68, and 69; nonelectrical machinery corresponds to SITC division 71; electric and electronic equipment corresponds to SITC division 72; and transportation equipment corresponds to SITC division 73.

To substantiate the existence of trade-investment cycles in manufactured goods between the United States and Japan, intra-industry trade indices and intra-industry direct investment indices are calculated for the above-mentioned five industries. Intra-industry direct investment indices are computed on the basis of a formula very similar to that of calculating intra-industry trade indices as follows:

$$I_t = \frac{(D_t + R_t) - (D_t - R_t)}{D_t + R_t} \cdot 100$$

$$= \frac{200 R_t}{D_t + R_t}$$

Again by scaling the index from 200 to 100, we have

$$I_t = \frac{R_t}{D_t + R_t} \cdot 100$$

where D_t is the direct investment made by U.S. firms in Japan and R_t is the reverse investment made by Japanese firms in the United States.

As has been done previously, intra-industry trade indices are calculated for the period 1962–1977. Since comparable direct investment data are available only for five industries from 1973 to 1981, intra-industry direct investment indices are calculated for this period. These indices are plotted in the appendix.

As can be seen from the figures, for chemicals and allied products, primary and fabricated metals, and nonelectrical machinery, there is evidence supporting the existence of trade-investment cycles between the United States and Japan. For chemicals and allied products the United States maintains the advantage in both trade and direct investment; that is, the United States exports to (and invests in) Japan more than its import (and direct investment) from Japan. For primary and fabricated metals, on the contrary, Japan has the advantage in both trade and direct investment; that is, Japan exports to (and invests in) the United States more than its import (and direct investment) from the United States. For nonelectrical machinery the United States has shifted from the position of a net exporter (vis-a-vis Japan) to that of a net importer in 1971, while its direct investment in Japan is still greater than Japan's direct investment in the United States.

There is also evidence of the existence of trade-investment cycles in electric and electronic equipment and in transportation equipment. For electric and electronic equipment Japan maintains the advantage in trade while the United States has the advantage in direct investment; there has been no direct investment from Japan to the United States. Finally, for transportation equipment the United States shifted from the position of a net exporter to that of a net importer in 1963 while it still maintains the advantage in direct investment; there has been no direct investment from Japan to the United States.

To provide a statistical test for the existence of investment cycles in manufactured goods of the five industries, the procedure previously used for testing the validity of the trade cycle model by testing the existence of a positive trend of intra-industry trade indices is employed. In this case, intra-industry direct investment indices are used. The regression results are summarized in Table 4. Note that there are only three industries with meaningful direct investment indices to be tested.

As can be observed from Table 4, the t value of the slope coefficient is significantly posi-

TABLE 4. REGRESSION RESULTS ON INTRA-INDUSTRY DIRECT INVESTMENT INDICES OF THREE INDUSTRIES

Industry	t Value	R^2
Chemicals and Allied Products	6.52**	0.88
Primary and Fabricated Metals	2.35‡	0.65
Nonelectrical Machinery	4.07*	0.85

* significant at five percent level
** significant at one percent level
‡ significant at six percent level

tive at the one percent level for chemicals and allied products, at the five percent level for nonelectrical machinery, and at the six percent level for primary and fabricated metals. Thus, the existence of investment cycles in manufactured goods is supported.

Due to the lack of direct investment data at a lower level of aggregation, it is not possible to test the validity of the trade-investment cycle model beyond what has been done here. Nevertheless, with the available data the empirical evidence lends support to the existence of trade-investment cycles in manufactured goods between the United States and Japan.

V. *Factors Explaining Why Different Industries Have Trade-Investment Cycles of Different Lengths*

There are four possible factors that could affect the length of a product's trade-investment cycle: R & D expenditure, tariff, experience effect, and product standardization. This section examines empirically whether these factors can account for inter-industry differences in the lengths of the trade-investment cycles.

The data which will be used are Japanese tariff, scale economies, product standardization, and skill ratio of all manufactured goods at the SITC three-digit level. The data on Japanese tariff are taken from Hawkins (1972) while the data on scale economies, product standardization, and skill ratio are taken from Hufbauer (1970). Hufbauer's procedure for deriving scale economies is as follows. Value added per man is compared with establishment size, using the regression equation $v=kn^{\alpha}$, where 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; 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 0.10, for example, indicates that a doubling of plant size would increase output per man by roughly 10 percent. In this study, scale economies is used as a proxy for experience effects; an increase in output per man can be regarded as having the same effect on a firm as a reduction in production cost. Product standardization is defined as the standard deviation of U.S. export unit values for shipments of a product to different countries divided by the unweighted mean of these unit values. The use of country destination for distinguishing between shipments is dicated by available data. If a product is standardized, presumably the unit values of different shipments would be similar. Finally, skill ratio refers to the percentage of an industry's labor force accounted for, in the United States, by professional, technical, and scientific personnel. This ratio is used as a proxy for R & D expenditures because it is impossible to obtain data on R & D expenditures at the SITC three-digit level.

Table 5 presents the length of cycle, Japanese tariff, scale economies, product standardization, and skill ratio of the 18 SITC three-digit manufactured goods which lend support to the existence of trade cycles. These 18 manufactured goods are selected on the criteria that the intra-industry trade indices for each product start from a value of less than 50 in 1962 and end with a value of greater than 50 in 1977 and that the intra-industry trade indices for each product show an upward trend between 1962 and 1977. As has been mentioned earlier in this paper, since the analysis covers only 16 years, it cannot be expected that all products show complete cycles during this period of time. Hence, the time it takes from the first trade date of a product to the switching of the United States from a net exporter to

TABLE 5. CHARACTERISTICS OF SELECTED SITC THREE-DIGIT GOODS

SITC No.	Length of Cycle	Japanese Tariff	Scale Economies	Product Standardization	Skill Ratio
512	22.4	8.7	0.086	0.9175	0.1564
531	22.3	5.2	0.086	0.9505	0.1075
611	35.1	10.9	−0.058	0.5896	0.0171
663	29.2	8.5	0.051	0.7681	0.0500
682	29.9	9.2	−0.067	0.5589	0.0735
692	20.5	10.7	0.041	1.3287	0.0966
711	26.0	9.0	0.084	0.9855	0.0913
712	22.7	9.0	0.062	0.5654	0.0913
714	24.8	9.0	0.030	0.5958	0.0913
715	25.6	9.0	0.031	1.3156	0.0913
718	28.1	9.0	0.030	1.2200	0.0913
719	20.4	9.0	0.036	1.2075	0.0913
722	14.8	9.9	0.081	1.7492	0.1523
731	17.0	6.2	0.011	0.8476	0.1218
735	13.4	6.2	0.006	1.3093	0.1218
862	27.4	14.3	0.060	1.9434	0.1622
892	24.3	7.1	0.034	1.3470	0.0730
895	19.8	7.1	0.066	0.9424	0.0730

Sources: Hawkins (1972) and Hufbauer (1970).

a net importer is defined as the length of the cycle. First trade dates of the 18 SITC three-digit goods are taken from Hufbauer (1970) while the switching dates are obtained when the index of each good is 50.

To examine whether the four factors can explain inter-industry differences in the lengths of the cycles, five industries are distinguished and the average values of the five variables are calculated. The five industries are chemicals and allied products, primary and fabricated metals, nonelectrical machinery, electric and electronic equipment, and transportation equipment. Table 6 summarizes these values.

As can be observed from Table 6, there is a positive relationship between length of cycle and Japanese tariff, a positive relationship between length of cycle and scale economies, a negative relationship between length of cycle and product standardization, and a negative relationship between length of cycle and skill ratio. These observations are consistent with the implications provided by the product life cycle model. The higher the Japanese tariff, the longer it takes to export to Japan and hence the longer the cycle; the larger the scale economies, the longer the duration of the U.S. cost advantage and thus the longer the cycle; the more standardized a particular product is, the easier it will be imitated by Japan and hence the shorter the cycle; and finally the more research-intensive a particular industry is, the shorter it takes to export abroad and thus the shorter the cycle.

To provide statistical support for the above four observations, regression analysis is used to test four hypotheses: (1) there is a positive relationship between length of cycle and Japanese tariff, (2) there is a positive relationship between length of cycle and scale economies, (3) there is a negative relationship between length of cycle and product standardization, and (4) there is a negative relationship between length of cycle and skill ratio. For statistical validity, all 18 SITC three-digit manufactured goods are used in the regression analysis. The length of cycle is regressed against Japanese tariff, scale economies, product standardization, and skill ratio for each SITC group. The regression results are summarized in Table 7.

TABLE 6. CHARACTERISTICS OF MANUFACTURED GOODS IN FIVE INDUSTRIES

Industry	Length of Cycle	Japanese Tariff	Scale Economies	Product Standardization	Skill Ratio
Chemical	22.35	8.49	0.0563	0.9427	0.1495
Metal	25.20	9.59	−0.0152	0.7818	0.0725
Nonelectrical Machinery	24.60	9.00	0.0394	1.0098	0.0913
Electronic Equipment	14.80	9.90	0.0627	1.0293	0.1523
Transportation	15.20	6.20	0.0978	0.8481	0.1218

TABLE 7. REGRESSION RESULTS ON FACTORS ACCOUNTING FOR INTER-INDUSTRY DIFFERENCES IN THE LENGTHS OF THE TRADE CYCLES

Variable	Regression Coefficient	*t* value
Japanese Tariff	1.61	3.41*
Scale Economies	1.35	0.06
Product Standardization	−3.76	−1.26
Skill Ratio	−76.90	−2.32*
	F value=6.47**	
	R^2 =0.67	

* significant at five percent level
** significant at one percent level

As shown in Table 7, all the variables have the expected signs. The F value is significant at the one percent level. The R^2 is 0.67 which suggests that 67 percent of the variations in the length of cycle is explained by the four independent variables. The t values for Japanese tariff and skill ratio are significant at the five percent level.

The fact that scale economies is not a significant variable in explaining the length of cycle is probably due to examining the length of cycle from the point of view of the United States only. From Japan's point of view, the larger the scale economies of a particular product is, the shorter it takes the Japanese producers to reduce the production cost and export the product back to the United States. Hence, the length of the cycle is shortened. This would neutralize the effect of lengthening the cycle from the impact of scale economies on U.S. production cost advantage. On the other hand, the reason why product standardization is not a significant variable in affecting the length of cycle is probably due to the fact that only part of the cycle is examined in this paper, i.e., the trade and investment between the United States and Japan. Product standardization could be a significant variable in explaining the length of cycle between Japan and a developing country because a product becomes more standardized when a developing country is able to produce it.

VI. *Conclusion*

The objectives of this paper have been to examine the trade and investment behavior in manufacturing industries between the United States and Japan by substantiating the existence of trade-investment cycles and to explain inter-industry differences in the lengths of trade-investment cycles. The empirical results indicate that the existence of trade-investment cycles is supported and that two factors (i.e., tariff and R & D intensity) have been fou nd to be important in explaining inter-industry differences in the lengths of the trade-investment cycles. For example, the reasons why the nonelectrical machinery industry has a longer cycle than the chemical industry are because Japan imposes a higher import tariff on nonelectrical machinery products than on chemical products and the nonelectrical machinery industry is less research intensive than the chemical industry.

THE CHINESE UNIVERSITY OF HONG KONG AND GEORGIA STATE UNIVERSITY

REFERENCES

Aliber, Robert Z. (1970), "A Theory of Direct Foreign Investment," *The International Corporation*, ed. by Charles Kindleberger, Cambridge, Mass., MIT Press.

Dunning, John H. (1979), "Explaining Changing Patterns of International Production: In Defence of the Eclectic Theory," *Oxford Bulletin of Economics and Statistics* 41 (November), pp. 269–295.

Grubel, Herbert G. (1968), "Internationally Diversified Portfolios: Welfare Gains and Capital Flows, *American Economic Review* 58 (December), pp. 1299–1314.

Grubel, Herbert G., and Llyod, P.J. (1975), *Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products*, London, MacMillan Press.

Hawkins, Robert G. (1972), "Tariffs and Tariff Structures: An International Comparison," *The United States and International Markets: Commercial Policy Options in an Age of Controls*, by Robert G. Hawkins and Ingo Walter, Lexington, Mass., D.C. Health and Company.

Hirsch, Seev. (1965), "The United States Electronics Industry in International Trade," *National Institute Economic Review*, No. 34 (November).

Hufbauer, G.C. (1966), *Synthetic Materials and the Theory of International Trade*, Cambridge, Mass., Harvard University Press.

Hufbauer, G.C. (1970), "The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods," *The Technology Factor in International Trade*, ed. by Raymond Vernon, New York, National Bureau of Economic Research.

Hymer, Herbert S. (1976), *The International Operations of National Firms: A Study of Direct Foreign Investment*, Cambridge, Mass., MIT Press.

Lessard, Donald R. (1974), "World, National, and Industry Factors in Equity Returns," *Journal of Finance* 29 (May), pp. 379–391.

Linnemann, Hans. (1966), *An Econometric Study of International Trade Flows*, Amsterdam, North-Holland Publishing Company.

Michaely, Michael (1962), *Concentration in International Trade*, Amsterdom, North-Holland Publishing Company.

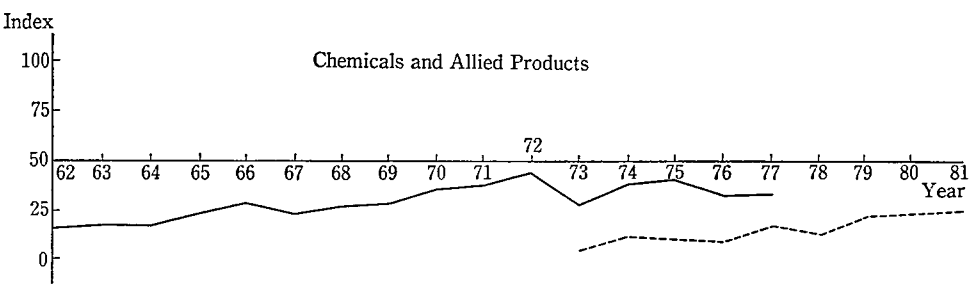
Rugman, Alan M. (1975), "Motives for Foreign Investment: The Market Imperfections and Risk Diversification Hypotheses," *Journal of World Trade Law* 9 (September/October), pp. 567–573.

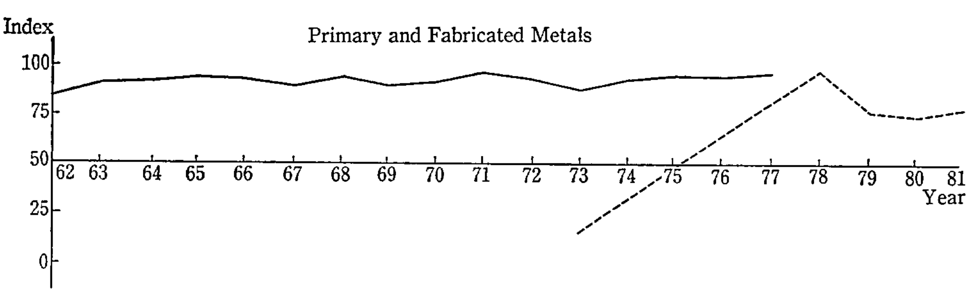
Rugman, Alan, M. (1980), "Internalization as a General Theory of Foreign Direct Investment: A Re-Appraisal of the Literature," *Weltwirtschaftliches Archiv* 116, (No. 2), pp. 365–379.

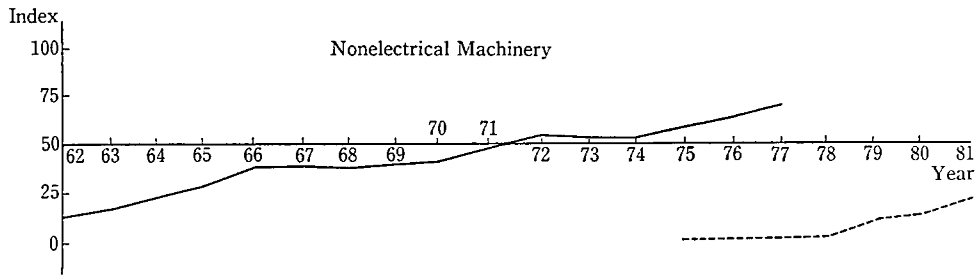
Solnik, Bruno H. (1974), "Why Not Diversify Internationally Rather than Domestically?" *Financial Analysts Journal* 30 (July/August), pp. 48–54.
Stobaugh, Robert B. (1971), "The Neotechnology Account of International Trade: The Case of Petrochemicals," *Journal of International Business Studies* 2 (Fall), pp. 41–60.
United Nations (1962–1977), *Commodity Trade Statistics*, New York, United Nations.
U.S. Department of Commerce (1973–1981), *Survey of Current Business*, Washington, D.C., U.S. Government Printing Office.
Verdoorn, P.J. (1963), "The Intra-Bloc Trade of Benelux," *Economic Consequences of the Size of Nations*, ed. by E.A.G. Robinson, London, MacMillan.
Vernon, Raymond (1966), "International Investment and International Trade in the Product Cycle," *Quarterly Journal of Economics* 80 (May), pp. 190–207.
Wells, Louis T., Jr. (1969), "Test of a Product Cycle Model of International Trade: U.S. Exports of Consumer Durables," *Quarterly Journal of Economics* 83 (February), pp. 152–162.

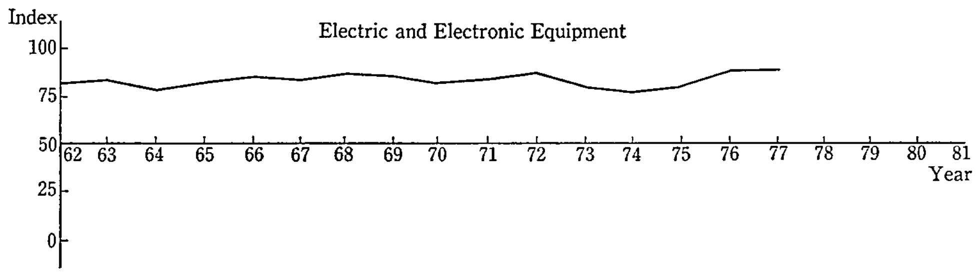
Appendix

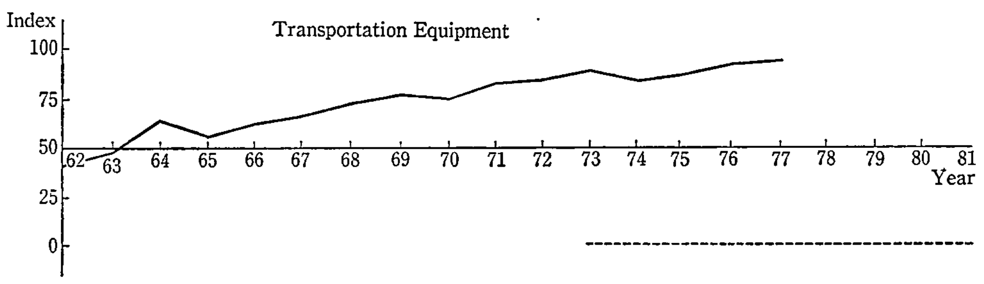
Graphs of Intra-Industry Trade Indices of Selected Industries' Products between the United States and Japan, 1962–1977, and Intra-Industry Direct Investment Indices of Selected Industries' Products between the United States and Japan, 1973–1981






Index
100
75
50
25
0
Nonelectrical Machinery
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81
Year


Index
100
75
50
25
0
Electric and Electronic Equipment
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81
Year


Index
100
75
50
25
0
Transportation Equipment
62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81
Year