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SOURCES OF CHANGES IN FACTOR INTENSITY OF TRADE

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Abstract

The factor proportions hypothesis of trade theory has been the subject of a large number of empirical tests but few of them have analyzed the changes in the factor content of trade in a country over time or across countries.

This study analyzes the changes in factor intensity of trade in Mexico, Japan, Korea, Taiwan and Israel during the 1960s. It traces back the changes in capital-labor ratios in the production of exports and import substitutes to variations in the sectoral composition of trade, changes in factor-output ratios (labor and capital), and changes in input-output coefficients.

I. Introduction

Following the seminal work of Leontief (1953) on U.S. trade, a number of studies have examined the factor intensity of foreign trade and its changes over time for various countries in an attempt to test the validity of the "factor content version" of the Hecksher-Ohlin theorem on the structure of foreign trade. 1/ Although this method has been shown not to be a valid test of the Hecksher-Ohlin theorem (Leamer 1980), measures of the factor intensity of trade are still useful in describing a country's trade structure. In previous studies, factor intensity measures for a country for a given period have not always been consistent with the factor endowments of that country. Changes in factor intensity, however, do seem to be consistent with changes in factor endowments. 2/

In spite of the interest in analyzing the levels and changes in the factor intensity of trade, very few studies have investigated the causes of these changes over time. Weiser (1968) examined the causes of changes in labor requirements of exports and imports in the United States between 1947 and 1962 by explicitly decomposing these changes into various factors in two steps in a discrete time period framework. He first decomposed the variation in labor requirements into the changes in production structure, trade pattern, and interaction of the two factors, and then further decomposed the changes in production structure into the changes in labor-output ratios and in input-output coefficients. The changes in production and trade structures each contributed about 40 percent, while the interaction factor accounted for about 20 percent. In the second step, the changes in labor-output and in input-output coefficients contributed about 60 and 40 percent respectively. Hong (1981) analyzed the causes of changes in the Korean trade structure during the 1966-73 period by applying basically the same method as Weiser (although

Hong's method is less direct). He found that on average 92 percent of the increase in capital-labor intensity in Korean export production was due to changes in production structure and 8 percent to changes in export composition. 3/ Heller (1976) applied a method similar to Hong's to the Japanese trade structure between 1956 and 1968 without explicitly computing contributions of factors; he found that the increases in the capital intensity of the Japanese exports were attributable both to changes in export composition and to the increase in capital intensity of the production process.

In this paper we examine the changes in the factor intensity of trade and their sources for Israel (1958-72), Japan (1960-70), Korea (1963-73), Mexico (1960-70), and Taiwan (1961-71) by applying a decomposition method based on a continuous time period. Similar to the approach of Weiser and Hong, our method decomposes changes in factor intensity of trade into changes in trade structure, factor (capital and labor)-output coefficients, and input-output coefficients. However, because our method is a discrete approximation to the Divisia index, it has several advantages over theirs: first, it avoids the arbitrariness of the two-step procedure; and second, it eliminates the problematic interaction term which inevitably arises in a discrete fixed weights decomposition.

The period analyzed for each economy corresponds to a time of rapid growth in its economic history. Thus, we may expect the results to show distinct patterns.

In section II the methodology used for the decomposition of changes in the factor intensity of trade is derived. Section III describes some characteristics of the sample economies for the analysis. Section IV briefly discusses the changes in the factor intensity for these five economies,

while section V reports and analyzes the causes of changes in the factor intensity of trade. Some concluding comments are presented in section VI.

II. Methodology

Our methodology decomposes the rate of change in factor intensity of trade into rates of change in the commodity composition of trade; the factor (capital and labor)-output coefficient; and the input-output coefficient. The approach is similar to growth accounting excercises that decompose observed changes into their sources but without necessarily revealing the causal links.

Define factor intensity of trade (F) for a country as equation (1).

$$(1) \qquad F = \frac{F_e}{F_m} = \frac{\sum_i \sum_j k_i r_{ij} e_j}{\sum_i \sum_j \ell_i r_{ij} e_j} \Big/ \frac{\sum_i \sum_j k_i r_{ij} m_j}{\sum_i \sum_j \ell_i r_{ij} m_j},$$

where

F_e = ratio of total capital to total labor in exports

F_m = ratio of total capital to total labor in imports

k_i = capital-output ratio in sector i

ℓ_i = labor-output ratio in sector i

r_{ij} = ith row, jth column element of Leontief inverse $(I-A)^{-1}$, where A is the input-output coefficient matrix and I is an identity matrix

e_j = jth sector's export share to total exports ($e_j = E_j / \sum_j E_j$, where E_j is the export value for sector j)

m_j = jth sector's import share to total imports ($m_j = M_j / \sum_j M_j$, where M_j is the import value for sector j)

In equation (1) the numerator measures the capital-labor ratio for the production of output which satisfies export demand, while the denominator shows the capital-labor ratio for the production of output in order to satisfy import demand. 4/ Therefore, if F is greater (less) than unity, then a country's exports are said to be capital (labor) intensive relative to its imports. Equation (1) indicates that factor intensity of trade depends on sectoral factor employment (capital and labor), interindustry relations and sectoral pattern of foreign trade.

Define the following:

$$(2) \qquad \alpha^s_{ijt} = \frac{s_i \; r_{ij} \; t_j}{\sum_i \sum_j s_i \; r_{ij} \; t_j} \qquad (s = k, \ell; \; t = e,m)$$

$$(3) \qquad \beta^s_{it} = \sum_j \alpha^s_{ijt} \qquad (s = k, \ell; \; t = e,m)$$

$$(4) \qquad \gamma^s_{jt} = \sum_i \alpha^s_{ijt} \qquad (s = k, \ell; \; t = e,m)$$

α^s_{ijt} indicates the share of the total use of factors (labor or capital) by sector i (labor or capital) required to produce output j, which is necessary to deliver t_j (exports or imports). β^s_{it}, the row sum of α^s_{ijt}, measures the amount of factor s needed to produce output i to be delivered to satisfy the demand for exports or imports for all the sectors ($\sum_j t_j$ where $t_j = e_j, m_j$). γ^s_{jt}, the column sum of α^s_{ijt}, shows the total amount of factor s required to produce output which satisfies t_j.

Denoting the rate of change defined as $\frac{dx}{x}$ by $\hat{x}$, we obtain the decomposition of the rate of change in factor intensity of trade (F) into the rate of change in the following three factors: trade structure, factor-output coefficients, and input-output coefficients. The rate of change in trade

structure in turn consists of the rate of change in export and import structures, while the rate of change in factor-output coefficients comprises the rates of change in capital-output and labor-output coefficients.

	rate of change in:	
(5) $F = \sum_j \hat{e}_j \, (\gamma^k_{je} - \gamma^\ell_{je})$	export structure	trade structure
$- \sum_j \hat{m}_j \, (\gamma^k_{jm} - \gamma^\ell_{jm})$	import structure	
$+ \sum_i \hat{k}_i \, (\beta^k_{ie} - \beta^k_{im})$	capital-output coefficient	factor output coefficient
$- \sum_i \hat{\ell}_i \, (\beta^\ell_{ie} - \beta^\ell_{im})$	labor-output coefficient	
$+ \sum_i \sum_j \hat{r}_{ij} \, [\, (\alpha^k_{ije} - \alpha^\ell_{ije})$	input-output coefficient	
$- (\alpha^k_{ijm} - \alpha^\ell_{ijm}) \,]$		

All the expressions in parentheses in equation (5) are calculated as means of initial and terminal values, and growth rates are computed by log differences. The growth accounting equation (5) is thus a Tornqvist-Theil quantity index which has been used as a discrete approximation of the Divisia index (see Diewert 1976). An interpretation of the weights attached to each rate of change is straightforward. The weight attached to the rate of change in export (import) structure is the difference between the total amount of capital and that of labor necesary to produce e_j (m_j) units of exports (imports). The weight given to the rate of change in factor-output coefficients is the difference between the amount of respective factor

required to produce all the exports and that required to produce all the imports. Finally, the weight attached to the rate of change in input-output coefficients is the spread between two differences: those between the amount of capital and of labor needed to produce e_j units of exports; and those between the amount of capital and of labor required to produce m_j units of imports.

In the analysis only the factor intensity of trade in manufactures (Hecksher-Ohlin goods) is examined. This is because an inclusion of primary commodities in the analysis would make an interpretation of the results difficult since the production of primary commodities requires not only capital and labor as primary factors of production, but also natural resources. Also in the analysis total input-output coefficients, which are computed by utilizing both domestic and imported intermediate goods, are applied to compute factor intensities of both exports and import substitutes. 5/

III. The Sample

The sample consists of four semi-industrial economies (Israel, Korea, Mexico, and Taiwan) and Japan at various points in time during the 1958-73 period. The sample was selected on the basis of the availability of comparable input-output data and capital and labor coefficients covering a period of substantial growth, and of change in the structure of trade. 6/ During these years Japan, Korea, Taiwan, and Israel pursued outward-looking export promotion strategies coupled with varying degrees of control over imports, while Mexico followed inward-looking import substitution stratetegies.

Table 1 presents selected indicators of growth and structure for the five economies. As a result of outward-looking strategies the smaller, more open economies -- Israel, Korea, and Taiwan -- significantly increased the share of trade in GDP during the periods shown, particularly the share of manufactured exports and imports. At the other extreme, Mexico reduced its trade ratios due to import substitution policies. In spite of export promotion policies, Japan maintained its relatively low shares throughout the period because of a rapid expansion of its domestic market. The share of manufactured goods in imports and exports shows some interesting patterns across economies. For Mexico and Israel the share of manufactured goods in imports is significantly higher than that in exports throughout the period, while Japan experienced a totally opposite pattern: a high share of manufactured goods in exports and a low share in imports. Korea and Taiwan had a relatively balanced pattern. These differences stem mainly from disparities in factor endowments and in the level of economic development. Japan, poor in natural resources, had to rely on imports for supply of raw materials, whereas economies rich in natural resources such as Mexico and Israel, exported significant quantities of products based on these resources. Except for Japan, which had reached a matured stage of development compared to the others, all the economies relied on foreign supplies for manufactured goods used primarily for production. The share of manufactured trade in total trade increased over time in all economies except Japan, where it had already reached a high level by 1960. In Korea and Taiwan (if food processing is excluded) the increase was particularly noteworthy. In every case the importance of intermediate products relative to total output increased. The net impact of the increased density of the matrix of inter-industry relations on the factor content of trade is discussed in Section V.

Table 1: Structural Characteristics

		Population (millions)	GNP per Capita (1980) (U.S.$)	Annual Growth Rate GDP (percent)	Shares in GDP (percent) Imports	Shares in GDP (percent) Exports	Share of Manufactures Trade in Total (percent) Imports	Share of Manufactures Trade in Total (percent) Exports	Share of Intermediate Products in Gross Ouptut (percent)
Mexico	1960	36.0	935	—	12.6	10.3	89.9[b]	35.9	37.7
	1970	50.4	1310	7.0	9.7	7.7	91.4[b]	40.8	38.1
Japan	1960	94.1	1470	—	10.4	10.8	47.6	84.3	51.5
	1970	104.3	3705	10.8	9.5	10.8	42.6	77.0	54.3
Korea	1963	27.0	290	—	16.3	4.9	69.0	48.5	43.6
	1973	32.9	630	10.2	33.0	29.9	81.5	79.5	50.4
Taiwan	1961	11.0	450	—	19.8	12.8	72.4	76.0 (26.8)[c]	40.8
	1971	14.8	830	9.5	32.6	35.1	76.2	82.6 (70.2)[c]	50.8
Israel	1958	2.0	2080	—	25.7	13.7[a]	67.6	43.9	39.5
	1972	3.1	4525	9.2	39.4	28.0	83.9	49.6	45.4

a. 1960.
b. Shares in merchandise exports.
c. Figures in parentheses exclude exports of the food processing sector.

Sources: World Tables: The Third Edition, 1983; and Chenery, Robinson, and Syrquin, 1984.

IV. Changes in Factor Intensity of Trade

The factor intensity of trade for the five economies for various years is reported in Table 2. It is computed by incorporating current year values in constant prices in equation (1). 7/ Capital-labor ratios for the production of exports (exports column) and for import substitutes (imports column) are obtained respectively as a numerator and denominator of equation (1), while the ratios of these two values [F in equation (1)] are shown in the last column. Capital-labor ratios for the production of exports and of import substitutes (exports and imports colunmns) can be meaningfully compared across periods for a given country, but not across countries, since the units used in the valuation of capital and labor differ among the countries. However, a comparison of the ratios between capital-labor coefficients of production for exports and those for import substitutes (exports/imports column) can be performed not only across periods but also across countries because these values are free of units.

Columns 1 and 2 in Table 2 indicate that capital-labor ratios for the production of both exports and import substitutes increased continously over time in all the economies. 8/ This phenomenon of capital deepening in production is consistent with the observation that the accumulation of capital is usually faster than that of labor in the process of development. At the same time, the rate of increase in these ratios was not uniform across the economies. Capital-labor ratios in the production of exports increased faster than those in the production of import substitutes in Mexico, Japan, 9/ Taiwan, 10/ and Israel, 11/ while the rate of increase in capital-labor ratios

Table 2: Factor Intensity of Trade (capital/labor ratios)

		Exports (F_e)	Imports (F_m)	Exports/Imports (F)
Mexico	1960	0.66	0.93	0.71
	1970	1.09	1.23	0.89
	Annual Growth Rate (%)	5.1	2.8	2.2
Japan	1960	0.89	0.98	0.91
	1970	2.50	2.38	1.05
	Annual Growth Rate (%)	10.9	9.4	1.5
Korea	1963	0.39	0.44	0.89
	1973	0.73	0.98	0.74
	Annual Growth Rate (%)	6.4	8.4	-1.8
Taiwan	1961	0.48	0.62	0.77
	1971	0.75	0.92	0.82
	Annual Growth Rate (%)	4.4	4.0	0.4
Israel[a]	1958	0.52	0.46	1.14
	1972	1.02	0.86	1.19
	Annual Growth Rate (%)	4.9	4.6	0.3

a. The results for Israel are chained from separate computations for 1958-65 and 1965-72. In the first period labor is measured in man days and in the second period in man hours.

in the production of import substitutes outpaced that in the export production in Korea. 12/

In spite of capital deepening in production in all the economies and in spite of capital deepening in the factor intensity of trade (exports/imports) in Mexico, Japan, Taiwan, and Israel, the factor intensity of trade measure exceeds unity only for Japan after 1965 and for Israel for the entire period.

V. Sources of Changes in Factor Intensity of Trade

The rate of change in factor intensity is decomposed into the changes in the following three factors in equation (5): trade structure, factor-output coefficients, and input-output coefficients. Since the change in factor intensity of trade (F) is the difference between the change in factor intensity of exports (F_e) and of imports (F_m), and since the change in factor intensities in exports and in imports often offset each other to result in a small change in factor intensity of trade, sources of changes in factor intensities of exports and imports are separately computed and presented in Table 3 in addition to the sources of changes in factor intensity of trade. 13/

Table 3 indicates significant capital deepening in the production of both exports and import substitutes in all cases, particularly in Japan and Korea. The main reason for the increase in capital intensity in the production of exports and import substitutes is the change in factor-output ratios. As shown in Table 4, this increase in capital intensity reflects the fall in labor-output ratios (increase in labor productivity). Capital output ratios actually declined (except in Japan where they increased marginally) but not fast enough to offset the fall in labor-output ratios.

Table 3: Sources of Changes in Factor Intensity of Trade

		Annual Growth Rate: Fe	Percent of Total			Annual Growth Rate: Fm	Percent of Total			Annual Growth Rate: F	Percent of Total		
			Trade Structure	Factor Output Ratio	Input-Output Coeff.		Trade Structure	Factor Output Ratio	Input-Output Coeff.		Trade Structure	Factor Output Ratio	Input-Output Coeff.
Mexico:	1960-70	5.1	26	62	12	2.8	-17	105	12	2.2	81	8	11
Japan :	1960-70	10.9	12	82	6	9.4	-6	99	7	1.5	120	-16	-4
Korea :	1963-73	6.4	-13	107	6	8.3	-1	97	4	-1.8	-35	-68	3
Taiwan:	1961-71	4.4	35	60	5	4.0	4	97	-1	0.4	846	-903	157
Israel:	1958-72	4.9	10	94	-4	4.6	-4	109	-5	0.3	208	-111	3

Table 4: Changes in Factor-Output Ratios a/

	Capital-Labor Ratio in the Production of:								
	Exports			Imports			Exports/Imports		
	Annual Growth Rate	% Due to: $\hat{k}$	% Due to: $\hat{\ell}$	Annual Growth Rate	% Due to: $\hat{k}$	% Due to: $\hat{\ell}$	Annual Growth Rate	% Due to: $\hat{k}$	% Due to: $\hat{\ell}$
Mexico	3.1	-12	112	2.9	-21	121	0.2	141	-41
Japan	8.5	2	98	8.8	7	93	-0.2	-188	88
Korea	6.7	-25	125	8.1	-18	118	-1.4	-13	-87
Taiwan	2.5	-273	373	3.8	-209	309	-1.4	91	-191
Israel	4.5	-46	146	4.9	-53	153	-0.4	116	-216

a. Changes in total factor-output ratios with an uncharged trade structure and input-output matrix. Percentage changes due to changes in labor-output coefficients (ℓ) should be interpreted as those due to a reduction in ℓ since the labor-output coefficient enters as a denominator in the computation of capital-labor ratios.

Exports: $\sum_i (\hat{k}_i \beta^k_{ie} - \hat{\ell}_i \beta^\ell_{ie})$ (1)

Imports: $\sum_i (\hat{k}_i \beta^k_{im} - \hat{\ell}_i \beta^\ell_{im})$ (2)

Exports/Imports: (1) - (2)

The net result in every case was an increase in the capital-labor ratio required to produce a given structure of exports and import substitutes with a fixed input-output matrix. The effect of changes in the composition of trade was to increase the capital intensity in the production of exports (except in Korea) and to reduce the capital intensity in the production of import substitutes (except in Taiwan). The increased density of the input-output matrix leads in general to an increase in the capital intensity of the output required to produce both the export and the import vectors.

The net impact of these effects on the factor intensity ratio F is less uniform. The increase in capital intensity due to the changes in factor-output ratios with a given trade structure and input-output matrix is faster in imports than in exports, leading, by itself, to a decline in the factor intensity ratio F. The decline in labor-output ratios is in general the main cause of the change in capital intensity. The effect of changes in trade structure on factor intensity goes generally in the opposite direction for exports and for import substitutes, resulting in a relatively large positive contribution to the changes in factor intensity. The impact of changes in input-output coefficients is to increase the factor intensity in F in all cases except Japan. The magnitude of these effects, however, is relatively small. 14/

VI. Conclusions

An analysis of changes in factor intensity of trade for Mexico, Japan, Korea, Taiwan, and Israel during the 1960s revealed that capital-labor intensity in the production of both exports and import substitutes increased in all cases. Moreover, the rate of change in capital-labor intensity was faster in the production of exports than of import substitutes in all

economies except Korea. Without information on the level of factor endowments and their changes in these economies as well as in their trading partners, it is not possible to test the validity of either the static or the dynamic version of the Hecksher-Ohlin theorem.

In spite of substantial variations in the level of economic development, in economic structure, and in development strategies in the economies analyzed, the sources of changes in factor intensity for exports and import substitutes are to be mainly attributed to the changes in factor-output coefficients. Changes in factor-output coefficients are in turn due mainly to the changes in labor-output coefficients. Although these findings are quite robust among the economies studied, observations should be made for a wider variety of economies.

Finally, in explaining the changes in factor intensity of trade (exports/imports), changes in trade structure are found to be very important. Since this finding implies possible effects of trade policies on factor intensity of trade, further studies of this relationship using detailed data on trade policies such as import protection are warranted.

APPENDIX

In this appendix the derivation of equation (5) is described.

Letting $\hat{x}$ denote the rate of change of a variable x as defined as $\frac{dx}{x}$, the rate of change in factor intensity of trade (F) can be expressed by the rate of change in the right hand side variables in equation (1) as (A-1).

$$\text{(A-1)} \qquad \hat{F} = \left(\sum_i \sum_j \widehat{k_i r_{ij} e_j}\right) - \left(\sum_i \sum_j \widehat{\ell_i r_{ij} e_j}\right) - \left(\sum_i \sum_j \widehat{k_i r_{ij} m_j}\right) + \left(\sum_i \sum_j \widehat{\ell_i r_{ij} m_j}\right)$$

Equation (A-1) can further be expanded as (A-2).

$$\text{(A-2)} \qquad \hat{F} = \sum_i \sum_j (\hat{k}_i k_i r_{ij} e_j + \hat{r}_{ij} k_i r_{ij} e_j + \hat{e}_j k_i r_{ij} e_j) \Big/ \sum_i \sum_j k_i r_{ij} e_j$$

$$- \sum_i \sum_j (\hat{\ell}_i \ell_i r_{ij} e_j + \hat{r}_{ij} \ell_i r_{ij} e_j + \hat{e}_j \ell_i r_{ij} e_j) \Big/ \sum_i \sum_j \ell_i r_{ij} e_j$$

$$- \sum_i \sum_j (\hat{k}_i k_i r_{ij} m_j + \hat{r}_{ij} k_i r_{ij} m_j + \hat{m}_j k_i r_{ij} m_j) \Big/ \sum_i \sum_j k_i r_{ij} m_j$$

$$+ \sum_i \sum_j (\hat{\ell}_i \ell_i r_{ij} m_j + \hat{r}_{ij} \ell_i r_{ij} m_j + \hat{m}_j \ell_i r_{ij} m_j) \Big/ \sum_i \sum_j \ell_i r_{ij} m_j$$

Utilizing definitions (3) and (4), (A-2) can be transformed into (A-3), which is equation (5) in the text.

(A-3)
$$\hat{F} = \sum_j \hat{e}_j \left(\gamma^k_{je} - \gamma^\ell_{je}\right) - \sum_j \hat{m}_j \left(\gamma^k_{jm} - \gamma^\ell_{jm}\right)$$
$$+ \sum_i \hat{k}_i \left(\beta^k_{ie} - \beta^k_{im}\right) - \sum_i \hat{\ell}_i \left(\beta^\ell_{ie} - \beta^\ell_{im}\right)$$
$$+ \sum_i \sum_j \hat{r}_{ij} \left[\left(\alpha^k_{ije} - \alpha^\ell_{ije}\right) - \left(\alpha^k_{ijm} - \alpha^\ell_{ijm}\right) \right]$$

Table A-1: Sectoral Classification

Sector	Israel	Japan	Korea	Mexico	Taiwan
Food Processing	1	1	1	1	1
Textiles	2	2	2	2	2
Clothing	2	2	3	3	3
Leather	2	2	3	4	3
Lumber and Wood	3	3	4	5	4
Paper	4	4	5	6	5
Printing	4	5	6	7	5
Miscellaneous	5	6-7	7-8	8	6-7
Rubber	6	8	9	9	8
Chemicals	7	9	10	10	9
Petroleum and Coal	7	10	11	10	10
Nonmetallic Minerals	8	11	12	11	11
Basic Metals	9	12	13	12	12
Machinery	10	13	14	13	13
Transport Equipment	11	14	15	14	14
Agriculture and Mining	12-13	15-17	16-17	15-16	15-18
Infrastructure & Services	14-17	18-23	18-22	17-21	19-23

FOOTNOTES

1/ See Deardorf (1983) for a survey of theoretical literature and empirical studies for the United States. For applications of the Leontief method to other countries see Tatemoto and Ichimura (1959) and Heller (1976) for Japan, Hong (1981) and Westphal and Kim (1977) for Korea, Kuo (1983) for Taiwan, and Carvalho and Haddad (1981) for Brazil.

2/ See Heller (1976) for Japan, Hong (1981) and Westphal and Kim (1977) for Korea, and Maskus (1983) for the United States.

3/ Computed from Table 8.13.

4/ rij in equation (1) captures both direct and indirect demand for the production of output. The gross measure (direct and indirect) rather than the direct measure has been shown to be appropriate for an analysis of the factor intensity of trade [see Deardorff (1982) and Hamilton and Svensson (1983)].

5/ Although there is some controversy over the appropriate coefficients (either total or domestic) in the computation of factor intensity of exports, we employed total coefficients for two reasons. First, the decomposition formula becomes more complicated otherwise, making an interpretation of the results difficult. Second, the changes induced by incorporating domestic coefficients for exports are small.

6/ The data came from a World Bank research project on "Sources of Industrial Growth" (Chenery, Robinson, and Syrquin). Publication is forthcoming.

7/ The level of aggregation was approximately 23 sectors in every case, with over 11 of them in manufacturing. The level of aggregation in each country and the classification of the manufacturing sectors are shown in Table A-1 in the Appendix. Imports include nominal tariffs and are regarded as competitive.

8/ Westphal and Kim (1977) analyzed changes in factor intensity for Korea between 1960 and 1968 by using input-output and factor-output coefficients for 1968 for the entire period. Thus they analyzed the changes in factor intensity due only to the changes in trade composition. Unlike us, they found that capital-labor ratios for the production of exports declined during the period. This results from ignoring the changes in production structure (see Table 3).

9/ In his studies on Japan between 1956 and 1968, Heller (1976) found that capital-labor ratios of Japanese exports increased continuously because of a shift in the composition of exports toward capital-intensive goods and because of relatively faster deepening in the capital intensity of these sectors. Urata (1983) also found that Japan's exports became more capital intensive relative to its imports between 1967 and 1975 by conducting a regression analysis.

10/ Kuo (1983) also found that Taiwan's exports were more labor intensive than its exports during the 1961-71 period. However her findings, unlike ours, indicate that Taiwan's exports were becoming more labor intensive compared to its imports over the period. She included the primary sector in her study, which uses labor-intensive technology and which experienced an increase in export surplus in the period considered.

11/ For Israel, see Halevi (1983).

12/ Hong (1981) found that capital-labor intensity increased faster in exports than in import substitutes between 1966 and 1973. Using the 1970 production structure, Hong (1976) observes a decline in the factor intensity from 1963 to 1966. Analyzing the 1963-70 and 1970-73 period separately, we observed the same shift in the direction of changes in factor intensity from negative to positive.

13/ The separate results for changes in factor intensities of exports and import substitutes are obtained by grouping the elements in equation (5) relating to F_e and those affecting F_m:

$$\hat{F}_t = \sum_j \hat{t}_j \left(\gamma^k_{jt} - \gamma^\ell_{jt}\right) + \sum_i \left(\hat{k}_i \beta^k_{it} - \hat{\ell}_i \beta^\ell_{it}\right) + \sum_i \sum_j \hat{r}_{ij} \left(\alpha^k_{ijt} - \alpha^\ell_{ijt}\right)$$

$(t = e, m)$

14/ An analysis for two subperiods for Korea (1963-70 and 1970-73) reveals that the contribution from changes in trade structure changed from substantially negative for the 1963-70 period to positive for 1970-73.

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