CHANGES IN TRADE STRUCTURE AND FACTOR INTENSITY: A CASE STUDY OF THE REPUBLIC OF KOREA

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I. INTRODUCTION

SINCE the latter 1960s, the Republic of Korea's rapid progress in industrialization has led to astonishing economic development. Congruent rapid growth in export-import has made the domestic economy part of the international system of division of labor. Manufacturing's expanding share of exports and imports has also greatly changed the trade structure.

Korea's industrial development is often described as export-led industrialization: it takes advantage of the country's relatively ample labor endowment and focuses on expanding the export of labor-intensive manufactures. Backing up this description is the well-known Heckscher-Ohlin theorem on the international division of labor: a country with relatively ample labor (compared to capital) has a comparative advantage in industries that use labor intensively. This theorem describes countries with relatively abundant labor like Korea as highly suited for specialization in labor-intensive industries and able to use export promotion policies in free trade systems for progress in industrialization. If this thinking is correct, industrial progress in Korea should be limited to the labor-intensive manufacturing sector and the trade structure should be labor intensive.

However, capital-intensive industries have also been developed under government protection since the early 1960s and the subsequent expansion of import-substitution industries is equivalent to that of labor-intensive industries. If Korea's industrialization experience is an example of success in industrial development, then the existence and role of capital-intensive industries must be reevaluated.[1] An attempt in that direction is Imaoka and Ohno's hypothesis on dual–industrial development in Korea and Taiwan, which says that export promotion and simultaneous, parallel expansion of capital-intensive industries by import substitution of intermediate demand were the factors that made their development possible [7].

This paper first examines whether the Korean trade structure became labor intensive as industrialization progressed. It then seeks, from the aspects of factor intensity, to empirically understand the trade structure and the changes in it during the period of industrial progress in Korea.

Then it discusses effects that simultaneous and parallel growth of import-

[1] See for example [5].

substitution and export-promotion industries, or labor- and capital-intensive indus-
tries, has had on the trade-industry structure.

The well-known Leontief index, an integrated index of factor intensity embodied
in trade, considers the effects that a country's trade-industry structure has, such
as the size of the coefficient of factor input for each industry, the export-import
configuration, and the effects ensuing from the intermediate demand structure.
The changes in Korea's trade and industry structure, shown by factor intensity,
are decomposed to the effects of (1) export promotion, (2) import substitution,
(3) changes in capital coefficient and labor coefficient, and (4) structural changes
in input-output matrix, by industry and by the rate of contribution for each cause.
The same measurements are made on Japan for comparison.

Section II discusses the methods of measuring the factor intensity of trade,
the decomposition method, and the data used. Section III gives measurements
on the Leontief index and analyze decomposition for Korea, which show that
the trade structure had become capital intensive by 1970. Changes during 1970–75
were toward higher labor intensity and during 1975–80 were toward higher
capital intensity. Chief factors in these changes were: changes in trade structure
and factor-input coefficients during 1970–75; changes in input-output structure
during 1975–80; and changes in trade structure during 1980–83.

Section IV examines, by industry, the effects of export promotion, import
substitution, and changes in capital and labor coefficients on change in the aggregate
trade-industry structure. The results show that export promotion or import
substitution in almost all manufacturing industries made the aggregate trade
structure more capital intensive; the increase in the labor intensity of trade during
1970–75 was caused mainly by reduced import share from agriculture; and the
manufacturing sector had contributed to the rise of capital intensity of trade
throughout both the 1970–75 and 1975–80 periods. The final section contains
the summary and conclusions.

II. MEASUREMENT METHODS AND DATA

A. *The Leontief Index*

The method of empirically measuring the trade-industry structure from the
factor intensity perspective has been developed to test the Heckscher-Ohlin theorem,
while Leontief's research was the first of many empirical studies to focus on
matching the conditions of a country's factor endowment with its factor intensity
embodied in trade.

Leontief [11] points out that measurements on the trade structure of the
United States—a country considered abundant in capital—actually show the same
patterns as a labor-abundant country. But since then the dispute has continued
over the "Leontief paradox," that is, the lack of correspondence between the
factor intensity of trade and the Heckscher-Ohlin theorem's propositions of com-
parative advantage. The dispute has led to various contrivances that try to improve
the Leontief index's method of measurement. The attempts have consisted of,

for a few examples, revisions in the handling of noncompetitive imports, and use of production factors other than labor and capital (quality of labor, human capital, technology, natural resources). Furthermore, Leamer [10] says the Leontief index's very formulation is inappropriate to expressing a country's factor endowment. Disputes about the Leontief index will be put aside here and it will be used to examine the trade structure, particularly its changes, from the viewpoint of factor intensity.

The Leontief index's equations are for measuring two proportional relationships: capital intensity of export (the proportion of capital and labor embodied in exports) and of import (proportion of capital and labor embodied in imports), as the factor intensity of trade. The capital intensity of export is defined as the ratio of capital to labor input that is directly and indirectly used to produce exports, while the capital intensity of import is defined as the ratio of direct and indirect capital and labor inputs that would be necessary to domestically produce those imported goods. The index thus expresses how much capital or labor is being imported and exported. If the factor intensity of trade is larger than 1, the trade structure is explained to be relatively capital intensive, while if the factor intensity of trade is smaller than 1, the trade structure is relatively labor intensive.

As specification of the index clearly shows, the factor intensity of trade can also be seen as an index that expresses, integrally, a country's trade and industry structure, which is a reflection of not just the trade structure (exports and imports) but of the production structure (linkage of industries and coefficients of capital and labor input) as well.

B. *Measurement Framework*

The procedures for measuring factor intensity of trade and for their decomposition analysis will now be discussed. Syrquin and Urata's [12] measurement formula will be used and the notation described here followed them.

The factor intensity of trade (F) is defined as:

$$F = F_e/F_m, \tag{1}$$

$$F_e = [k'(I-A)^{-1}e] / [l'(I-A)^{-1}e],$$
$$F_m = [k'(I-A)^{-1}m] / [l'(I-A)^{-1}m], \tag{2}$$

where

F_e = the proportion of capital and labor embodied in export,
F_m = the proportion of capital and labor embodied in import,
k' = the capital-output ratio (row) vector,
l' = the labor-output ratio (row) vector,
e = the export share (column) vector,
m = the import share (column) vector,
A = input-output coefficient matrix,
I = unit matrix.

By differentiating and reorganizing equations (1) and (2), the rate of change $(\hat{F})$ in the factor intensity of trade is expressed in the equation:

TABLE I

INDUSTRIAL CATEGORIES

1. Agriculture, forestry, and fisheries	11. Electrical equipment
2. Mining	12. Transportation equipment
3. Construction	13. Other manufactures
4. Food	14. Commerce
5. Textiles	15. Finance and insurance
6. Paper and pulp	16. Real estate
7. Chemicals	17. Transport and communications
8. Basic metals	18. Utilities (power, gas, water)
9. Metal products	19. Othe services
10. General machinery	

$$\hat{F} = \sum_j \gamma_j{}^e \cdot \hat{e}_j - \sum_j \gamma_j{}^m \cdot \hat{m}_j + \sum_j \beta_j{}^k \cdot \hat{k}_j - \sum_j \beta_j{}^l \cdot \hat{l} + \sum_i \sum_j \alpha_{ij} \cdot \hat{b}_{ij}. \qquad (3)$$

Equeation (3) means that the rate of change ($\hat{F}$) in the factor intensity of trade is explained by the rate of change in the jth industry's export share ($\hat{e}_j$), the rate of change in the jth industry's import share ($\hat{m}_j$) the rate of change in the ratio of labor-output ($\hat{l}_j$), of capital-output ($\hat{k}_j$) and the rate of change in the inverse matrix $[(I-A)^{-1}]$ coefficient ($\hat{b}_{ij}$).

The coefficients for each rate of change can be seen as the elasticity of each variable (e_j, m_j, k_j, l_j, and b_{ij}) to the factor intensity of trade.[2] For example, a change in the jth sector's export share, $\hat{e}_j$, affects only $\gamma_j{}^e \cdot \hat{e}_j$ in the factor intensity of aggregate trade, or that component of the change in the factor intensity of aggregate trade, which is produced by a change in the jth sector's export share (i.e., export's contribution) is interpreted as $\gamma_j{}^e \cdot \hat{e}_j$.

The first term of equation (3) is the sum of the contribution of change in each sector's export share which are taking place as a part of change in the aggregate trade structure. Similarly, the equation's second term is the contribution by change in the import structure, the third by change in capital-output ratio, the fourth by the labor-output ratio, and the fifth by change in the input-output structure.

C. Data

Data used in the measurements are capital, labor, output, export and import, and input-output coefficients. Nineteen industry sectors (see Table I) are used for the categories common to both Korea and Japan.[3]

The Bank of Korea's input-output tables [1] for 1970, 1975, 1980, and 1983 are used to find the total input and output by industry and the input-output coefficients. The tables are deflated by a value-added deflator by industry to real values in 1975. For the data in 1975 prices for Japan, a link table for the years 1965, 1970, and 1975 is used [8].

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[2] See Section VI.C for the meaning of α_{ij}, β_j, and γ_j.

[3] Because of problems with the availability of data on capital stock, seventeen sectors must be used for measurement in the 1980s.

TABLE II

FACTOR INTENSITY OF TRADE

	1970	1975	1980	Rate of Change (%)	
				1970–75	1975–80
F_e	1.7502	2.4054	2.8465	37.44	18.34
$F_e{}^k$	2.3312	2.2731	1.8511	−2.49	−18.57
$F_e{}^l$	1.3320	0.9450	0.6503	−29.05	−31.19
F_m	1.3961	2.3041	2.5724	65.04	11.64
$F_m{}^k$	2.0616	2.2482	1.8033	9.05	−19.79
$F_m{}^l$	1.4767	0.9757	0.7010	−33.93	−28.15
F	1.2537	1.0440	1.1066	−16.73	5.99

Source: Compiled by author.

Note: $F_e = F_e{}^k/F_e{}^l$; $F_e{}^k$, $F_e{}^l$ = capital and labor embodied in exports. $F_m = F_m{}^k/F_m{}^l$; $F_m{}^k$, $F_m{}^l$ = capital and labor embodied in imports.

Data on capital stock by industry are taken from the Korean Development Institute [3] for Korea (net capital stock) and from the Economic Planning Agency [9] for Japan (fixed capital stock). For data on labor, tables on number of employees by industry are appended to the input-output tables for each country.

III. CAUSES OF CHANGE IN THE FACTOR INTENSITY OF TRADE

A. Factor Intensity of Trade

Table II shows the results of measuring changes in factor intensity of trade. The Leontief index (F) for Korea in 1970, 1975, 1980, and 1983 exceeds 1 for every year.[4] If this were to be interpreted as an index of factor endowment, it would show that Korea had already become a capital-abundant country by 1970. This is a result somewhat different from measurements in the past. Table III shows that Hong [4], for one, concludes that the country was labor abundant in 1970 and capital abundant in 1975. Hwang [6] gives measurements showing that Korea was labor abundant throughout the period from 1966 to 1980.[5]

At any rate, it is clear from the table that the index declines during 1970–75, making the trade structure less capital intensive, but it reverses toward increase in 1975–80 and 1980–83, making the trade structure more capital intensive.[6]

Breaking down the decline in the index during 1970–75 shows that the factor

[4] Results of the 1980s are shown in Appendix Table.

[5] As already stated, there is a great deal of disagreement about methods of measuring the Leontief index and the input-output coefficients used in these two studies. Hong, for example, uses a table of competitive imports in measuring the degree of factor intensity for imports, but a domestic table for measuring the degree of factor intensity for exports. In contrast, this paper uses a table of competitive imports for both imports and exports.

[6] The direction of change is the same as given by Hwang's measurement results [6].

TABLE III

EXAMPLE OF MEASUREMENTS USING THE LEONTIEF INDEX
FOR THE REPUBLIC OF KOREA

	1960	1966	1970	1975	1980
Hong	1.087	0.6329	0.9524	1.1364	
Hwang		0.9976	0.9772	0.7964	0.8558

Sources: [4] [6].

intensity embodied in export (F_e) and the factor intensity embodied in import (F_m) were increasing together. However, because the increase in F_m was much more rapid, the aggregate trade structure was changing toward more labor intensive. The quantity of labor embodied in per unit trade declined from 1.33 to 0.95 for exports and from 1.47 to 0.98 for imports, while the quantity of capital increased from 2.06 to 2.25 for imports and declined from 2.33 to 2.27 for exports. In other words, the pattern for Korea's trade structure during this period is one of labor abundance. Although aggregate labor productivity increased, the trade structure moved toward, in relative terms, more labor intensive.

In contrast, the Leontief index was increasing during 1975–80. This is because factor intensities embodied in both import and export were climbing while intensities of export were climbing faster. The major causal factor is that although the required quantities of capital and labor were declining for both per unit of import and export, there was a much more dramatic drop in the quantity of labor necessary for per unit export. The major feature of change in the trade structure during this period was the capital intensification of exports.

The proportion of capital and labor embodied in export climbed from 1.75 in 1970 to 2.41 in 1975, and then to 2.85 in 1980 and the proportion embodied in import rose from 1.39 in 1970 to 2.30 in 1975, and to 2.57 in 1980. Forming the backdrop for this trend was Korea's heightening of aggregate capital intensity. The trade structure's labor intensification during 1970–75 and its capital intensification during 1975–80 were created by relative differences in the changing factor intensities that are embodied in export-import.

B. Decomposition

The methods in equation (3) shall now be used to analyze the decomposition of changes in the Korean trade structure. Changes in factor intensity of trade are in three parts: (1) changes in the export-import structure (i.e., changes in the share of export and import composition); (2) changes in factor input (i.e., changes in the capital and the labor coefficients); and (3) changes in the structure of input-output (i.e., changes in the input-output coefficient). The rate of contribution for each will then be measured.

The measurements give rates of contribution for each item in Table IV in percentages. The results show that for the decline in the Leontief index in 1970–75, the rate of contribution of export-import structure is 55.5 per cent and

TABLE IV

RATE OF CONTRIBUTION BY FACTOR TO CHANGES IN
TRADE FACTOR INTENSITY

	1970–75	1975–80
Export-import structure	−55.51	22.88
Exports	49.52	174.88
(−)Imports	105.03	151.99
Factor-input structure	−55.38	26.42
Capital	−132.61	−67.46
(−)Labor	−77.22	−93.88
Input-output structure	10.89	50.69
Total	−100.00	100.00

Source: Compiled by author.

that of factor input is 55.4 per cent. In contrast, changes in the input-output structure have the effect of intensifying capital of only 10.94 per cent.

Looking in greater detail at the export-import structure shows that changes in export composition have the effect of increasing capital intensity, but the effects from decline in capital intensity by changes in import composition are at least twice as high. A breakdown of factor input's effects shows that changes in the capital coefficient decrease the factor intensity of trade whereas changes in the labor coefficient increase it. However, the effect of change in the labor coefficient is only about half that of change in the capital coefficient, so that, overall, change in factor input contributes to make the factor intensity of trade lower.

The factor intensity of trade for 1975–80 increased toward more capital intensive (the Leontief index increased). The rates of contribution were about 23 per cent for export-import, 26 per cent for factor input, and 51 per cent for input-output. Compared to 1970–75, both export-import and factor-input structure changed their direction of contribution to increasing the factor intensity of trade. By doing so, aggregate factor intensity was becoming more capital intensive.

A comparison of all factors in those two periods shows three major features about their rates of contribution.

First, the export composition in 1975–80 was rapidly changing toward higher capital intensity of trade. The rate of contribution is at least three times, with absolute figures at least twice, what they were in 1970–75. Second, the change in the capital coefficient contributed to a decline in the factor intensity of trade in both periods but 1975–80's rate of contribution in absolute terms was half that of 1970–75's. Third, the input-output factor's rate of contribution increased significantly from 10 per cent in 1970–75 to 50 per cent in 1975–80.

C. *Factor Intensity of Trade by Region*

The measured index for the Korean structure of trade and industry, as seen in trade with the rest of the world, was greater than 1, indicating that the structure

TABLE V

FACTOR INTENSITY OF TRADE BY REGION

	Japan	Asian NICs	ASEAN	U.S.A.-Canada	Western Europe
1970					
F	0.693	1.424	3.920	1.250	0.666
F_e	1.397	1.602	1.757	1.688	1.664
F_m	2.015	1.125	0.448	1.315	2.498
1975					
F	0.551	0.882	3.861	1.356	0.596
F_e	1.844	2.224	2.668	2.531	2.265
F_m	3.610	2.520	0.691	1.866	3.800
1980					
F	0.595	1.175	2.711	1.457	0.744
F_e	2.216	2.563	3.085	3.088	2.780
F_m	3.723	2.181	1.138	2.120	3.739

Source: Compiled by author.

is capital intensive. The following discussion revolves around the results of trade by region.

Table V divides Korea's trading partners into five countries and regions: Japan, the Asian NICs, ASEAN, the United States-Canada, and Western Europe, and gives the results of measuring F, F_e, F_m for each. F's value indicates that the structure of trade to Japan (0.693 in 1970, 0.511 in 1975, and 0.595 in 1980), to Western Europe (0.666 in 1970, 0.596 in 1975, and 0.744 in 1980) and to the Asian NICs (0.882 in 1975) was labor intensive while the structure of trade to the United States-Canada and ASEAN during the same three years was capital intensive.

The pattern of trade with Japan and Western Europe being labor intensive, with ASEAN being capital intensive, and with the Asian NICs being intermediate are predictable results. But trade with the United States-Canada being capital intensive is unexpected.[7] This is because the capital-labor ratio of exports to the United States-Canada is high, almost the same as that to ASEAN: 3.088 to the United States-Canada and 3.085 to ASEAN, in 1980. That was much higher than the 2.216 capital-labor export ratio to Japan and the 2.563 ratio for the Asian NICs. The structure in 1980–83 (Appendix Table) was almost the same as in the 1970s, while the pattern of trade with the Asian NICs was labor intensive as it was in 1975.

Observations of the capital-labor ratio of exports and imports allow the assigning features to trade structure by region. The structure of trade with Japan is one in which Korea exports labor-intensive goods and imports capital-intensive goods. The reverse is the case with ASEAN, Korea exports capital-intensive goods and

[7] The results are from measurements based on the structure of industry and technology in Korea. If the measurements were based on the U.S. structure, the opposite results could be obtained.

TABLE VI

CHANGES IN EXPORT AND IMPORT RATIOS IN
MANUFACTURING INDUSTRIES

(%)

	Export Ratio		Import Ratio	
	1970–75	1975–80	1970–75	1975–80
Food	133.87	65.94	52.29	−25.52
Textiles	27.86	−3.38	−42.70	−23.62
Paper & pulp	131.08	51.97	−8.90	−15.10
Chemicals	161.95	28.78	−24.20	−37.88
Basic metals	164.19	44.56	−27.10	−38.71
Metal products	121.78	57.24	−73.85	−16.93
General machinery	179.39	8.47	−38.32	−40.02
Electrical equipment	73.49	−9.09	−33.45	−19.64
Transportation equipment	939.42	49.63	9.19	−25.21
Other manufactures	29.37	−12.69	104.38	18.51
Agriculture, forestry, & fisheries	117.81	−2.20	39.86	0.77

Source: Compiled by author.

imports labor-intensive goods. With Western Europe, both exports and imports are highly capital intensive, and particularly high capital-labor ratio in imports, as with Japan: 3.739 for Western Europe and 3.723 for Japan in 1980. Exports and imports to the Asian NICs have about the same ratio of capital to labor, their factor intensity indicating a horizontal trade structure.

IV. STRUCTURAL CHANGES IN THE MANUFACTURING SECTOR AND THEIR EFFECTS

A. Changes in Export and Import Ratios

Table VI shows the rate of change in export and import ratios[8] for industries in the Korean manufacturing sector for 1970–75 and 1975–80. The trends in export and import ratios in those two periods feature a relative movement toward import promotion in 1970–75 and toward import substitution in 1975–80.

The export ratio for all industries in 1970–75 is on a uniformly rising trend. With the exception of the textile, electrical equipment, and other manufacturing industries, the increase is at least twice in five years with an especially dramatic rise in transportation equipment. The decline in import ratios in almost all industries shows a continuing import substitution. There is an extraordinary increase in import ratios in the food, transportation equipment, and other manufactures industries. Comparing the size of the decline in the import ratio and the rise in the export ratio, shows that only the textile industries can be considered

[8] The export ratio is defined and measured as exports divided by domestic production and the import ratio is imports divided by total domestic demand (domestic demand+imports).

TABLE VII

DIRECT AND DIRECT-INDIRECT CAPITAL-LABOR RATIOS
FOR MANUFACTURING INDUSTRIES

	Direct Capital-Labor Ratios			Direct-Indirect Capital-Labor Ratios		
	1970	1975	1980	1970	1975	1980
Food	1.993*	2.864*	2.952*	0.900*	1.420*	1.165*
Textiles	2.812	2.781*	2.247*	1.812	2.312	2.242*
Paper & pulp	3.832	4.073	3.927	2.465	3.032	3.162
Chemicals	4.570	4.972	5.278	2.870	3.214	3.435
Basic metals	4.928	12.533	16.417	3.197	5.394	5.560
Metal products	1.680*	3.707	3.793*	2.313	4.205	4.118
General machinery	2.458*	4.808	5.381	2.501	4.358	4.426
Electrical equipment	1.667*	2.434*	2.126*	2.100	3.034	2.824
Transportation equipment	3.007	5.062	7.219	2.426	4.220	4.947
Other manufactures	2.064*	2.584*	4.236	1.633	2.223	2.595
All manufacturing	2.486	3.305	3.839			
All industry				1.255	2.025	2.334

Source: Compiled by author.
* Industries with capital-labor ratios lower than the average for manufacturing.

import substitution types, the remaining industries are, relaively, export promotion types.

The rise in export ratio slowed generally in the 1975–80 period, and in textiles, electrical equipment, and other manufactures export ratios declined. Except for other manufactures, the import ratio uniformly declined. Comparing the changes in these two sets of ratios, four industries demonstrated import substitution trends: textiles, chemicals, general machinery, and electrical equipment, and the number of such industries increased during the 1975–80 period.

B. *Trends in Factor Intensity*

Let's look next at structural changes as shown by trends in the capital-labor ratio of ten industries in the manufacturing sector. Table VII shows the direct capital-labor ratio and the direct-indirect capital-labor ratio by industry in 1970, 1975, and 1980. The trend for both ratios is rising in almost every industry. This is reflected in the ratio for all manufacturing that is derived by dividing total capital by total labor. It climbed from 2.49 in 1970 to 3.31 in 1975 and then to 3.84 in 1980.

Five industries were in the group with high capital-labor ratios in 1970, but of these, textiles had move to the low capital-labor ratios group by 1975. Conversely, metal products and general machinery had moved into the high group.

C. *Elasticities for Factor Intensity of Trade*

An examination of the results of measuring coefficients by factor and by industry will now be made using equation (3) to decompose the factor intensity of trade.

TABLE VIII
VALUES OF ELASTICITY FOR FACTOR INTENSITY OF TRADE ACCORDING TO CAUSE AND INDUSTRY

	$\gamma_j{}^e$	$(-)\gamma_j{}^m$	$\beta_j{}^k$	$(-)\beta_j{}^l$
1970–75				
Food	−0.03003	−0.01843	−0.00310	0.00308
Textiles	0.00915	0.01374	0.10525	0.12893
Paper & pulp	0.00119	0.01325	−0.01188	0.00786
Chemicals	0.00682	0.08184	−0.05415	0.02958
Basic metals	0.01076	0.07267	−0.11439	−0.00485
Metal products	0.00399	0.01625	−0.01024	−0.00708
General machinery	0.00105	0.09276	−0.09512	−0.05128
Electrical equipment	0.00695	0.02257	−0.00922	−0.00576
Transportation equipment	0.00150	0.04113	−0.03536	−0.01211
Other manufactures	−0.01762	0.00531	0.09707	0.11115
1975–80				
Food	−0.02893	−0.02168	0.00195	0.00594
Textiles	−0.00712	0.00029	0.10446	0.11006
Paper & pulp	0.00107	0.00457	−0.00277	0.00568
Chemicals	0.00993	0.03680	−0.01674	0.02891
Basic metals	0.03941	0.07674	−0.07549	0.07057
Metal products	0.01389	0.00560	0.00448	0.00839
General machinery	0.00442	0.07868	−0.07530	−0.02849
Electrical equipment	0.02043	0.01969	0.00386	0.00560
Transportation equipment	0.01889	0.04940	−0.02486	0.00079
Other manufactures	−0.01894	−0.00161	0.06589	0.07223

Source: Compiled by author.

Table VIII shows, by industry, the elasticity of export share ($\gamma_j{}^e$), the elasticity of import share ($\gamma_j{}^m$), the elasticity of capital-output ratio ($\beta_j{}^k$) and the elasticity of the labor-output ratio ($\beta_j{}^l$). The meaning of the four coefficients can be interpreted, as shown below, by the process of deriving equation (3).[9]

$\gamma_j{}^e$: The difference between the total quantity of capital and the total quantity of labor the jth industry (directly-indirectly) uses per unit of export.

$\gamma_j{}^m$: The difference between the total quantity of capital and the total quantity of labor (directly-indirectly) the jth industry requires to domestically produce import per unit.

$\beta_j{}^k$: The difference between the quantity of capital (directly-indirectly) that the jth industry uses to produce aggregate industry per unit export, and the quantity of capital (directly-indirectly) that the jth industry requires to domestically produce the equivalent to one unit of import.

$\beta_j{}^l$: The difference between the quantity of labor that the jth industry (directly-indirectly) uses to produce aggregate industry's per unit export and the quantity of labor the jth industry (directly-indirectly) requires to domestically produce a unit of what is imported.

[9] For further details, see [12].

From the viewpoint of factor intensity, the coefficients γ_j^e and γ_j^m are indices showing what change in import-export for one industry means to a country's entire industrial system. The values for 1970–75 in manufacturing show that γ_j^e is negative only in the "food" and "other manufactures" categories, i.e., an increase (export-labor-intensive type) in their exports makes the aggregate trade structure more labor intensive. The manufacturing sector's remaining industries have a positive γ_j^e, their increased exports (export-capital-intensive type) make the aggregate trade structure more capital intensive.

The effects of import substitution show that γ_j^m is negative in "food" only and import substitution (import-labor-intensive type) makes the trade structure more labor intensive. In all other industries, import substitution (import-capital-intensive type) makes the trade structure more capital intensive.

Food, textiles, and other manufactures are categorized as having an export-labor-intensive structure for 1975–80. Food and other manufactures are also categorized as having an import-labor-intensive structure.

β_j^k and β_j^l are indices showing how each change in the coefficients of capital and labor for each industry affects the aggregate trade structure. β_j^k is positive in 1970–75 for textiles and other manufactures, i.e., those industries where the rise (capital-capital-intensive type) in the capital coefficient makes the entire trade structure capital intensive. The rise in the capital coefficient in the other industries has the reverse effect (capital-labor-intensive type) of making trade more labor intensive.[10] β_j^l is positive (labor-labor-intensive type) in five manufacturing categories: food, textiles, paper and pulp, chemicals, and other manufactures. The remainder are labor-capital-intensive types. For 1975–80, food, textiles, metal products, electrical equipment, and other manufactures are categorized as capital-capital-intensive types, while general machinery belongs to the labor-capital-intensive type.

The major feature shown by these observations is that the effects of export promotion and import substitution make the entire trade structure for manufacturing, with a few exceptions, more capital intensive. Further, industries such as metals, general machinery, and electrical equipment, which are categorized as labor intensive when the basis for observation is direct capital-labor ratio (Table VII), belong to export- and import-capital-intensive types. In a straight-on view, an expansion of exports by industries with high labor intensity would seem to make the trade structure more labor intensive, but it may do the exact opposite— make the trade structure more capital intensive.

D. *Structural Changes in the Manufacturing Sector*

The examination now turns to the rate of contribution by industry (see Table IX).

1. *Export-import structure*

The export-import structure's rate of contribution in 1970–75 is −55.5 per cent,

10 A rise in the capital coefficient of a certain industry works to make the aggregate trade structure more labor intensive when the effect of capital intensification from imports is greater than the effect of capital intensification from exports, which is produced by a rise in capital coefficient.

TABLE IX

RATE OF CONTRIBUTION BY FACTOR AND BY INDUSTRY TO CHANGES
IN TRADE FACTOR INTENSITY

(%)

	Export-Import	Export	(−)Import	Factor Input	Capital	(−)Labor
1970–75						
Food	−3.191	−4.084	−0.893	0.761	0.065	−0.696
Textiles	4.028	3.479	−0.548	7.223	−34.449	−41.672
Paper & pulp	3.117	0.217	−2.900	2.044	1.061	−0.983
Chemicals	−1.674	9.510	11.184	31.765	20.043	−11.722
Basic metals	23.340	5.101	−18.239	−57.482	−56.381	1.102
Metal products	10.219	2.278	−7.940	−3.175	−0.711	2.464
General machinery	4.264	1.572	−2.692	−8.898	11.706	20.604
Electrical equipment	−0.162	10.639	10.800	−0.457	1.399	1.856
Transportation equipment	0.908	7.915	7.007	−6.004	−3.258	2.746
Other manufactures	0.743	3.055	2.312	14.974	−6.294	−21.269
(Total)	(41.592)			(−19.249)		
Agriculture, Forestry, & fisheries	−70.314	28.620	98.934	−71.832	−12.631	59.201
1975–80						
Food	22.800	19,423	−3.377	2.711	−1.271	−3.981
Textiles	1.513	1.427	−0.086	−24.150	−25.482	−1.331
Paper & pulp	−1.030	1.747	2.777	5.808	1.942	−3.866
Chemicals	15.823	4.014	−11.809	18.047	6.091	−11.956
Basic metals	48.858	14.772	−34.086	1.161	−11.207	−12.367
Metal products	11.387	11.507	0.120	1.362	−1.361	−2.723
General machinery	−38.134	7.128	45.262	27.572	47.246	19.673
Electrical equipment	−0.189	6.605	6.795	0.376	−2.071	−2.446
Transportation equipment	14.720	21.983	7.263	13.099	12.529	−0.571
Other manufactures	3.865	3.192	−0.672	25.446	−26.907	−52.353
(Total)	(79.613)			(71.432)		
Agriculture, Forestry, & fisheries	−67.324	53.606	120.930	−81.163	−5.188	75.975

Source: Compiled by author.

which tends to make the aggregate trade structure more labor intensive. An examination by industry shows that change in the agriculture-forestry-fishery sector's export-import structure highly affects (−70.3 per cent) labor intensity, and manufacturing sector contributes (41.6 per cent) to increase capital intensity. The effect from basic metals (23.3 per cent) and metal products (10.2 per cent) is

especially large. The food and chemical industries have a labor-intensive effect. The large rate of contribution of the agriculture-forestry-fishery sector during this period came from a rapid drop in the import share, from 30 per cent in 1970 to 18 per cent in 1975.

Export-import structural factors in 1975–80 contributed to increasing capital intensity at a rate of 22.9 per cent. The agriculture-forestry-fishery sector contributed to labor intensification (−67.3 per cent) and the manufacturing sector toward capital intensification (79.6 per cent) as previously. Industries in the manufacturing sector with a high effect on capital intensity were food (22.8 per cent), chemicals (15.8 per cent), basic metals (48.9 per cent), metal products (11.4 per cent), and transportation equipment (14.7 per cent). Those with a reverse effect toward more labor intensity were general machinery (38.1 per cent) and paper and pulp (1.0 per cent).

Comparing the two periods shows that (1) basic metals and metal products contributed to the capital intensification of factor intensity of trade throughout the 1970; (2) food and chemicals had effects that made the factor intensity of trade more labor intensive during 1970–75 but this reversed in 1975–80; and (3) general machinery made a big shift toward higher labor intensity in 1975–80.

2. Factor-input structure

The rate of contribution by changes in the coefficient of factor input on changes in factor intensity of trade were negative in 1970–75 at −55.4 per cent but became positive in 1975–80 at 26.4 per cent. Here, too, the changes in the capital and labor coefficients in the agriculture-forestry-fishery sector contributed to moving the aggregate trade structure toward more labor intensive in the same way as with the export-import structure (72 per cent in 1970–75 and 81 per cent in 1975–80). The manufacturing sector contributed to labor intensification (−19.3 per cent) in 1970–75, but that contribution reversed (71.4 per cent) in 1975–80. Although Table IX does not show this sector because it is not involved in foreign trade, utilities (electricity, gas, water) had the effect of capital intensification throughout the two periods (34.0 per cent and 38.9 per cent).

Changes in the factor-input coefficient for industries in the manufacturing sector: basic metals (−57.5 per cent), general machinery (−8.9 per cent), and transportation equipment (−6.0 per cent) had a labor intensive effect. The changes in textiles (7.2 per cent) and chemicals (31.8 per cent) had the reverse effect of capital intensification. The only industry in the manufacturing sector that had a labor-intensive effect during 1975–80 was textiles. Those industries with a high rate of contribution to capital intensity were chemicals (18 per cent), general machinery (27.6 per cent), transportation equipment (13.1 per cent), and other manufactures (25.4 per cent).

E. Development Patterns and Factor Intensity for the Manufacturing Industries

The measurement results should be examined, finally, by industry, in a form that corresponds to arguments about development patterns in the manufacturing sector. These industrial categories can be viewed from two different concepts.

TABLE X

INDUSTRIAL GROUP CATEGORIES

	Industry
Dual–industrial development	
A	Chemicals, basic metals
B	Transportation equipment
C	Textiles, paper & pulp, metal products
D	Food, general machinery, electrical equipment
Chenery-Taylor	
Initial industrial group	Food, textiles
Intermediate industrial group	Paper & pulp, chemicals
Mature industrial group	Basic metals, metal products
(Machinery industry)	General machinery, electrical equipment, transportation equipment

Note: "Other manufactures" is excluded.

One is the dual–industrial development hypothesis that divides industries in the manufacturing sector into four groups: (A) capital-intensive intermediate goods industries; (B) capital-intensive final goods industries; (C) labor-intensive intermediate goods industries; and (D) labor-intensive final goods industries and sees the industrialization of Korea as an expansion of A, C, and D [7]. The other is the Chenery-Taylor hypothesis in which stage of economic development and pattern of industrial development are examined to classify manufacturing industries into three categories: initial, intermediate, and mature [2].

Table X shows how the nine manufacturing categories that this paper uses fit into the above two industrical classifications.

Table XI shows the export and import elasticity of factor intensity in relation to categories for dual–industrial development (A, B, C, and D) and the Chenery-Taylor (initial, intermediate, and mature) hypotheses for Korea and Japan. The dual–industrial development category shows a structure in which D's increase in exports is making trade more labor intensive but the increase in exports for C, a group that is also labor intensive, is making trade capital intensive in the same way as A and B. This is different from the situation in Japan, where C and D's exports have a labor-intensification effect. The Chenery-Taylor categories show that exports and import substitution by the initial industry group are structured in a way that makes trade more labor intensive, which is almost the same as the Japanese structure.

With this structure as the backdrop, Table XII lists the effects of change in export-import in these industrial groups on aggregate trade factor intensity. In the dual–industrial development categories, structural change in the export-import of A and C contributes to the capital intensification of trade. But D has the reverse effect of labor intensification. The patterns of industrial development by import substitution of capital-intensive intermediate industries (A) and by export from labor-intensive industries (C and D), which is emphasized by the dual–industrial development hypothesis, is delineated from the viewpoint of factor

TABLE XI

EXPORT-IMPORT ELASTICITY OF FACTOR INTENSITY
OF TRADE BY INDUSTRIAL GROUP

A. KOREA

	Export $(\gamma_j{}^e)$		$(-)$Import $(\gamma_j{}^m)$	
	1970–75	1975–80	1970–75	1975–80
Dual–industrial development				
A	0.01758	0.04934	0.15451	0.11354
B	0.00150	0.01889	0.04113	0.04940
C	0.01463	0.00784	0.04324	0.01046
D	−0.02203	−0.00408	0.09690	0.07669
Chenery-Taylor				
Initial	−0.02055	−0.03605	−0.00469	−0.02193
Intermediate	0.00801	0.01100	0.09509	0.04137
Mature	0.01475	0.05330	0.08892	0.08234
(Machinery)	0.00950	0.04374	0.15646	0.14777

B. JAPAN

	Export $(\gamma_j{}^e)$		$(-)$Import $(\gamma_j{}^m)$	
	1970–75	1975–80	1970–75	1975–80
Dual–industrial development				
A	0.13896	0.12817	0.09010	0.06949
B	0.00978	0.00939	0.00282	0.00376
C	−0.03500	−0.02571	0.00427	0.00195
D	−0.01676	−0.02238	−0.04617	−0.02951
Chenery-Taylor				
Initial	−0.05541	−0.04355	−0.05492	−0.03821
Intermediate	0.04205	0.04646	0.03910	0.03748
Mature	0.09632	0.08396	0.05562	0.03580
(Machinery)	0.01400	0.00260	0.01122	0.01062

Source: Compiled by author.

intensity of trade. In other words, capital-intensive intermediate goods industries create capital-intensive effect (64.7 per cent in 1975–80) through import substitution, which is much larger than labor-intensive effect (−3.7 per cent) produced by exports from labor-intensive industries, i.e., dual-development industrialization causes the trade structure to capital-intensify.

The dominant feature of the Chenery-Taylor industrial categories is that changes in the export-import structure of the mature industrial group make trade more capital intensive. Comparing the two countries, Korea's structure in 1975–80 is almost the same as Japan's structure in 1965–70. Taken in combination with the results shown in Table XII, and viewed from just the categories of the Chenery-Taylor hypothesis, suggests a similarity between the trade-industry structure of the two countries during this period.

TABLE XII

RATE OF CONTRIBUTION OF EXPORT-IMPORT BY INDUSTRY GROUP

	Korea		Japan	
	1970–75	1975–80	1965–70	1970–75
Dual–industrial development				
A	21.67	64.68	71.09	301.91
B	0.908	14.72	−6.46	31.22
C	17.36	11.87	163.77	84.47
D	0.91	−15.52	−163.36	20.14
Total	40.41	75.75	65.04	437.74
Chenery-Taylor				
Initial	0.84	24.31	19.88	100.08
Intermediate	1.44	14.79	9.07	76.68
Mature	33.56	60.25	65.64	221.80
(Machinery)	5.01	−23.60	−29.56	39.18

Source: Compiled by author.

V.   CONCLUSION

As factor intensity in the industrial development process shows, the trade structure in Korea during the 1970s was becoming more capital intensive, especially in the manufacturing sector, and it would be inappropriate to explain industrialization during this period as specialization toward labor-intensive industry. The manufacturing sector's trade-industry structure was, in the aggregate, becoming more capital intensive during this period. The simultaneous forward movement of import substitution in the capital-intensive industries and export expansion in the labor-intensive industries was supporting a dual–industrialization pattern. This final section summarizes the findings.

First, seen from factor intensity, changes in the Korean trade structure were toward labor intensification in 1970–75 and toward capital intensification in 1975–80 and 1980–83. The labor intensification during 1970–75 was mainly caused by a decline in agriculture-forestry-fishery imports. The manufacturing sector was contributing to capital intensification.

Second, a comparison of 1970–75, 1975–80, and 1980–83 shows that changes in the input-output coefficient and the export structure, during the latter 1970s, made the Korean trade more capital intensive. In 1980–83, the export-import structure changed significantly toward capital intensification, while the factor-input structure reversed.

Third, a very interesting thing about observations by industry is that the capital intensity for each industry and the capital intensity of aggregate trade do not always match. That is to say, expansion in exports by labor-intensive industries does not always result in increased labor intensity in the trade structure. The measurements in this paper show that many industries in the Korean manufacturing sector during the 1970s and early 1980s were simultaneously moving ahead with export

promotion and import substitution, and the changes in almost all industries were creating a more capital-intensive trade structure.

Fourth, the 1970s' and 1980s' trade structure is labor abundant for trade with Japan and Western Europe and capital abundant for trade with ASEAN and the United States-Canada. The structure of trade with the Asian NICs is horizontal.

Fifth and last, the Chenery-Taylor industrial categories show that Korea's trade structure in 1975–80, as seen from factor intensity, is very similar to the Japanese structure in 1965–70.

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APPENDIX TABLE

A. FACTOR INTENSITY OF TRADE

	1980	1983	Rate of Change (%)
F_a	9.735	12.438	27.76
F_m	9.692	11.793	21.68
F	1.004	1.055	5.003

B. RATE OF CONTRIBUTION TO CHANGES IN FACTOR INTENSITY OF TRADE, 1980–83 (%)

Trade	160.31
Factor input	−115.60
Input-output	55.33

C. FACTOR INTENSITY OF TRADE (F) BY REGION

	Japan	Asian NICs	ASEAN	U.S.A.-Canada	Western Europe
1980	0.4304	1.343	7.895	1.518	0.5458
1983	0.5834	0.9508	6.551	1.655	0.7684