PART 3

TRADE THEORIES AND THE REAL WORLD TRADE PATTERNS

6. A Comparative Static Application of the Heckscher-Ohlin Model of Factor Proportions: Korean Experience

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A COMPARATIVE STATIC APPLICATION OF THE HECKSCHER-OHLIN MODEL OF FACTOR PROPORTIONS: KOREAN EXPERIENCE

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I. INTRODUCTION

ach of the so-called empirical tests of the Heckscher-Ohlin theorem as reviewed in Deardorff [1984] was undertaken in a static setting. This paper applies the comparative static version of the Heckscher-Ohlin model as the basis for an empirical analysis of the Korean experience, and demonstrates that the evolution of Korea's trade pattern has conformed over time to what might be expected under a comparative static version of the Heckscher-Ohlin theorem, combined with changing capital and labor endowments.[1]

Our comparative static approach is based on the models of Rybczynski [1955], Jones [1971; 1974] and Krueger [1977] that imply certain aspects concerning the composition of output and real wages as capital accumulates, and hence suggest a plausible simple relationship among trade, factor endowments and factor intensities. As Deardorff [1984] correctly points out, the Heckscher-Ohlin trade theory is not yet stated in the forms that are compatible with the real world complexities, and the so-called empirical tests do not derive rigorously from the theories.[2] Unfortunately, our approach is also subject to the same type of criticism: the intuitive content of the com-

[1]As noted by Deardorff, the Heckscher-Ohlin theorem is a relationship among three variables: factor abundance, factor intensity, and trade. And yet most of the studies reviewed in Deardorff [1984] have looked at trade and factor intensities at a given point in time. However, our comparative static approach rather naturally involves data on shifting factor endowment and examines the consistency among all three variables.

[2]This point is very much elaborated by Leamer [1984, pp. 1-59].

parative static Heckscher-Ohlin model is quite simple and straightforward, but what is done in this paper is again a simple empirical observation using the Heckscher-Ohlin model as "a basis" of analysis.

Section II summarizes the essential comparative static propositions on shifting production and trade patterns that are implied by the 2-sector, 3-factor Rybczynski-Jones-Krueger model with a primary good sector and a multi-commodity manufacturing sector. Section III reviews the Korean experience and finds it roughly consistent with the model. It presents some relevant estimates of the shifts in factor endowment ratio, factor prices and factor intensities as well as the shifts in commodity and factor content of Korea's trade during the period 1960-1980. Section IV gives a concluding remark. The Appendix contains in the first part the basic framework of the 2-sector, 3-factor model presented in Section II, and in the second part the conditions under which trade reveals a country to be labor abundant.

II. MULTI-COMMODITY COMPLETE SPECIALIZATION TRADE MODEL

As in Jones [1971], Krueger's [1977] 2-sector, 3-factor, multi-manufactured-commodity complete specialization model postulates that land $(\bar{L})$ is a specific factor in the primary sector (X-sector) and capital (K) is a specific factor in the manufacturing (Y_i-sector), while labor $(\bar{N})$ is mobile between these two sectors.[3] Every production function is linear homogeneous with respect to either labor and capital or labor and land. This model can accommodate the Lewis type segmented labor markets that are typically observed in the early stage of developing economies. The manufacturing wage rate equals the marginal product of labor in the primary sector in the neoclassical full-employment economy or equals a given constant subsistence wage rate in a "pure" Lewis economy of infinite supply of labor.[4] We may now write down the important propositions that are implied by the Rybczynski-Jones-Krueger version of the comparative static Heckscher-Ohlin

[3]It is assumed that manufactured commodities can be ordered for all possible wage-rental ratios so that commodity 1 (Y_1) has the lowest capital-labor ratio, commodity 2 (Y_2) has the next lowest, and so on up to commodity n (Y_n) which has the highest capital-labor ratio.

[4]In a "modified" Lewis economy, the manufacturing wage rate equals the marginal product of labor in the manufacturing sector but the manufacturing minimum wage floor is determined by the (variable) average per worker income in the traditional primary sector that keeps increasing as labor migrates to the manufacturing sector.

theorem (see also the Appendix).

Proposition 1: Consider an equilibrium with manufacturing production being specialized in the most labor-intensive commodity Y_1. In a "pure" Lewis economy, the real wage would remain constant at a given subsistence level even if there were capital accumulation and manufacturing output expansion. For a country that started as an X-exporter, there would inevitably come a point where it became a Y_1-exporter. Furthermore, the lower the initial land per labor endowment, the smaller would be the capital accumulation necessary to reach the "crossover point".[5]

Proposition 2: Once the country reaches the stage of a neoclassical full employment economy (or a modified Lewis economy), capital accumulation and the associated labor migration to the manufacturing sector will start raising the wage (and lowering the rental on capital), thereby leading to capital deepening in Y_1 manufacturing. If capital accumulation in the manufacturing sector continued, a point would be reached at which the wage-rental ratio rendered profitable the production of the less labor-intensive Y_2 as well as the most labor-intensive Y_1.[6]

Proposition 3: A region is defined as a group of countries sharing the same initial factor price ratio. The propositions 1 and 2 forecast the production of relatively few (i.e., one or two) manufacturing commodities at each stage of development. As Krueger [1977, p. 16] indicates, however, how many constitute "few" depends on the number of commodities relative to the number of regions; "failure of production pattern to overlap might still imply

[5]For any given countrywide capital-labor endowment, the manufacturing sector's capital-labor ratio depends on the country's land-man ratio: the more land there is, the higher will be the marginal (and average) product of labor in the primary sector, the more capital-intensive the manufacturing sector of specialization, the more capital intensive the techniques of production used within this manufacturing sector and the lower will be the rate of return on capital. In a land-abundant country, the comparative advantage within manufacturing need not lie, from the beginning, in the extremely labor-intensive commodities (such as Y_1). [See Krueger, 1977; Jones, 1971.]

[6]At that point, continued capital accumulation would result in increased output of Y_2 and reduced output of Y_1, following the Rybczynski theorem, and the factor prices and number of the manufacturing labor force will be constant. At some point, the overall manufacturing capital-labor ratio would reach the capital-labor ratio of Y_2 production, specialization would be complete in Y_2, and then the wage-rental ratio as well as the capital intensity of Y_2 would start increasing as further capital accumulation occurred. Leamer [1984, p. 20] also derives the same results with a 3-good 2-factor model.

the production of a sizable number of individual manufacturing commodities" in each region. Furthermore, protection may enable domestic production of all noncompeting importables. In a capital-poor country the level of protection necessary for domestic production increases monotonically as the commodities lie further away (in terms of their capital intensities) from the region's (to which the country belongs) natural specialization set. However, the "(output) weighted average" sectoral capital intensities should in any case equal the overall (aggregate) manufacturing capital-labor ratio of a country. As such, the actual output weight for extremely capital-intensive protected sectors would be severely limited (not only by the protection costs but also) by the inadequate domestic capital endowments.[7] That is, with protection, every manufactured commodity can be produced domestically and yet, due to the limited capital endowment, output and export of a relatively capital-poor country would still be dominated by relatively labor-intensive commodities and its imports by capital-intensive ones. However, due to the indeterminacy problem, our proposition does not imply that, in a capital-poor country, "the more" labor intensive is a sector, "the larger" will be its exports. Output weights should be larger for labor-intensive sectors as a whole but the weights do not have to be distributed strictly in proportion to labor intensities.[8] Therefore, the capital accumulation of a country should imply the shifting of "output weights" towards more capital-intensive sectors "on average" and, unless the shifts in domestic demand pattern more than offsets (factor-content-wise) the shifting output pattern, the "export weights" of the country should shift towards more capital-intensive commodities and import

[7]In the absence of protection, the more labor-abundant of any pair of regions cannot produce any commodity more capital intensive than the least capital-intensive commodity produced in the other. If the two regions produce a commodity in common, the more labor-abundant region would have a lower wage-rental ratio and would produce the common commodity using a more labor-intensive technique. At least one commodity produced in a region will be exported to other regions and all nonproduced commodities will constitute (noncompeting) importables. All the exports of a region to capital-richer regions will be more labor-intensive commodities than all its imports from them. The opposite is true in its trade with capital-poorer regions. The intra-regional pattern of specialization is bound to be indeterminate.

[8]In other words, our proposition does not imply a strictly negative correlation between the sectoral export magnitude and sectoral capital intensity in a capital-poor country. Output or export weights may well be concentrated on a few labor-intensive sectors. In a multi-commodity framework, the Hecksher-Ohlin theory holds in a weighted average sense and not in the strictly positive or negative correlations sense. For the indeterminacy of output and trade pattern, see Hong [1969; 1970] and also Deardorff [1982].

weights should shift towards more labor-intensive commodities "on average" (see second part of the Appendix).

These propositions show that a so-called empirical test of the Heckscher-Ohlin theory cannot consist exclusively of the testing of the factor intensity characteristics of exports or imports but should also include the testing of differences in capital intensities of manufacturing among different regions in a cross-section analysis, and the testing of shifts in these intensities over time in a growing economy in a time-series analysis.

III. THE KOREAN EXPERIENCE: AN INTERPRETATION

1. Cross-Over Point in a Pure Lewis Economy

According to the Korean manufacturing census data, the number of workers employed in manufacturing increased by about 10 percent per annum on average during 1958-1966 and there was no increase in the real wage rate.[9] Therefore, one may regard the period prior to 1967 in Korea as having been consistent with the pure Lewis economy of infinite supply of labor to manufacturing sector from traditional sectors. It was during this period (i.e., 1962-1966) that the Korean government launched the export promotion drive.

In 1960, total commodity exports of Korea amounted to about $31.8 million and among them only about $4.5 million (14 percent) belonged to SITC code numbers 5 through 8. About 85 percent of these so-called manufactured products consisted of the following seven items: cotton fabrics ($2.44million), pig iron ($0.46 million), unwrought bismuth ($0.33 million), electrolytic copper ($0.22 million), ginseng tonic ($0.21 million), menthol and menthol balls ($0.09 million), and rock crystal ($0.06 million). By 1966, however, total commodity exports amounted to $250 million and, according to the input-output table, 82 percent of them consisted of manufactured products. Having had the fourth highest population density in the world (following the Netherland, Taiwan and Belgium), Korea could reach the "cross-over point" from a primary goods exporter to a manufactures exporter with a slight capital accumulation and a vigorous export drive.

[9]Nominal farm household income increased by about 18 percent per annum on average during 1962-1966 and the average manufacturing wage also increased by about 18 percent per annum during 1960-1966. Since there was an inflation of about 18.7 percent per annum on average during 1960-1966 (approximated by changes in the GNP deflator for the whole industry), there was no increase in either real farm household income or real wages during the period.

Table 1 presents the shifting factor content of Korea's commodity exports. The ratio of capital to labor directly and indirectly employed in the Korean manufacturing sector for the production of its entire commodity exports (which include primary goods) did not increase during 1960-1966. It rather declined slightly from 3.2 in 1960 to 3.0 in 1966 (in thousand 1980 dollars per worker). Furthermore, Table 2 shows that the capital intensity of the Korean manufacturing sectors did not increase either during 1960-1966.

Table 1 - *Factor Intensity of Commodity Trade*[a]
(in thousand 1980 dollars per worker[b])

	1960	1966	1980[c]
Whole industry			
Exports.	1.9	2.8	10.3
Imports.	1.5	4.3	12.9
Manufacturing			
Exports.	3.2	3.0	8.9
Imports.	3.9	4.8	12.2

[a]Factor intensity represents the ratio of capital to labor which were (directly and indirectly) required in the whole industry or in the manufacturing sector only in order to produce total commodity exports or to replace competitive imports. Factor requirements were computed by applying the matrix of domestic input coefficients (A^d). 1960 figures were computed by applying the 1963 A^d matrix. -
[b]The 1980 prices for 1960 and 1966 figures were obtained by applying the GNP deflator for capital formation in manufacturing and the exchange rate of 631.4 won per dollar to the sectoral trade and input coefficient data expressed in 1970 prices in Hong [1979]. - [c]For the capital-output ratios of non-manufacturing sectors in 1980, the 1977 capital coefficients based on the 1977 National Wealth Survey were used, and therefore the capital requirements for 1980 exports and import replacements must have been somewhat underestimated.

Source: Bank of Korea [1963; 1966; 1980]; Economic Planning Board [1960; 1966; 1977; 1980]; Hong [1979].

Unlike the ratio for the "manufacturing sector" only, the ratio of capital to labor which was directly and indirectly employed in "whole industry" for the production of Korea's entire commodity exports increased significantly during 1960-1966. The disparity between these two ratios reflects the rapidly declining protion of primary products (which had extremely low capital intensities) in Korea's total commodity exports during 1960-1966 (declining from 53 percent in 1960 to 31 percent in 1963 and to 18 percent in 1966).[10]

[10]The Proposition 1 in Section II assumes that primary product (X) is land intensive

Table 2 - *Factor Intensities of Manufacturing Sectors*[a]
(in thousand 1980 dollars per worker[b]*)*

Sector	Capital/labor ratio		
	1960	1966	1980
Wearing apparel.	1.5	1.6	2.1
Electronics & telecom	2.1	1.7	4.6
Misc. manufactures	4.1	2.6	5.3
Textiles.	3.1	3.1	7.4
Intermediate products I	3.7	3.8	8.7
Food products	5.1	5.0	11.8
Machinery.	3.5	3.7	11.2
Transport equipment	4.2	4.0	16.6
Intermediate products II	5.5	5.8	19.6
Iron & steel	5.4	3.6	44.5
All manufactures	3.9	3.8	10.4

[a]In oreder to reduce the complexities in analysis of output and trade pattern, manufacturing sectors are aggregated into nine groups in this paper taking account of the similarities in capital intensities: wearing apparel (including footwears, leather products and miscellaneous textile products), electronics & telecommunication equipment, textiles, miscellaneous manufactures (including precision instruments, furniture and printing), intermediate products I (consisting of wood products, rubber products and metal products), machinery (including electrical machinery), transport equipment, intermediate products II (consisting of chemicals, petroleum & coal products, nonmetallic mineral products, nonferrous metal products, and pulp & paper products), and iron & steel products. - [b]1980 prices were obtained by applying the GNP deflator for fixed capital formation in manufacturing and the exchange rate of 613.4 won per dollar.

Source: Economic Planning Borad [1960; 1966; 1980].

The relatively low capital intensity of competitive import replacements in 1960 seems to be due to the absence of well diversified import-substitution activities in relatively capital-intensive manufacturing sectors. In 1960, only about 30 percent of total manufactured imports could be classified as "competitive imports." Though still insignificant in absolute magnitude involved, there appeared vigorous import-substitution efforts in various

and never uses capital in its production process. In discussing our empirical results, however, primary product simply becomes the extremely labor-intensive product. This is just an example of what is implied by the statement that the Heckscher-Ohlin theory is not yet stated in the forms that are compatible with the real world complexities.

capital-intensive manufacturing sectors during 1960-1966. Consequently, about 70 percent of Korea's manufactured imports in 1966 could be classified as "competitive imports," and so do we observe the relatively high capital intensity of competitive import replacements in 1966.[11]

Table 3 presents the shifts in sectoral weights in the form of "growth" elasticities, i.e., percentage change in the value of sectoral gross outputs, domestic demand, exports and imports divided by the percentage change in total gross output value of all manufacturing during 1960-1966 and 1966-1980. In terms of the percentage share in total manufactured exports, food products, textiles, intermediate products I and miscellaneous manufactures were "major" export sectors of Korea in 1960 and also in 1966. However, if we examine the growth elasticities of sectoral exports for the period 1960-1966, we can see that the most rapidly expanding (i.e., leading) export sectors were electonics & telecommunication equipments, wearing apparels, intermediate products I, and iron & steel.[12] Table 2 shows that these "leading" export sectors of Korea during the period 1960-1966 were the relatively labor-intensive ones. Wearing apparel and electronics & telecommunication equiment were the most labor-intensive sectors. In 1966, the capital intensity of intermediate products I was equal to the manufacturing average. Korea did not have an integrated steel mill until the 1970s and hence the iron & steel sector had a below average caital intensity in 1966. The growth elasticity of output of every labor-intensive sector was larger than its domestic demand elasticity during 1960-1966.[13]

[11]In any case, if we examine Table 1, the capital intensity of competitive-import replacements does not look much higher than that of exports in Korea. However, Hong [1979] shows that the capital intensity of "non-competitive imports" was much higher than that of either exports or competitive-import replacements.

[12]As of 1966, the absolute export magnitude of electronics & telecommunication equipment and iron & steel was still insignificant, but there was a drastic increase in export-output ratios of these two sectors during 1960-1966.

[13]However, in cases of the moderately capital-intensive machinery and transort equipment sectors, we could observe demand elasticites significantly exceeding output elasticities and consequently revealing very high growth elasticities of imports. In the case of the highly capital-intensive intermediate products II, the output elasticity significantly exceeded demand elasticity but what we observe is not a high growth elasticity of exports but instead a low growth elastidity of imports. These suggest that intermediate products II was the heavily protected capital-intensive import-substitute sector, while the moderately capital-intensive machinery and transport equipment sectors were the "not-so-heavily-protected" major import sectors of Korea during 1960-1966.

	Growth elasticity[a] *during*							
	1960-1966				1966-1980			
	output	demand	export	import	output	demand	export	import
Wearing aparel.	1.4	1.2	12.4	0.4	0.8	0.5	2.2	2.4
Electronics & telecom	32.3	17.2	175.0	9.7	5.5	4.2	13.3	5.2
Misc. manufactures. .	1.05	0.6	4.1	0.1	0.9	0.8	1.5	1.9
Textiles.	0.8	0.7	3.8	4.8	0.6	0.5	1.2	0.6
Intermediate prod. I.	0.8	0.7	6.8	3.2	0.6	0.4	1.1	0.4
Food products.	0.8	0.8	2.7	1.0	0.8	0.9	0.4	1.6
Machinery.	1.0	1.6	1.3	2.2	1.5	0.9	2.3	0.7
Transport equipment	1.7	3.0	0.5	11.3	0.8	0.5	14.0	0.5
Intermediate prod. II	1.3	1.0	3.1	0.7	1.4	1.1	2.5	0.7
Iron & steel.	1.5	1.4	4.5	1.5	2.2	1.5	5.2	0.8
All manufactures. . .	1.0	0.95	4.1	1.1	1.0	0.87	1.8	0.8

[a]Percentage change in sectoral gross output, domestic demand, export and import value divided by percentage change in total manufacturing output value during 1960-1966 and 1966-1980.

Table 3 - *Sectoral Weight Shifts in Manufacturing*

Source: Bank of Korea [1960; 1966; 1980].

2. Rising Wage Rate and Capital Deepening

During 1966-1980, the number of workers employed in the Korean manufacturing sector expanded by about 3.6 times (i.e., by 9.5 percent per annum on average). The real wage rate (obtained by applying the GNP deflator for manufactring value added) increased by about 11.6 percent per annum on average, while the capital intensity of the manufacturing sector increased by about 7.5 percent per annum.[14] Assuming a constant constant rental price on capital, such rates of change imply a point elasticity of factor substitution of about 0.65 for the period. However, this must be an overestimation of the actual elasticity of substitution because, owing to the increased availability of domestic and foreign capital, if there were any change in rental

[14]During 1967-1975, both farm household income and manufacturing wage rose by about 24 percent per annum on average in nominal value and during 1976-1983 both increased by around 25 to 26 percent per annum on average in nominal value. The most surprising fact is the almost exact similarity between the rates of change in farm household income and those of manufacturing wages during each time period.

[15]Postulating a declining rental on capital, Hong [1979, pp. 236-237] persents 0.4 as

on capital during this period that may well have been a fall.[15] In our paper, "capital deepening" is understood as the change in sectoral capital intensity in response to the rising (sectoral) wage-rental ratio, i.e., the point elasticity of factor substitution.

3. Shifting Commodity and Factor Content of Trade

In the 1970s, there emerged a new group of "leading" export sectors in terms of the rates of expansion (if not in terms of the absolute magnitudes) consisting of machinery, transport equipment and iron & steel products. These belonged to the relatively capital-intensive group of sectors making Korea's overall commodity composition of exports shift towards more capital-intensive ones. In Table 1, we can see that the ratio of capital to labor which were directly and indirectly employed in the Korean manufacturing sector for the production of its entire commodity exports rose from 3.0 in 1966 to 8.9 in 1980.

Table 4 shows that Korea was the net importer of every manufactured commodity except textiles in 1960. By the mid-1960s, Korea became a net exporter of every labor-intensive manufactured commodity except electronics & telecommunication equipment. By 1980, electronics also became a net export sector of Korea. Among the capital-intensive commodities, iron & steel became the net export sector of Korea in 1980.

Although Korea has always been a net importer of agricultural products, due to lack of domestic demand, Korea was a net exporter of mineral ores until the late 1960s. One can see from Table 4 Korea's comparative advantage being revealed strongly first in the labor-intensive manufactures and then spreading into some capital-intensive commodities such as iron & steel (generating domestic demand for mineral ores) and transport equipment. On the other hand, Korea's comparative disadvantage was revealed most strongly in capital-intensive manufactures (especially in machinery and intermediate products II), agricultural products and, later, also in minerals.

In Korea, we could clearly observe the labor-intensive sectors dominating its commodity exports in the early phase of export-oriented growth and the capital-intensive export sectors emerging in the later phase. Furthermore, Table 2 clearly shows that the techniques of production of every

an estimated point elasticity of substitution for the Korean manufacturing sector during the period 1967-1973. This point elasticity of 0.65 (or 0.4) in an expost accounting sense is consistent with the actual elasticity of 0.65 and neutral technical progress but is also consistent with, say, Cobb-Douglas production function and strongly biased (such as labor-augmenting) technical progess.

manufacturing sector became very much capital-intensive during 1966-1980.

	1960	1966	1970	1980
Labor-intensive sectors				
Wearing apparel.	– 0.006	0.10	0.52	3.3
Electronics & telecom. . . .	– 0.001	– 0.01	– 0.04	0.3
Textiles	0.007	0.05	0.01	1.2
Misc. manufactures.	– 0.104	0.03	0.16	0.6
Intermediate products I . .	– 0.002	0.05	0.07	1.4
Capital-intensive sectors				
Food products.	– 0.013	0.03	– 0.10	– 0.9
Machinery	– 0.079	– 0.37	– 0.82	– 3.2
Transport equipment	– 0.005	– 0.20	– 0.40	– 0.6
Intermediate products II. .	– 0.341	– 0.42	– 0.75	– 2.8
Iron & steel	– 0.034	– 0.09	– 0.32	0.2
All manufacturing	– 0.579	– 0.83	– 1.67	– 0.5
Agricultural products. . . .	– 0.292	– 0.39	– 0.26	– 2.3
Minerals.	0.014	0.02	– 0.90	– 6.5

[a]Applying the GNP deflator for manufacturing value added and the exchange rate of 613.4 won per dollar.

Table 4 - *Sectoral Net Exports: Commodity Composition of Trade (billion 1980 dollars*[a])

Source: Bank of Korea [1960; 1966; 1970; 1980; 1984].

During 1966-1980, the labor-intensive sectors consisting of textiles and intermediate products I as well as food products revealed very low growth elasticities of output and exports. The percentage share of these sectors in total manufactured output and exports drastically declined during this period. On the other hand, the output elasticity of the electronics & telecommunication sector was extremely high and so was its export elasticity. The output elasticity of wearing apparel was relatively low but its absolute magnitude significantly exceeded that of the domestic demand elasticity and consequently revealed a high growth elasticity of exports.

Among the capital-intensive sectors, machinery, intermediate products II and iron & steel had very high output and export elasticities. As with wearing apparel, the output elasticity of transport equipment was relatively low but its magnitude significantly exceeded that of its domestic demand elasticity and consequently it had a high growth elasticity of exports.

Among the labor-intensive sectors, wearing apparel and electronics & telecommunication equipment kept increasing their shares in total

manufacturing employment throughout the 1960s and 1970s. Because of the "indeterminacy" element, the increase in output or export share of some labor-intensive sectors (in spite of the continuous capital accumulation and an overall capital deepening in Korea) does not contradict the multi-commodity Heckscher-Ohlin trade theory so long as the weighted average capital intensity of Korea's manufactures exports as a whole keeps increasing in accordance with the progress in per worker capital accumulation in its manufacturing sector as a whole.

Tables 1 and 2 show that the (average) capital intensity of Korea's manufacturing production as a whole was larger than the ratio of capital to labor employed in the manufacturing sector for the production of its entire commodity exports but smaller than that for the replacement of the competitive imports in 1966 and also in 1980. These results suggest that Korea was relatively abundant in labor in 1966 and also in 1980, though there was a substantial increase in capital per worker over the period 1966-1980 (see Appendix).

IV. CONCLUDING REMARKS

Krueger [1977] suggests that the policy-cum-structural factor market distortions in the form of, say, lower rental-wage rates applied to the capital-intensive manufacturing sectors in a labor-abundant country would result in expanded production and exports of the excessively capital-intensive commodities with excessively capital-intensive techniques of production, while the relatively higher rental-wage rates that would result for the labor-intensive manufacturing sectors would make the very labor-intensive sectors to become profitable with excessively labor-intensive techniques of production. This implies that, across the country, we should expect to observe more significant disparities in capital intensies of manufacturing sectors and manufactured exports of a country with substantial factor market distortions than in those of a country with moderate distortions in factor markets, and that, within a country of substantial factor market distortins, we should expect the disparities to become more conspicuous as time passes. On the other hand, Deardorff [1979] suggests that the domestic production of extremely capital-intensive commodities in a labor-abundant country behind a high protectionist wall will lower the wage rate in the country and hence induce the production of extremely labor-intensive commodities in place of the commodities with intermediate capital intensities, making these extremely labor-intensive commodities the export goods of the country.

In this paper, we have observed that the evolution of Korea's trade pattern

has conformed over time to what may be expected under the comparative static version of the Heckscher-Ohlin theorem. However, we could not show to what extent the observed pattern has been influenced by the distortions in factor and commodity markets. Furthermore, Korea has been expanding its trade with less developed countries than itself, and yet this paper has not attempted to measure the differences in factor intensity of Korea's trade disaggregated by destination and origin.

The "application" of "static" theory of comparative advantage is difficult because there is no experience with autarky from which to draw price data. However, in our observation of the "comparative static" aspect of comparative advantage, although the relationship between trade and prices is not yet well understood, at least the fact that a country has engaged in trade throughout history does not become so critical. Admittedly, our study is far from a conclusive test of the Heckscher-Ohlin theory. But it is highly suggestive and hence would foster understanding of growth and trade phenomena and would stimulate the efforts for a more rigorous and theoretically correct empirical "test" of the trade theories.

APPENDIX

A 3-Factor, 2-Sector Model: The Basic Framework

We now write down the basic structure of the 3-factor, 2-sector multi-manufactured-commodity complete-global-specialization (à la Krueger) model presented in Section II. We let w represent wage, r the rental on capital, v the rent on land, n_i and k_i the quantity of labor (N_{yi}) and capital (K_i) used per unit output in the ith manufacturing of Y-sector, respectively, and n_x and z_x the quantity of labor (N_x) and land (L) used per unit output in the X-sector, respectively. With a small open economy we may further, without loss of generality, normalize the unity for every commodity price. Total amounts of labor (N) and land (L) are given constant. Then the basic competitive equilibrium relations for the model can be summarized as follows:

Case A: Complete specialization in Y-sector in one manufactured com-

$$z_x = z_x(w/v) \tag{A.1.1}$$

$$n_x = n_x(w/v) \tag{A.1.2}$$

$$n_1 = n_1(w/r) \tag{A.1.3}$$

$$k_1 = k_1(w/r) \tag{A.1.4}$$

$$z_x v + n_x w = 1 \tag{A.2.1}$$

$$k_1 r + n_1 w = 1 \tag{A.2.2}$$

$$(n_x / z_x)\bar{L} + (n_1 / k_1)K = \bar{N} \tag{A.3.1}$$

modity, say Y_1:

Case B: Incomplete specialization in Y-sector with wage and rental (w^*, r^*)

$$k_i^* = k_i(w^*/r^*) \tag{B.1.1}$$

$$n_i^* = n_i(w^*/r^*) \tag{B.1.2}$$

$$n_x^* = n_x(w^*/v^*) \tag{B.1.3}$$

$$z_x^* = z_x(w^*/v^*) \tag{B.1.4}$$

$$k_i^* r^* + n_i^* w^* = 1 \tag{B.2.1}$$

$$z_x^* v^* + n_x^* w^* = 1 \tag{B.2.2}$$

$$\sum_i k_i^* Y_i = \sum_i K_i = K \tag{B.3.1}$$

$$\sum_i n_i^* Y_i = \sum_i N y_i = N_y \tag{B.3.2}$$

$$n_x^* X = N_x \tag{B.3.3}$$

$$z_x^* X = \bar{L} \tag{B.3.4}$$

$$N_x + N_y = \bar{N} \tag{B.3.5}$$

rigidly tied to the given world manufactured commodity prices (i.e., unity): where the subscript *i* represents any two manufactured commodities actually in production out of n commodities in Y-sector, and $k_1/n_1 < k_2/n_2 < \ldots < k_n/n_n$.

Case C: Complete specialization in Y_1 in Y-sector in pure Leontief economy

$$k_1 = k_1(\bar{w}) \tag{C.1.1}$$

$$n_1 = n_1(\bar{w}) \tag{C.1.2}$$

$$k_1 Y_1 = K \tag{C.2.1}$$

$$n_1 Y_1 = N_y \tag{C.2.2}$$

$$\bar{N} - N_y = N_x \tag{C.2.3}$$

in which wage equals the given constant subsistence wage rate
In a modified Lewis economy, we have $w = f(z_x / n_x)$.

In Case A of complete specialization, there exists, as proved by Jones [1971, p. 7], the general monotonic relationship between factor returns and factor endowments independent of the given set of commodity prices.[16] In Case B of incomplete specialization in Y-sector, (a small) capital accumulation does not alter factor prices. We only observe the Rybczynski effect with a constant N_y. In Case C of pure Lewis economy, there is no change in factor prices and factor intensity of the manufacturing sector, but the number of labor employed in the X-sector keeps decreasing as capital accumulates in the manufacturing sector.

Factor Content of Trade: Trade-Revealed Factor Abundance

We adopt Leamer's version [1984, pp. 15-53] of the static Heckscher-Ohlin-Vanek model and let the following two equations describe the relation

$$K_t = K - sK_w \tag{1}$$

$$N_t = N - sN_w \tag{2}$$

between K_t, factor $K_e - K_m$, $N_t = N_e - N_m$, K_e and N_e and the implicit trade in factor services that are employed in the manufacturing sector:
where are capital and manufacturing worker services embodied in commodity exports, respectively, K_m and N_m those embodied in competitive import replacements, respectively, K and N are the factor supplies to the manufacturing sector of the country in question, K_w and N_w are the total world's factor supplies to manufacturing sectors of all

[16] In a 3-factor (K, N, L) 2-commodity (X, Y_1) model of Case A, the profit conditions are insufficient to determine the factor returns solely from a knowledge of commodity prices. Eqs. A.2.1, A.2.2 and A.3.1 privide a set of three relationships in the three factor prices and, as parameters, the two commodity prices and all the factor endowments [see Jones, 1971, pp. 5-7].

countries, and s is the country's consumption share. These two equations are manipulated to obtain the conditions under which trade reveals the country to be labor abundant.

Theorem: $K_m/N_m > K/N > K_e/N_e$ implies that the country's manufacturing

$$N(K - K) > K(N - N_t), \text{ or } -NK_t > -KN_t. \quad (3)$$

sector is relatively abundant in labor, i.e., $N/N_w > K/K_w$ (or $K_w/N_w > K/N$).

Proof: Eqs. (1) and (2) imply that $N/N_w > K/K_w$ if, and only if,
Suppose first that $K_e - K_m = K_t < 0$, and $N_e - N_m = N_t < 0$; then since $NK_m > KN_m$ and $KN_e > NK_e$, we get $N/N_w > K/K_w$. Now suppose that $K_t > 0$ and $N_t > 0$; then since (3) becomes $NK_t < KN_t$, we get $N/N_w > K/K_w$. If $K_t < 0$ and $N_t > 0$, then the simple fact that $K_m/N_m > K_e/N_e$ implies $N/N_w > K/K_w$ as proved by Leamer [1984, p. 53].[17] Q. E. D.

In a 2-factor multi-commodity model, the commodity composition of trade is indeterminate but the net flow of factor services is not. What is happening is that, as Leamer [1984, p. 17] states, any given net export of factor services can be achieved in many different bundles of net commodity exports.

As shown before, capital accumulation implies an increase in the K/N ratio (where $N = \sum N_i$) with or without an increase in the wage rate. Unless the shift in domestic demand pattern more than offsets (factor-content-wise) the shifting production pattern, we expect the K_e/N_e ratio to increase. This result is assured in the world of identical homothetic utility function. However, so long as the country in question is relatively abundant of labor, the relationship $K_m/N_m > K/N > K_e/N_e$ will be maintained.

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[17]Leamer [1984] insists that the proper procedure to examine the trade-revealed factor abundance when K_t and N_t have both positive or negative signs is to compare K_t/N_t with K/N or with K_c/N_c where K_c and N_c represent factors embodied in the commodities used in the country in question. We have shown that factor abundance can be revealed simply by comparing the more conventional K_m/N_m and K_e/N_e with

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