ABSTRACT

NATIONAL CHARACTERISTICS AND THE
COMMODITY COMPOSITION OF TRADE
IN MANUFACTURED GOODS

By

Sohrab Behdad

This study is a test of the Heckscher-Ohlin theory and alternative theories of international trade.

By applying the most recent input-output tables and the industry input coefficients of the United States, the United Kingdom, and South Korea to their bilateral trade structure, it is found that the Heckscher-Ohlin theory is capable of explaining the commodity composition of trade among developed and less developed economies. This result becomes more pronounced when trade only in manufactured goods is considered. But the theory fails to predict the pattern of trade between developed and less developed economies.

Similarly, bilateral trade of the same three countries are examined to test the human capital approach and neotechnology theories of trade. The results indicate that while these theories can explain commodity flows among developed economies, they all fail in their attempt to explain trade among less developed countries.

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The existence of a systematic relationship between national characteristics and the commodity composition of trade is tested for the manufacturing trade of twenty-three countries, according to each hypothesis. It is found that with the exception of the scale economies hypothesis all theories perform satisfactorily. However, among them the human capital approach, the stage of production theory, and the product cycle theory indicate the strongest showing.

Considering the results of the bilateral tests and the regression analysis of the trade of twenty-three countries, the study concludes that the various existing theories are useful in explaining different segments of international trade flows. The Heckscher-Ohlin theory may be considered relevant for explaining trade among less developed countries, while the product cycle and human capital models are best suited for predicting trade among developed countries and between developed and less developed economies.

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INTRODUCTION

This study is an attempt to test empirically the Heckscher-Ohlin theory and alternative theories of international trade.

International trade is brought about by differences in the relative prices of commodities. "It is the inequality as to the relative prices in isolation," stated Ohlin, "that is a necessary condition for establishment of trade" [5, p. 7]. But the main body of the "pure" theory of international trade seeks to determine the predominant factor or set of factors which are responsible for the international differences in relative prices.

There are many variables in a country's economic structure which have a bearing on that country's comparative advantage. As Kuznets pointed out: "Foreign trade flows . . . are affected by many complex factors in which technological changes, social inventions, economic advantages, political revolutions and diversities in the structure and endowment of nations all play their part" [2, p. 106]. Yet a theory of trade must be capable of determining the exact relationship of these or any other variables with the comparative advantage of a country within a systematic and logically consistent framework.

The Ricardian theory of trade singled out relative labor productivity among countries in the production of different commodities as the predominant force in determining comparative advantage. According to this theory, pre-trade commodity price ratios in each country are determined by the relative average productivity of the factor of production (which to Ricardo was labor but could be any other factor as well) in producing different commodities. However, the Ricardian theory provides no explantion of what accounts for the differences in average labor productivity.

The Heckscher-Ohlin (H-O) theory of trade attempts to explain the commodity composition of international trade through differences between the relative endowment of factors of production among countries and the relative factor intensity of traded commodities. As introduced by Heckscher [1] and later elaborated by Ohlin [2], the theory considers other forces as secondary in nature and rarely strong enough to change the direction of the predominant force of the relative factor endowment. Thus, on theoretical grounds the H-O theory assumes no variations in production functions among countries. In this respect the H-O theory is diametrically opposed to the Ricardian explanation of trade.

For almost two decades the H-O theory enjoyed the full respect of economists not only because of its fresh insight into the cause of comparative advantage but also because of the simplicity and clarity of its logic which could lend itself to the neoclassical analytical framework. However, several empirical studies of the theory, beginning with Leotief's well-known tests of the structure of United States trade [3], indicated the limitation of the H-O theory's explanation of the commodity composition of world trade.

The failure of the H-O model to survive empirical tests has led during the past several years to the development of new alternative theories for explaining the commodity composition of international trade. These new theories have undertaken two distinctly different paths. One group, the neofactor theories, attempts to reformulate the traditional version of the H-O theory by modifying the concept of factors of production through the inclusion of factor qualities. The second group, the neotechnology theories, criticizes the assumption of similarity of production functions among countries in the H-O theory and seeks to explain the commodity composition of manufactured trade through differences in the technological capabilities of countries. However, despite their plausible assumptions, the alternative theories, especially those of the second group, lack a rigorous theoretical framework similar to the H-O model.

Through a reconsideration of the H-O theory this study will attempt to show that the factor proportion explanation of trade may be acceptable under certain restricted conditions. It is hypothesized that trade structure will tend to conform with the H-O theory more strongly between countries that are not widely different in their level of economic development. By further restricting the theory to an explanation only of the pattern of manufacturing trade, an even better performance of the theory is expected. This hypothesis is based on the presumption that the H-O theory's critical assumptions of identical demand pattern, similar production functions, and unique factor intensity ranking of commodities will tend to hold more strongly under the above-state conditions.

The above hypothesis, along with alternative theories of trade, will be tested in a comprehensive study of trade patterns of the United States (1970), the United Kingdom (1969), and South Korea (1969).

The second part of the study is an analysis of the trade pattern of twenty-three countries according to the H-O theory and alternative explanations of comparative advantage. The existence of a significant and systematic relationship between the commodity composition of trade and the national characteristics of each country is tested in order to determine the explanatory power of each theory.

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Chapter 1

HECKSCHER-OHLIN THEORY OF INTERNATIONAL TRADE

1.1 The Theory and its Assumptions

Postulating a simple world of two countries which produce two commodities with two factors of production, the H-O theory states that each country will have a comparative advantage in producing the commodity that uses the country's relatively abundant factor relatively intensively.

The model is based on the following assumptions:*

1. Perfect competition exists in the factor and commodity markets.
2. Capital and labor (factors of production) are qualitatively identical in both countries.
3. There is perfect mobility of factors within the country but no inter-country factor movement.
4. Supply of factors are given and are fully employed (full wage-price flexibility).
5. Production functions have the following characteristics:

   i. They are homogeneous of the first degree (constant return to scale);

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*These assumptions were first explicitly stated by Samuelson [28].

ii. They are identical for the same commodity in both countries;

iii. They exhibit different and unchanging factor intensities for different commodities for all possible relative factor prices (no factor reversal); and

iv. The law of diminishing marginal productivity holds.

6. No trade barriers or transportation cost exit.

Under the above assumptions each country will export the commodity which uses the country's relatively abundant factor more intensively. It can be shown that the results follow from the above assumptions under the alternative definitions of "factor abundance": They are defined firstly in terms of relative factor prices (in the Ohlin sense [24, p. 7]), and secondly in terms of relative factor supplies in each country (as Jones suggests [13].) Subsequently, in section 1.2.3. the logical bases for choosing one definition over another will be introduced along with the problems that may arise by accepting the more logical definition.

1.2.1 The Relative Price Definition of Factor Abundance

Given two countries, I and II, with country I relatively abundant in capital and country II in labor, and two commodities, X and Y, being capital and labor intensive, respectively. Defining relative factor abundance in terms of relative factor prices, country I is capital abundant if $(Pk/Pl)_2 > (Pk/Pl)_1$, where Pk and Pl are capital and labor prices respectively, while the subscripts 1 and 2 refer to the two countries. It must be shown that country I has a comparative advantage in the production of X, and country II in the production of Y, which would be manifested in a lower relative price of X to Y in country I and the opposite for country II.

In Figure 1-1 let XX and YY represent the isoquants for commodities X and Y. By the homogeneity assumption any one of the isoquants for either commodity can represent the family of isoquants for that commodity, and because of the assumption of identical production functions in both countries, Figure 1-1 represents the relevant production conditions in both countries. The only matter of distinction between the two countries will be inequality of factor price ratios.

As the figure indicates PQ and CC' (which is parallel to DD') are the relevant factor price ratios in countries I and II, respectively. It is postulated that capital in country I and labor in country II are the relatively cheaper factor. From this it should follow that country I enjoys a comparative advantage in production of X, the capital intensive commodity, and country II in the production of Y, the labor intensive commodity. To show this a common measure of production costs for both commodities in the two countries can be developed by converting the cost of production of each commodity expressed in terms of labor and capital inputs into its equivalent in terms of only one factor, say capital.

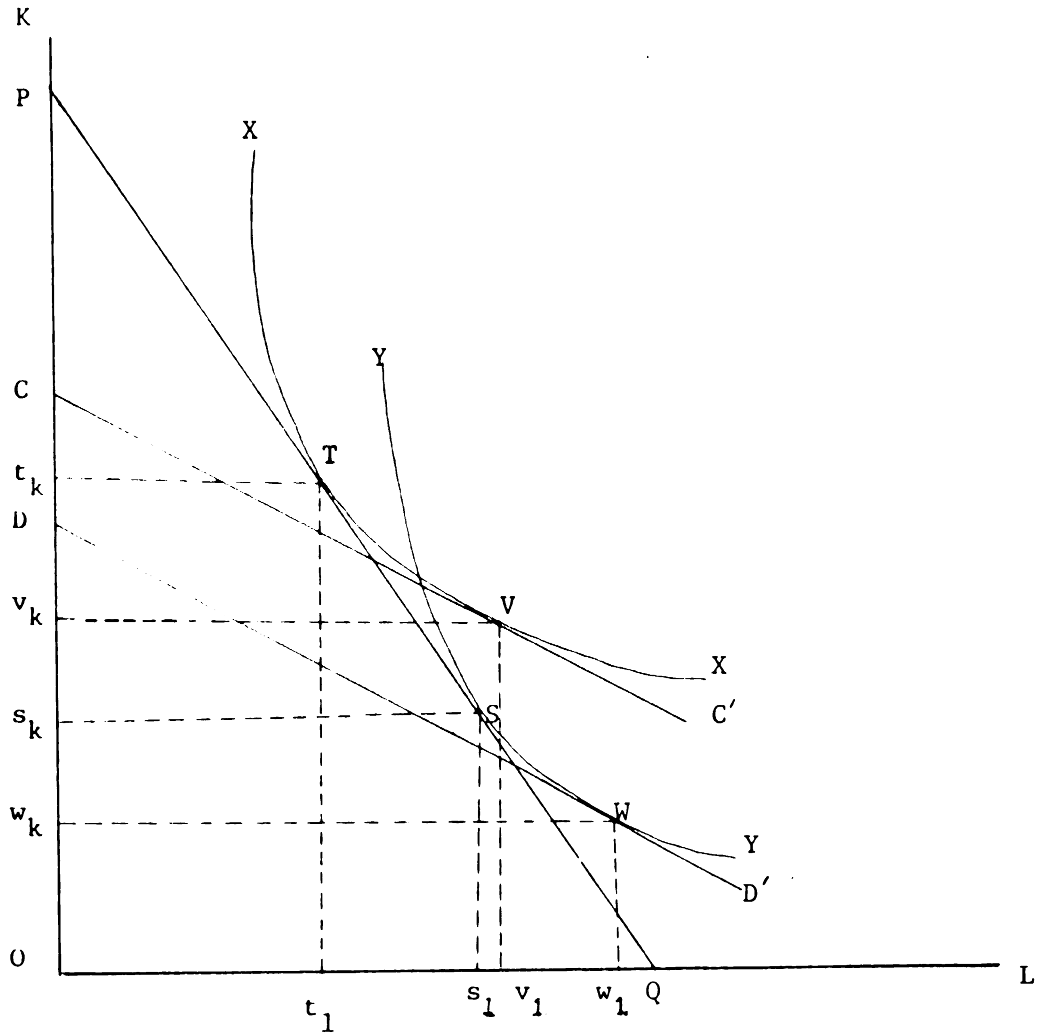

Figure 1-1

The Relative Price Definition of Factor Abundance

In country I, the production of a given quantity of X requires Ot_k of capital and Ot_l of labor. Ot_l of labor is equivalent to Pt_k of capital. Therefore, the total cost of producing X in country I, with capital as the unit of account, is $Pt_k + Ot_k = OP$.

Similarly, for country II production of the same quantity of X requires Ov_k of capital, and Ov_l of labor, $Cv_k + Ov_k = OC$ units of capital. As a result the cost ratio of X between countries II and I is $\frac{(OC)}{(OP)}$. In the same manner the relative cost of Y between the two countries will be (OD)/(OP). It can be seen from Figure 1-1 that $OC/OP > OD/OP$, indicating that country II has a comparative advantage in production of Y and country I in production of X, the commodities which use the countries' relatively cheaper factor more intensively.

1.2.2 <u>The Relative Supply Definition of Factor Abundance</u>

Alternatively, factor abundance may be defined in terms of the relative supply of factors of production. By this definition country I is capital abundant and country II is labor abundant if $K_1/L_1 > K_2/L_2$, where K and L denote the physical supply of capital and labor in countries I and II, as indicated by the subscripts. Our task is to show that this difference in relative factor endowment will result in the comparative advantage of country I in the production of X, the capital intensive good, and country II in the production of Y, the labor intensive good. The Edgeworth-Bowely box diagram will be utilized in this demonstration.

Consider once again countries I and II, each producing commodities X and Y, with factors K and L. In Figure 1-2 boxes I and II indicate the total supply of K and L in countries I and II. The origin of X isoquants is at point 0_x for both countries and of the Y isoquants is at Q_y for country I and at Q'_y for country II. Along any ray from the origin such as Q_xTS the ratio of marginal physical product of capital and labor in the production of X must be equal in both countries, if the production functions are homogeneous of the first degree and identical in both countries. Furthermore, the ratio of marginal physical products of both factors in the production of X and Y must be equal at points similar to S and T since these points are on the contract curves of countries I and II. It follows that the ratios of marginal physical product for both commodities are the same at points S and T along any ray such as 0_xTS. As a result, rays Q_yS and Q'_yT must be parallel, remembering that the Y production functions are also homogeneous of the first degree as in the case for X.

To prove that points similar to S and T along the rays from the origin are possible post-trade production equilibrium points, it must be shown that at these levels of production the relative commodity prices are equal in both countries [16].

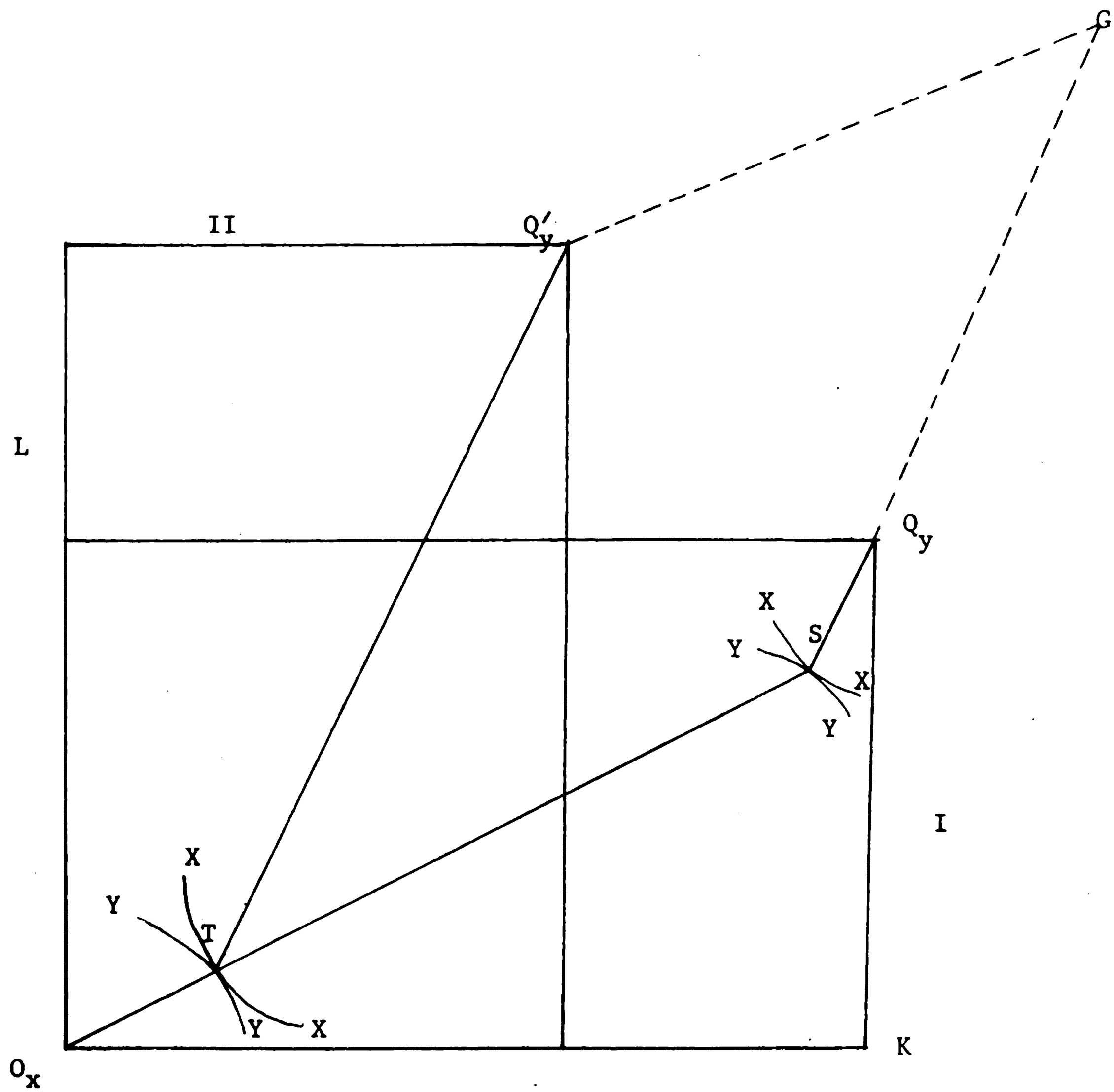

Figure 1-2

The Relative Supply Definition of Factor Abundance

Let $L'X_I$ and $L'X_{II}$ denote marginal productivity of labor in the production of X in countries I and II. Similarly, let $L'Y_I$ and $L'Y_{II}$ stand for marginal productivity of labor in the production of Y in the two countries. Recalling that under the assumption of perfect competition the value of the marginal product of labor is equal in both industries in each country, the following relationships are obtained:

$$PX_I \cdot L'X_I = PY_I \cdot L'Y_I \tag{1a}$$

or

$$(PX_I/PY_I) = (L'Y_I/L'X_I) \tag{1b}$$

where PX_I and PY_I are the prices for commodities X and Y in country I.

Similarly for country II:

$$PX_{II} \cdot L'X_{II} = PY_{II} \cdot L'Y_{II} \tag{2a}$$

or

$$(PX_{II}/PY_{II}) = (L'Y_{II}/L'X_{II}). \tag{2b}$$

However, because of the constant return to scale assumption the marginal productivity of any one factor is constant at all production points along any ray from the origin, such as O_xTS. Hence at points T and S the following equalities hold:

$$L'X_I = L'X_{II} \tag{3}$$

and

$$L'Y_{I} = L'Y_{II} \cdot \qquad (4)$$

From relations (1), (2), (3), and (4) it can be concluded that:

$$PX_{I}/PY_{II} = PX_{II}/PY_{II} \qquad (5)$$

In other words, points of intersection of any ray from the origin O_x with the two contract curves (such as S and T) are proved to be possible post-trade production equilibrium points for both countries.

Furthermore, at any equilibrium point such as S and T, country I produces relatively more of commodity X and country II more of commodity Y. To show this in Figure 1-2 draw Q'_yG parallel to O_xS to intersect the extension of SQ_y at point G. Given that SQ_y is parallel to Q'_yT, Q'_yT is equal to SG. However, because $O_xS > O_xT$, it follows that

$$Q'_yT/O_xT > GS/O_xS \qquad (6)$$

yet Q_yS is clearly smaller than GS; therefore

$$Q'_yT/O_xT > Q_yS/O_xS \qquad (7)$$

The above analysis shows that when the relative endowment of countries is defined in terms of the physical supply of factors of production, comparative advantage will be revealed in terms of the physical supply of commodities. That is, each country will produce more of the commodity that uses the abundant factor more intensively. In these terms country I has comparative advantage in production of X and country II in production of Y in the above example.

1.2.3 Definition of Factor Abundance and the Demand Assumption

It is possible for the comparative advantage in production of a commodity (as demonstrated above) to be nullified by a strong internal demand preference for that commodity. For example, although a higher ratio exists in the production of capital intensive to labor intensive goods in the capital rich country, a strong demand for the capital intensive commodity may make the relative price of this commodity higher in the capital abundant country. In other words, it is possible for the comparative advantage indicated by the factor endowment ratio to be reversed by a strong demand bias in the opposite direction. Therefore this version of the model requires the additional assumption that the demand patterns are similar in both countries.

Although Ohlin admitted [24, p. 10] the existence of dissimilar demand patterns among countries, he maintained that such differences are small enough not to reverse the logical outcome of the model. However, even equality of demand functions is not sufficient for the logical consistency of the H-O theory. The demand functions must also be such that differences in income levels would not affect the demand patterns. This condition is satisfied if it is further assumed that demand functions are homogeneous of the first degree [25], that is, the income elasticity of demand is equal to unity for each commodity in both countries. But such assumption may or may not be consistent with reality. If it is not, then the pattern of trade predicted by the factor endowment ratios may not be realized.

Alternatively, the relative price definition of factor abundance implies that the commodity which uses more of the relatively cheaper factor in a country will have a lower relative price in that country as compared to the second country. Although this interpretation of factor abundance does not require an explicit assumption as to the demand condition, it falls short of a meaningful explanation of the trade pattern. What the theory states is nothing more than the unique Samuelsonian relation between factor price and commodity price rations [27,28]. Thus even though the relative price definition of factor abundance is logically true, it is "trivial," as Jones put it, in the sense that all it can explain is that "each country exports that commodity in the production of which it enjoys a comparative advantage" [13, p. 4], without really showing that the factor endowment ratio alone is responsible for the comparative advantage.

Therefore the physical definition of factor abundance is to be considered the satisfactory explanation of the pattern of trade, even if it may be invalidated by perverse demand conditions. It is this definition of factor abundance that is relied upon on all empirical verification of the theory.

1.3.1 Empirical Verification of the H-O Theory: Leontief's Tests

The first* comprehensive test of the factor proportion theory was carried out by Leontief [18] through the application of interindustry input-output relations.

This method consisted of measuring the total (direct and indirect) capital and labor requirements of one million dollars of exports and of competitive import replacements (those imports that are domestically produced) in the United States. According to the H-O model, it is expected that the United States, the most capital abundant country in the world, would engage in international trade to compensate for its scarce factor, labor, and would enjoy a comparative advantage in the production of capital intensive goods. However, Leontief found that a representative one million dollar basket of U.S. exports requires a smaller capital/labor ratio than its equivalent amount of competitive import replacements, Table 1-1. Clearly,

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* Although MacDougal [21] and Kravis [14] attempted to test the H-O theory their results cannot be considered conclusive because of the inadequacy of the methods which they applied.

Table 1-1

Domestic Capital and Labor Requirements
Per Million Dollars of U.S.
Exports and Competitive Import
Replacements (of Average 1947 Composition)

	Capital (k)	Labor (1)	k/1	$\gamma = \frac{(k/l)_{imp.}}{(k/l)_{exp.}}$ *
	Dollars, 1947 prices	Man years		
Exports.......	2,550,780	182,313	13,992	1.300
Imports.......	3,091,339	170.004	18,184	

* γ is refered to as the coefficient of factor intensity of trade.

Source: Columns 1 and 2 from W. Leontief, "Domestic Production and Foreign Trade, the American Capital Position Re-examined," Economia Internazionale, February, 1954.

this result is contrary to the H-O prediction of the trade pattern, for it indicates that the U.S. specializes in the export of labor intensive rather than capital intensive commodities. As Leontief puts it: "This country [U.S.] resorts to foreign trade in order to economize its capital and dispose of its surplus labor, rather than vice versa" [18, p. 25]. This is the so-called paradox by which is meant a seeming contradiction between given facts and expected results.

The Leontief test generated a strong wave of criticisms based on statistical and methodological grounds as well as an intense reevaluation of the theory and its assumptions. On statistical grounds the major reservation about the test was the method of estimating the input coefficients, especially with regard to capital coefficients. Diab [8] considered Leontief's estimates of the capital coefficients for agriculture too high. But after reducing them to one half Leontief's estimates he obtained the same results. Leontief's capital coefficients are open to another, more substantial criticism. As Buchanan [6] pointed out, instead of employing the estimates of the service of capital required per unit of output, Leontief used the estimates of the amount of investment in capital goods per unit of output. However, the investment coefficients can be regarded as a proxy for capital (stock) coefficients only if the durability of capital in all industries are identical, which is an implausible assumption. On this basis the capital coefficients employed by Leontief suffer from a strong deficiency.

Furthermore, some reservations were expressed by Swerling [31] as to the selection of the year upon which the study is based. He points out that 1947 trade was "highly atypical of world trading relations in general and of United States agriculture trade in particular." By that year, "postwar disorganization of production overseas had not yet been corrected . . ., and close to half of United States exports were financed by grants and credits under various foreign aid programs."

In his second study, Leontief [19] considered most of the many criticisms that were directed toward his earlier test. He applied the 1951 trade flow of the United States to the 1947 input-output table of the industries. However, the result was not significantly different from what he obtained in the first study.

On methodological grounds the main thread of criticism asks two questions: First, is the input-output method appropriate for the analysis of international problems, and second, is the extension of U.S. conditions of production to the estimation of factor requirements of U.S. imports a correct method of analysis of trade patterns?

The difficulty with the application of input-output analysis, critics maintain, is in the fixed coefficient characteristics of the input-output models which imply that the input ratio for the production of each good is fixed and invariant with respect to the relative prices of inputs. Thus input-output models, Valavanis-Vail [37] argues, "except for rare luck are logically incompatible with international trade." That is so because "we cannot be sure that every factor will be completely used up, either with trade or in its absence." If each country employs all of its factors fully before trade, there will be no assurance that the same will be true after a change in the world's composition of outputs, as the result of trade. Although the question raised by Valavanis-Vail is valid, it is irrelevant to Leontief's study. Leontief utilized the input-output tables for estimating the indirect factor requirements of each product under the existing equilibrium condition [5, p. 177].

The other criticism of the fixed coefficient characteristics of the model is the view expressed by Ford [10, p. 67] that in the input-output models the input coefficients are given regardless of the output level of the industry. This implies that factor requirement remain the same for a proportionate decrease or increase of one million dollars of exports and import competing goods. However, Ford maintains that "an industry could be labor intensive for most increases in output and yet when it has to increase by its contribution to the one million dollars of trade it could be easily capital intensive." In other words, factor intensity reversal may occur with scale changes. This, however, is inconsistent with the homogeneity assumption of the H-O theory. For factor intensity reversal to occur the isoquants must change their relative position with respect to the two factors of production as the level of production changes. But the characteristic of the homogeneous production functions is that they expand along the rays from the origin, that is, the marginal rate of technical substitution is equal along such rays for each family of isoquants which cannot be true if isoquants change their relative positions. This criticism, therefore, is not valid on theoretical grounds. Besides, Leontief does not change the level of output but only estimates the factor requirements for an average bundle of exports and import competing goods [5, p. 177].

Extension of the American condition of production to U.S. imports constitutes the second and potentially the most important methodological criticism of Leontief's tests. He employed factor input coefficients along with the interindustry input-output relations of the United States to estimate the factor requirements of a one million dollar bundle of that country's imports. This in Leontief's terminology is called the factor requirement for import-competing industries for supplying, domestically, a one million dollar reduction of imports. It is argued by Ford [10,pp. 58-61], Swerling [31], and Elsworth [9] that in comparing exports and imports one should take the actual factor requirements in the country where the product is being produced, instead of applying the same condition of production for both exports and imports. In an attempt to reconcile the H-O theory with Leontief's results, Elsworth asserts that it is possible that the United States exports capital intensive goods (relative to its imports) and, at the same time in producing import replacements, also uses capital intensive methods.

This type of argument may be interpreted to mean that the conditions of production in the United States and the rest of the world are such that factor intensity reversal occurs. This factor reversal may be caused either by widely different factor price ratios between two trading countries or by variations in production functions between two countries. But both these arguments are in direct violation of the assumptions of the H-O theory, and if Leontief's test is a test of the H-O theory then such methodological criticisms are invalid. However, it can be argued that factor reversal, for either of the above reasons, is an empirical reality, and if so, we are outside the framework of the H-O theory. These possibilities will be discussed in sections 1.4.2 and 1.4.3.

In an attempt to salvage the theory, Leontief reconciled the paradox by redefining the factor endowment of the United States. He asserted [18, pp. 25-29] that although it may appear that the capital/labor endowment ratio of the United States is higher than that of any other country in the world, the high efficiency of American labor makes this country a relatively labor abundant one. To be exact, he claims that this efficiency factor is about three. That is, using the same amount of capital, one man year of American labor is equivalent to three man years of foreign labor. This relative effectiveness of American labor is attributed to "entrepreneurship, superior organization, and favorable environment" [18, p. 29]. Leontief, however, does not explain how he arrived at the efficiency factor of three or why the efficiency factor is attributed to labor only and not to capital. But this claim cannot be supported empirically. A study by Kreinin [15] shows that this efficiency factor is about 1 1/5 or at most 1 1/4, which fails to support Leontief's claim or his attempt in reconciling the paradox. Furthermore, Arrow, Chenery, Minhas, and Solow [1], in their inter-country study of production functions, have found significant differences only in over-all efficiency, and therefore even if American techniques of production are more efficient, this situation cannot be attributed only to labor. Most importantly, however, Leontief's explanation is theoretically unsatisfactory. As Robinson pointed out: "A comparative advantage theory based on relative factor endowment cannot seek explanation in productivity concept by redefining the units of measurement of factors of production, when it fails in what it had been trying to explain" [25].

1.3.2 Other Tests of the H-O Theory

Tests similar to that of Leontief pertaining to the trade of Japan [33], Canada [40], West Germany [26], East Germany [30], India [6], and the United Kingdom [11] yielded mixed results. Bharadwaj's study of India indicated that India's exports to the United States are more capital intensive than their competitive import replacements from that country. However, he explained this negative result by the atypical nature of Indian trade in 1951, which is characterized by unusually high imports of agricultural goods from the United States. Tatemoto and Ichimura [33] attributed the high capital/labor ratio embodied in the exports of Japan as compared to its import replacements to the high concentration of that country's trade with underdeveloped Asian countries which are presumed to have a lower capital/labor endowment ratio than Japan. They concluded that the Japanese trade pattern is consistent with the H-O theory, especially since the capital/labor ratio embodied in Japanese exports to the United States estimated separately, is lower than that for Japan's total exports. Similarly, the higher capital/labor ratio required for East Germany's exports as compared to its competitive import replacements is explained by Stolper and Roskamp [30] in relatively low capital labor endowment ratio of other Communist countries which are East Germany's major trade partners.

However, Wahl's [40] study of Canada's trade (1949) revealed that Canadian exports to the United States and to the United Kingdom are, on the average, more capital intensive than Canadian import replacements from these countries. This result along with the presumption that both the United Kingdom and the United States were capital rich relative to Canada around 1949 appears to be inconsistent with the H-O pattern of trade. The structure of West German [26] trade, and the fact that its exports are more capital intensive than its import competing replacements, cannot support or reject the H-O theory because the relative factor endowment position of West Germany vis-à-vis its trading partners is not clear. Only a bilateral study of West German trade with individual groups of countries may offer a more definite statement of the comparative advantage position of that country.

Recently R. Baldwin [2] updated Leontief's test of U.S. trade pattern by using 1958 trade data and 1958 factor requirement coefficients and input-output table. The result indicated that the Leontief paradox still holds. However, in a bilateral test, the study confirms the H-O pattern in U.S.-Western European, and U.S.-Japanese trade.

Based on the 1963 input coefficients of U.S. industries, the direct capital and labor requirements of

U.S. exports and import replacements for 1958-60 and 1968 are estimated in a study by the United States Tariff Commission [35]. The result indicated that while the paradox prevail in both periods the 1968 imports are less capital intensive relative to exports than they were for U.S. trade during 1958-60. However, these estimates are deficient since they exclude the indirect capital and labor requirements of U.S. trade. The change in the relative factor intensity of U.S. trade between the two periods may not be all attributed to a change in the commodity composition of trade but also to variations in the structure of U.S. industries and a change in the degree of their vertical integration.

1.4.1 Reexamination of the H-O Theory and its Critical Assumptions

The inconclusive nature of the empirical tests of the H-O theory is based by the critics on the five following factors:

1. Factor reversal: uncertainty about the existence of a unique factor intensity ordering of commodities for all relevant factor price ratios in different countries.

2. Different production functions: variations in production function for the same commodity in different countries. Factor quality differences may be considered as a case of variation in production functions.

3. Demand: substantial differences in the demand pattern of countries which may reverse the pattern of trade as indicated by comparative advantage in production of commodities.

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4. Natural resources: special characteristics of natural resource base commodities.

5. Barriers to trade: tariffs, quotas, or other instruments of commercial policies which disturb the free flow of international trade.

The following sections examine the above violations of the H-O assumptions, attempting in each case to evaluate the empirical validity of the assumption and to point out the conditions under which the H-O assumptions may be considered realistic.

1.4.2 Factor Intensity Reversal

A necessary condition for realization of the H-O pattern of trade is the assumption that the production functions exhibit different (among commodities) and unchanging (among countries) factor intensities for all possible factor price ratios. This means that a commodity which is capital intensive relative to another commodity remains capital intensive irrespective of the relative factor prices, and so also will a labor intensive good. This is called the strong Samuelsonian factor intensity assumption.

If production functions are of the Cobb-Douglas form,

$$Q_i = A_i K^{a_i} \cdot L^{b_i} \qquad (a > o,\ b > o) \qquad (8)$$

where Q_i is output of industry, i, K and L are capital and labor inputs, and A_i, a_i, and b_i are the parameters, it is shown below that the relative factor intensities are independent of factor price ratios, and thus the strong factor intensity assumption holds.

From (8) the marginal productivity of labor and capital in industry i can be written as:

$$\partial Q_i/\partial L = A_i b_i K^{a_i} L^{b_i - 1} \tag{9}$$

$$\partial Q_i/\partial K = A_i a_i K^{a_i - 1} L^{b_i} \tag{10}$$

and the marginal rate of substitution between capital and labor:

$$(\partial Q_i/\partial L):(\partial Q_i/\partial K) = (b_i/a_i)(K/L) \cdot \tag{11}$$

Recalling that under perfect competition the marginal rate of substitution is equal to the factor price ratio, the optimal capital/labor ration in industries i and j will be:

$$X_i = (K/L)_i = (a_i/b_i)(w/r) \tag{12}$$

$$X_j = (K/L)_j = (a_j/b_j)(w/r) \cdot \tag{13}$$

With equality of factor price ratios among industries in equilibrium, the relative factor intensities can be written in the form:

$$(X_i/X_j) = (a_i/b_i):(a_j/b_j) \tag{14}$$

which is independent of the relative factor prices.

However, production functions may be best fitted in the form:

$$Q_i = (A_i K^{-b_i} + a_i L^{-b_i})^{-1/b_i} \tag{15}$$

as suggested by Arrow, Chenery, Minhas, and Solow [1], in which case we can show that relative factor intensity is not necessarily independent of factor price ratios.

The marginal productivity of capital and labor in industry i can be written as:

$$\partial Q_i/\partial L = a_i(Q_i/L)^{b_i + 1} \tag{16}$$

$$\partial Q_i/\partial K = A_i(Q_i/K)^{b_i + 1} \tag{17}$$

and the marginal rate of substitution between capital and labor will be:

$$(\partial Q_i/\partial L):(\partial Q_i/\partial K) = (a_i/A_i)(K/L)^{b_i + 1}. \tag{18}$$

Equality of the marginal rate of substitution with factor price ratios, under the perfect competition assumption, yields the following optimum factor use ratios in industries i and j.

$$X_i = (K/L)_i = (A_i/a_i)(w/r)^{1/(b_i + 1)} \qquad (19)$$

$$X_j = (K/L)_j = (A_j/a_j)(w/r)^{1/(b_j + 1)} \qquad (20)$$

where $1/(b + 1) = Z$ is the elasticity of substitution for each industry. With market equilibrium, the relative factor intensity can be written as

$$(X_i/X_j) = [(A_i/a_i)^{Z_i} : (A_j/a_j)^{Z_j}](w/r)^{Z_i - Z_j}. \qquad (21)$$

Therefore, factor intensity can be independent of factor price ratios only if $Z_i = Z_j$. That is, factor intensity reversal is ruled out only when the elasticities of substitution for industries i and j are equal. With factor intensity reversal the neat and clear conclusions of the H-O theory do not necessarily hold. Consider the relation for the optimal factor use ratio for industry i which can be rewritten from equation (19) in the logarithmic form:

$$\mathrm{Log}(K/L)_i = \mathrm{Log}(A_i/a_i) + 1/(b_i + 1)\mathrm{Log}(w/r). \qquad (22)$$

This relation between the factor use ratio and relative factor prices can be drawn as a straight line for any industry with a slope of $Z_i = \frac{1}{b_i + 1}$. If for any two industries the elasticities of substitution are different, the two lines will definitely intersect at some critical factor price ratio, at which point the relative factor intensities will be reversed.

In Figure 1-3 the straight lines of XX and YY represent the optimal factor use ratio for industries X and Y at different factor price ratios. At the relative factor price of $(w/r)_2$ commodity X is capital intensive and commodity Y is labor intensive. However, when the relative price of labor increases to $(w/r)_1$ the optimum factor input ratios indicate that Y is more capital intensive than X, and at the point $(w/r)_0$ both commodities have the same factor intensity. The far-reaching implication of this possibility is that if the relative factor prices in the two trading countries are such that they are as widely different as $(w/r)_1$ and $(w/r)_2$, or more precisely if they are such that they fall on different sides of $(w/r)_0$, then nothing definite can be said about factor intensity of commodities, and the H-O pattern of trade will not hold for at least one of the trading countries.

Let E_1 and E_2 denote the factor endowment ratio of countries I and II for which the range of relative factor prices in country I will be between $(w/r)'_1$ and $(w/r)''_1$ and in country II will be between $(w/r)'_2$ and $(w/r)''_2$. As shown in Figure 1-3 factor reversal occurs in the relevant range of relative factor prices. Country II, which is richly endowed with labor, will have a comparative advantage in Y, the labor intensive commodity.

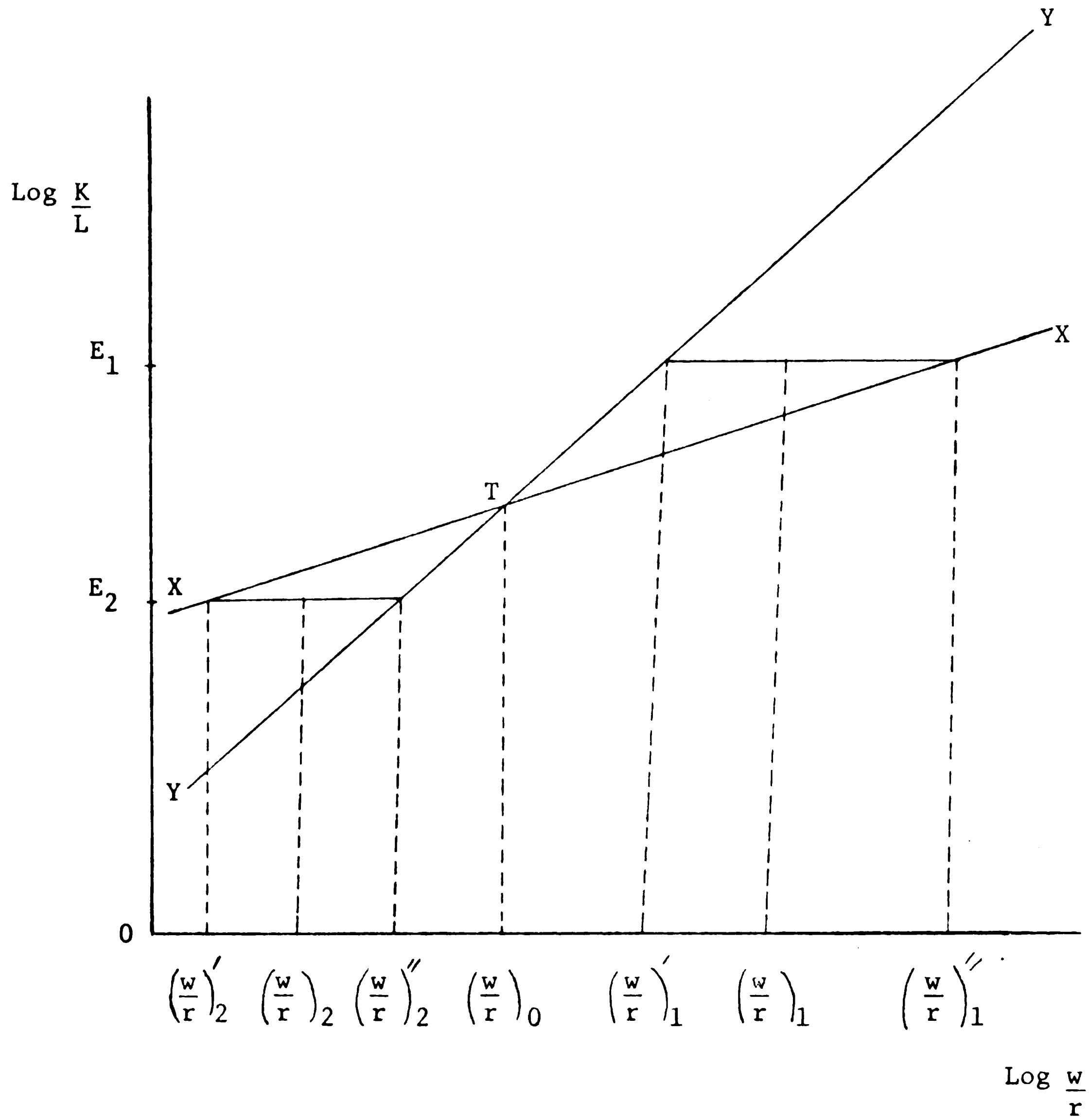

Figure 1-3

Factor Intensity Reversal

Country I, which is capital abundant, will have a comparative advantage in the production of X, the labor intensive commodity in that country. Thus country II's production and trade conform with the H-O pattern while those of country I do not.

The important question is how widespread is this phenomenon, if it exists at all. In Samuelson's view [29], "factor intensity reversal is much less important empirically than it is interesting theoretically." It was Minhas [22] who suggested that factor reversal is in fact an empirical possibility. He maintained that, based on the study with Arrow, Chenery, and Solow [1], production functions are not internationally characterized by the Cobb-Douglas form but are best fitted in the form of CES production functions represented above by equation (8).

In a test of twenty-four industries in nineteen countries Minhas found [22,pp. 35-39] that in fact factor reversal occurs between five pairs of industries (from twenty-five pairs) in the relevant range of factor price ratios. However, the result of these estimates depends upon the method of estimating the value of elasticities of substitution. Leontief [20], using Minhas' data but with an alternative method of estimating elasticities, found that only seventeen of 210 possible factor reversals occur in the relevant range of factor prices between the U.S. and India. He therefore concluded that the strong factor intensity assumption is supported by Minhas' data.

Alternatively, the strong factor intensity assumption can be tested by ranking the factor intensities of industries among countries. Then, if the assumption that for any ratio of factor prices "the optimal ratio of capital to labor in any given industry i is always greater or less than any other industry j were true, then the ranking of industries between the two countries with widely different factor price ratios must match" [22, p. 39]. In fact Minhas performed the same ranking for the U.S. and Japan and found the Spearman rank correlation coefficient of only 0.328, "which is nowhere near unity, the value implied by the strong factor intensity assumption."

However Ball [3] showed that when Minhas' ranking is applied to only non-agricultural goods, the rank correlation coefficient for both direct and total input requirement of U.S. and Japanese industries increases. If both agricultural and food products are eliminated on the basis of greater dissimilarities in the composition of output and methods of production among countries, the rank correlation coefficient increases further. Ball maintains, therefore, that factor intensity assumption cannot be rejected as was done by Minhas. Nor can it be accepted.

Similar results were introduced by Lary [17] who used non-wage value added per employee as an index of capital intensity in his bilateral comparison of manufacturing industries between the U.S. and the U.K., the U.S. and Japan, and the U.S. and India. Lary takes the direct input coefficients to measure factor intensity. But for a two-factor H-O model only the total requirement coefficients are the proper measure of factor intensity. And if only direct factor input is used, "we no longer remain within the bounds of a two factor world and all sorts of extraneous things (like differences in the degree of vertical integration among industries) can effect the nature of the results" [22, p. 41].

Although there is no strong basis for rejecting the uniqueness of factor intensity ranking of commodities among countries, the issue is not settled. However, with reference to Figure 1-3, it may be concluded that the wider the factor price ratio differential between two countries, the higher the probability of factor reversal for a larger number of commodities.

1.4.3 Production Functions and Factor Qualities

Two necessary assumptions of the H-O model are the equality of production functions and factor qualities in the trading countries. However, differences in factor qualities can be transformed into differences in production functions, and thus their equality is the only significant assumption with respect to the inter-country condition of production.

Thus the empirical validity of the H-O theory is not insured if variations of significant magnitude are observed in the production functions in different countries.* Consider Figure 1-4, which depicts a situation where production functions of X and Y are distinctly different in countries I and II. It can be observed that relative to Y, X is capital intensive in country I and labor intensive in country II. Recalling that country I is abundant in capital and country II in labor, according to the theory both countries can produce X cheaper than Y. Therefore the direction of trade cannot be determined unequivocally but will depend on the relative intensity of each product in each country and the relative factor endowment of the two countries. Suppose the relative factor intensities of commodities and the relative factor endowment of country I are such that the relative price of X there is less than that in country II. Then country I will export X and country II will export Y. For country I the pattern is consistent with the H-O theory, but for country II it is not. Therefore the pattern of trade is not necessarily consistent with the H-O pattern if wide variations exist in the production functions as demonstrated above.

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*This problem is different from factor intensity reversal, which may be caused by differences in the elasticities of substitution of production functions. Here, however, while the elasticities of substitution may be equal, the problem arises from differences in efficiency and scale coefficients of the production function of a commodity among the countries.

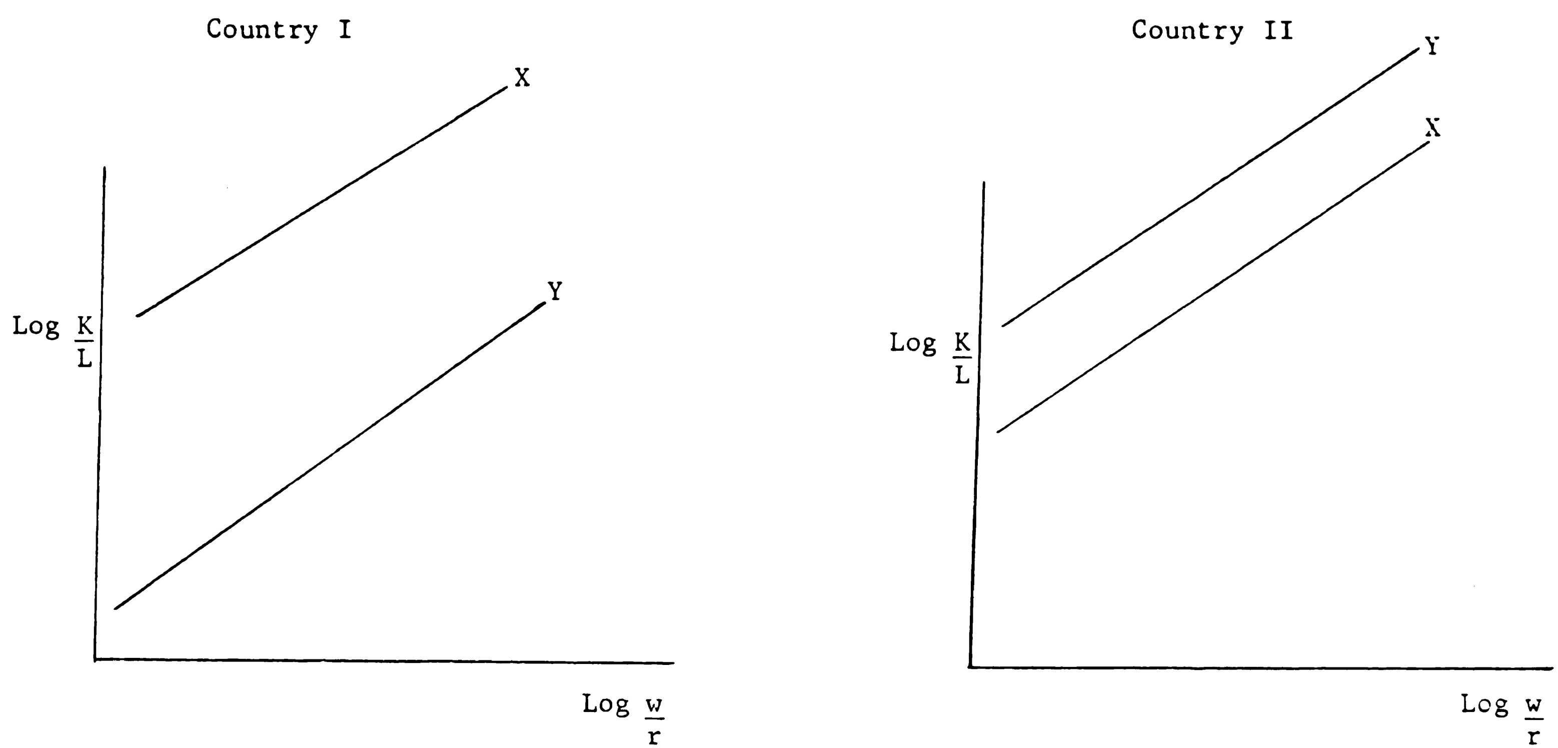

Figure 1-4

Different Production Functions Between Countries

Although there is no justification for assuming similar production functions for all types of commodities in all countries, it is reasonable to assume a high degree of similarity in production functions of manufactured goods, mainly because of the widespread diffusion of technology among countries, and the standardized methods required for production of these goods. Therefore on an a priori basis it appears that this adverse possibility can be reduced if the H-O theory is applied only to the manufactured goods.

1.4.4 Identical Demand

The analysis in section 1.2.2 indicated that the logical consistency of the H-O theory, with its relative supply definition of factor endowment, requires an explicit assumption about demand patterns in trading countries. According to this assumption, demand functions must be identical in both countries and should be homogeneous of the first degree to insure independence of demand pattern from income. However, neither parts of this assumption may be considered realistic on an a priori basis, specially when we consider countries with significantly different income levels. In general the wealthier nations are the more developed economies, and economic development in most cases implies a higher degree of industrialization, automation, and urbanization, all of which will inevitably affect the consumer's conception of utility and thus his demand pattern. Although the equalization force of the international demonstration effect may tend to influence the demand patterns of the less developed countries (LDC's), it cannot be assumed that the patterns are identical in such widely different countries as India and the U.S.

Furthermore, a unitary income elasticity of demand for all goods is hardly an empirical reality; different goods have different income elasticities. The H-O theory faces special difficulty if a systematic bias exists in demand for capital intensive commodities in the wealthier countries, which are with rare exceptions the capital rich countries.

It can be anticipated that in these countries there will be a demand bias toward manufactured consumer durable goods, higher quality housing, and for non-traded services. The first and second items are definitely capital intensive commodities. For services, however, relative factor intensity is not as easily determined, since there are significant variations in quality and definition of services between the very high and very low income countries. Certain aspects of manufacturing in an industrialized society may be considered as labor intensive services in the less developed economies.* At the same time changes in the quality of services in the development process often embodies high degrees of

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*For example, the television set in a modern economy replaces the old Coffee House in a village of a traditional economy for the evening entertainment.

mechanization and automation which tend to increase their capital intensity.*

Therefore a distortion in the H-O pattern of trade may occur as a result of a systematic consumption bias toward capital intensive commodities in the capital rich countries. A capital rich country (U.S.) which produces relatively more of the capital intensive commodities than a poor, labor abundant country (India), may demand so much more of the capital intensive commodities that the pattern of trade will be reversed. This possibility is likely to be limited if we apply the theory to countries with not too dissimilar income levels.

1.4.5 Natural Resources

The tests of the H-O theory consider capital and labor as the only significant factors in determining the commodity composition of trade. However, Diab [8] and Vanek [38,39] have pointed out that exclusion of natural resources may distort the indicated pattern of trade for capital abundant countries that are not well endowed with natural resources. The distortion is caused they argue, by the high proportion of natural resource primary goods, which have a relatively high capital intensity, in the imports of these countries.

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*The most notable change of this type may be observed in communication, information, and transportation services.

However, the difficulty in the treatment of natural resources in the H-O theory may be considered from a different perspective. A considerable amount of capital and labor must be expended to bring a resource into a form which is usable for production purposes, namely primary goods. As long as the conditions of the production of primary goods are similar in all countries we can treat them as intermediate inputs within the two-factor model of the H-O theory, with no problem. But difficulty arises when we apply factor requirements for the extraction and utilization of natural resources of one country to another one. In a country with an unfavorable endowment of natural resources, their supply can be expanded only at a relatively high cost and with the employment of highly capital intensive methods. Hence the actual production functions for natural resources can be different for two countries because of the relative accessibility and quality of resources. And since there is no reason to believe that natural resources are distributed evenly among the countries of the world, they cannot be treated very easily in the context of the H-O theory, which requires identical production functions for each commodity in all countries. It should be emphasized here that the difficulty with natural resources comes from their characteristic as a produced commodity and not because of their exclusion as a factor of production. The only solution is to consider natural resources as non-competing imports when they are not easily available in a country. But since we have no operational criterion for "easily available" resources, and because any natural resource is scarce in one country or another, the H-O theory appears to be incapable of including natural resource oriented commodities.

In reality the problem is more complicated as a result of the mobility of capital across national boundaries to the countries in which natural resources are located. However, the important consideration then is the location of capital, not its ownership. That is, a capital poor but natural resource rich country may become abundant with capital as a result of the inflow of foreign capital for the extraction and export of its natural resources. One can no longer then consider the recipient country capital scarce if its relative endowment of capital changes vis-à-vis the other country.

1.4.6 Trade Barriers

A theory of comparative advantage can predict the pattern of trade only if no artificial barriers exist to the free flow of international trade. Otherwise, although the theory may be capable of explaining comparative advantage, that is the forces that determine the relative prices of commodities in isolation in each country, it can fail to predict the commodity composition of their trade. This, Travis [34] points out, is the most important reason for the failure of the H-O theory in predicting the pattern of world trade.

This view is supported in a study by Tarshis [32], which examines the wholesale prices of selected commodities in the U.S., the U.K., the Soviet Union, and Japan. He found that the comparative advantage of each country, as reflected in the relative commodity prices in that country, is consistent with the factor proportion theory. In many cases, however, the direction of trade is clearly contrary to the pattern indicated by the relative prices of commodities.

A study by Vaccara [36] revealed significant and positive correlations between nominal tariff rates and the direct labor cost and labor use coefficients in 311 American manufacturing industries. But a subsequent study by Basevi [4] showed that once nominal rates are replaced by effective tariff rates the above relationships are no longer significant.

Iqbal [12] applied a more accurate measure of factor intensity along with effective tariff rates to a limited number of less advanced industries and demonstrated that a positive relation exists between the labor/capital requirement (direct plus indirect) of these industries in five less developed countries and the effective rate of protection in the developed countries.

Therefore, while there are no conclusive studies of the relationship between comparative advantage and the tariff distortions in the total U.S. trade and the trade among developed economies, it is reasonable to expect, based on Iqbal's study, some systematic distortions in the trade pattern between the developed and the less developed economies.

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Chapter 2

ALTERNATIVE THEORIES OF TRADE

2.1 Introduction

The apparent failure of the H-O model to explain the commodity composition of trade prompted the development of alternative theories. While the H-O theory assumes uniformity of factors of production and equality of production functions, alternative theories seek to explain the flow of trade through differences in either factor qualities or in the production functions. The factor quality approach, or the so-called neofactor theories,* may be considered an extension of the H-O theory. They attempt to replace the simple concept of capital and labor by a more realistic and somewhat more complex notion of factor endowment which incorporates factor qualities as well as quantities. On the other hand, the second approach, or the so-called neotechnology theories,* in sharp contrast with the H-O theory, sets out to explain the flow of international trade through differences in production functions.

*As referred to by Hufbauer [11, p. 195].

2.2 Neofactor Theories: The Human Capital Approach

Proponents of neofactor theories maintain that while the logical framework of the H-O theory is valid, its treatment of factors of production is hopelessly crude. The central concern in this approach is the development of a more meaningful measure of labor instead of what the H-O theory has provided for, namely simple and undifferentiated labor. It is argued that by considering the stock of physical capital and the number of workers at work as the relevant measures of society's endowments of factors of production, one ignores a substantial part of society's resources which have been channeled into the stock of "waiting" in the form of human capital, [15].

Similar to the stock of physical capital, the human capital endowment of an economy, manifested in the skill composition of the workers, will affect the productive capacity and the structure of relative costs and outputs of the economy [4,23]. Proponents of the human capital approach therefore maintain that the H-O theory ignores a significant part of society's resources embodied in the form of human capital, and in their view there should be little surprise if the theory cannot stand the test of empirical verification.

The recognition of skills as a determinant of the commodity composition of trade dates back to 1956 when Kravis [18] found that American workers receive higher wages in export industries than in import competing industries. He attributed the relatively high wages in export industries to the higher skill mix of these industries. This hypothesis was later tested and confirmed by Waehrer [27] through a statistical analysis of the relationship between wages and skills in Kravis' industries. Both Kravis and Waehrer concluded that the U.S. has a comparative advantage in the production and export of skill intensive commodities.

While the above studies present some relationship between the skill mix and comparative advantage, the effort was not put within a systematic model for explaining commodity composition of trade. The general contention of the human capital approach has been put forward in two different forms. Human capital may be considered along with physical capital as one composite factor of production, capital, with unskilled labor (the number of man years) being the second factor. This approach was suggested by Kenen and Yudin [16], Kenen [15], Bharadwaj and Bhagwati [5], and Roskamp and McMeekin [22]. They estimated the wage differentials between unskilled labor and various skilled categories, The excess of earnings of a skilled over an unskilled worker was considered as a return to the human capital invested in him for education and training. The stock of human capital is then estimated by applying a "realistic" rate of return to his earnings.

Kenen [15], through the application of the above method and assuming 12.7 and 9 percent rates of return to human capital, measured the physical and the human capital embodied in one million dollars of American imports and exports for 1947 trade. However, the results were only a slight improvement over those of Leontief (in terms of the H-O model) and thus the paradox prevails.

With a similar approach, Roskamp and McMeekin [22] undertook a study of West German trade and found that one million marks of Germany's exports contain a higher ratio of human capital to labor and human capital to physical capital than it's one million marks of import competing commodities. They concluded that Germany experiences a comparative advantage in the production of skill intensive relative to capital and labor intensive commodities.

Bharadwaj and Bhagwati [5] applied Kenen's method to Indian trade during 1953-54. Although their results indicated that Indian exports are, on the average, more labor intensive relative to imports, an unexpected situation existed that the inclusion of human capital reduced the degree of relative labor intensity of Indian exports.

Using wage differentials as a proxy for human capital has several shortcomings. First, one must choose a "standard" wage rate for "standard" unskilled labor, a selection which is often arbitrary and therefore may bias the results rather considerably. Once the "standard" wage rate is established, a more difficult task is to select a "realistic" rate of return to human capital. Once again the choice is relatively arbitrary and can affect the results significantly. However, the other shortcoming of Kenen's method lies in attributing the total wage differentials to skill levels, and thus to human capital. What is assumed away is the effect of the monopoly power of labor unions in the labor market on the wages of the skilled workers.

Within the context of Kenen's approach, the stock of human capital may be measured directly by estimating the cost of education for each skill level. In this way Baldwin [2] estimated the total capital embodied in imports and exports as the sum of the physical capital and the educational cost for required skills. He found that for U.S. trade in 1962, after excluding natural resource intensive commodities, the coefficient of factor intensity of trade* becomes 0.97, and thus the paradox is reversed.

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*The ratio of factor intensity of imports to exports, or

$$\gamma = \frac{(K/L)_m}{(K/L)_x} .$$

An alternative method for assessing the human capital requirement of trade was introduced by Keesing [12, 14]. He attempted to find the relationship between the commodity composition of trade and interindustry skill differentials by looking into the actual skill mix of industries. "The availability of labor skills determines the pattern of international location and trade of manufactured products, those not closely tied to natural resources," said Keesing [12, p. 28]. This hypothesis is based on the observation that labor is much less mobile internationally than capital. While in the absence of labor mobility skills may be acquired only through a long process of industrial experience and educational training, the mobility of capital and the transformation of new technology embodied in capital goods are rather prevalent among economies. Therefore, within the framework of the H-O theory, it is only the relative endowment of skilled to unskilled labor that determines the pattern of trade.

Kessing classified labor skills into five categories:

I. Professional, technical, and managerial.
II. Craftsmen and foremen.
III. Clerical, sales, and services.
IV. Operative (semi-skilled).
V. Laborers (unskilled).

Applying the immediate skill requirements of U.S. industries* in 1950 to 1957 imports and exports of the U.S. and eight other countries, he found that U.S. exports are more skill intensive than imports by using three different definitions of skill intensity (Table 2-1). Moreover, for the other countries he discovers that the relative skill intensity ratio of exports to imports is larger than one for West Germany, Sweden, and the U.K. and smaller than one for the Netherlands, Belgium, Italy, France, and Japan.

Keesing's results cannot be considered conclusive and affirmative verification of the human skill theory without properly identifying the relative skill endowment of the countries under study. If one accepts that the U.S. is the most skill abundant country in the world, then the U.S. result is a positive confirmation of the theory. However, very little can be concluded from the trade structure of the other eight countries without specific knowledge of their relative skill endowment in terms of trading partners.

Hufbauer [11] attempted to test for the generality of Keesing's hypothesis by correlating the skill intensity of exports with the skill endowment of a

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*The application of U.S. skill coefficients to the trade structure of other countries may be justified on the basis of the tests performed by Keesing [12], and Hufbauer [11], which show significant similarity of ranking of skill intensities of industries among countries.

Table 2-1

Keesing's Estimate of Skill Intensity
of U.S. Trade (1957)

Definition of skill intensity ratio	Group (I + II) / Group (IV + V)	Group I / Group (IV + V)	Group II / Group (V + V)
Export skill ratio / Import skill ratio	1.724	1.582	1.800

Note: Groups refered to in this table correspond to the skill categories used by Keesing.

Source: [12, p. 291, Table 3].

selected group of countries. He found 0.695 and 0.822 for the Spearman and weighted rank correlation coefficients between the two variables.

In criticism it should be noted that both Keesing and Hufbauer apply the immediate (i.e. the final stage) instead of the total input requirements of each industry, thus ignoring the indirect input requirements for the industry. Their estimates will thus be biased to the extent that the degree of vertical integration and the indirect factor requirements may vary among industries.

2.3.1 Neotechnology Theories

The H-O theory assumes that the technological conditions of production are similar in all countries. However, in actual fact a country may enjoy a comparative advantage as a result of favorable technological conditions.

A country with large domestic markets can have a comparative advantage in the production of a decreasing cost commodity. More significantly, the comparative advantage may be the result of the development of a more efficient process for producing the old commodities or from the monopoly position resulting from new innovations in producing new products.

The proponents of neotechnology theories of trade maintain that "a complete explanation of trade must take account of differences in technological capabilities and the relative efficiency among countries and industries [1,p. 241]. All neotechnology theories assume demand as given and similar factor endowment ratios in all countries, and they set out to explain the commodity composition of trade through comparative technological advantage. In this section several neotechnology explanations of trade will be presented under the four alternative theories of scale economies, stage of production, technological gap, and the product cycle.

2.3.2 Scale Economies

According to the scale economies explanation of trade, a country with a large home market will tend to enjoy a comparative advantage in the production of those commodities which exhibit the greatest scale economies.

Hufbauer, the first proponent of this thesis in 1966, pointed out that the above proposition carries with it a "hidden" assumption, that "internal commodity price ratios are established in all countries before trade opens; that is to say that all goods are produced everywhere before trade commences" [10, p. 23]. The assumption implies that small nations could not, with reliance on international markets, develop a scale economy industry. However, Hufbauer argued that while contrary to this assumption production and trade are often simultaneous,

geographical and psychological barriers to trade, along with the protective measures of tariffs and quotas, prevent a small country from taking advantage of international markets [10, p. 3; 11, p. 176].

In a detailed study of the trade and development of synthetic materials Hufbauer found that the size of home markets, as measured by gross domestic product, "exercises considerable influence over the direction of synthetic materials trade" [10, p. 72].

Baldwin [2] tested the scale economies hypothesis by applying Weiss' estimates of scale index [29] for each industry (the percentage of employees in establishments with 250 or more employees) to an average one million dollar bundle of U.S. imports and exports for 1962. The results supported the theory in the cases of U.S. total trade and trade with Canada and the less developed countries but contradicted it in trade with Western Europe and Japan.

In a recent study, Hufbauer [11] introduced a more sophisticated method for testing the scale economies theory. As a measure of the scale coefficient he estimated the percentage change in value added per worker for a percentage change in the plant size for each one of the three-digit SITC group of U.S. manufacturing industries.* This

* A detailed explanation of the method of estimation of this coefficient and the coefficients of the following three neotechnology theories will be presented in Chapter 5, where the bilateral trade structure of the U.S., the U.K., and South Korea will be tested.

coefficient is then weighted by the relative size of exports of each commodity group in the export baskets of the U.S. and twenty-three other countries for 1963 to obtain the coefficient of scale economies embodied in exports. Hufbauer tested the theory by estimating the Spearman and the weighted correlation coefficients between the rank ordering of scale coefficient of exports and the size of manufacturing output of the economies as a measure of economic size. He found the two coefecients to be 0.627 and 0.788, respectively and concluded that the test confirms the theory.

2.3.3 Stage of Production

The stage of production hypothesis attempts to explain comparative advantage in terms of the level of economic development and the technological sophistication of production in the economy. The essential logic of the thesis grows out of economic development studies which are concerned with structural transformation and growth through import substitution. The theory states that the less advanced economies tend to specialize in the production of finished consumer goods while the more advanced economies specialize in production of consumer goods. The reason for this pattern of specialization is that the required technology for the production of consumer goods is less complicated and is less capital intensive. In addition there already exists a substantial domestic market in the less developed economies for these commodities which were imported prior to their domestic production [24, p. 5; 9, pp. 6,7].

The only test of this theory was performed by Hufbauer [11] by estimating the proportion of consumer goods in the exports of twenty-four countries (as explained in section 5.3), he found the Spearman and rank correlation coefficients between consumer goods ratio in exports and the GDP per capital as a measure of the level of economic development to be coefficients of 0.818 and 0.801 respectively. This, in Hufbauer's view, confirms the theory's hypothesis.

2.3.4 Technological Gap

The dynamics of industrial development manifested in the introduction of innovations and imitations is considered by the technological gap theory as the significant factor which shapes and affects the structure of manufacturing trade among countries.

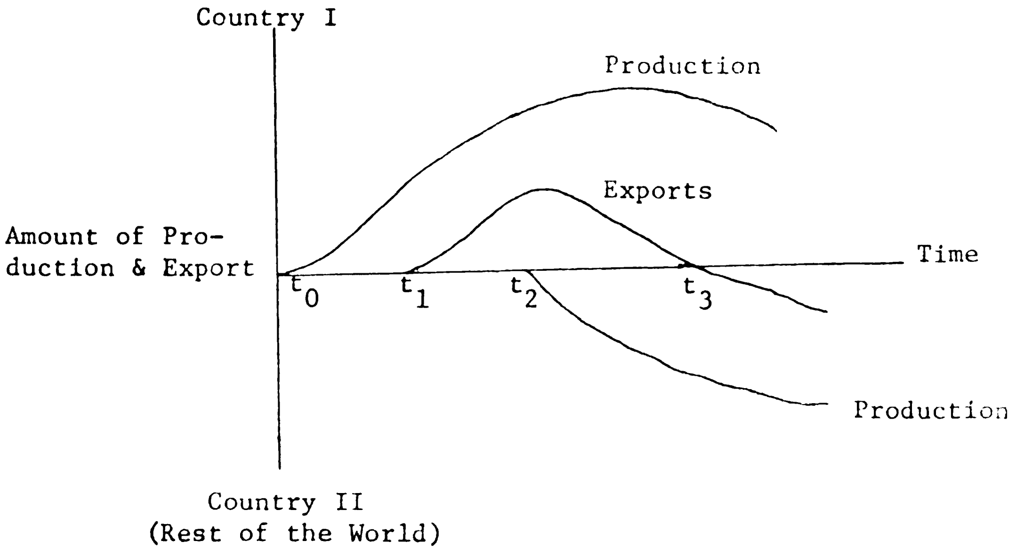
The effect of technological change on the structure of trade became the focus of studies during the 1950's when the dollar shortage problem became apparent. The works of Hicks [7], Balogh [3] and Williams [28], among others, concentrated on the consequences of technological progress, particularly of the U.S., on the relative prices of commodities in the international market. However, Kravis [19] pointed out that the effect of technological change on the structure of trade is not only through the forces of comparative cost and therefore through relative price adjustments but, more significantly, through "the advantages which result from the possession of the newest product and of the most recent improvement on the old kind" [19, p. 151]. This is the so-called availability thesis.

Since the innovation of new products and processes is the result of systematic efforts of producers in research and development, Keesing [13] and Gruber, Mehta, and Vernon [6] attempted to test Kravis' hypothesis indirectly by considering the relationship between the level of activities in research and development and the export performance of a selected group of U.S. industries. They found a positive and significant correlation between the proportion of expenditure on, and the proportion of scientist and engineers in research and development and the level of export performance of the industry.

The simplistic version of the technological gap theory introduced by Kravis in the above proposition was formulated into a dynamic model by Posner [21]. Posner assumes no international differences in factor proportions, no factor mobility, and no transportation cost among countries in this model. If a country introduces a new product or an improvement of an old product, the country will enjoy a comparative advantage in the production of that product in the international market until other countries become capable of producing this new product. The lag between the time that the product was introduced and the time that another country can imitate it is called "imitation lag" (t_0t_2 in Figure 2-1). The size of the lag may depend on the availability of technological requirements for the imitating country and on the extent of legal barriers to patent rights.

However, once the other countries are able to set up similar production processes, the leading country loses its favorable position and the export of the new commodity declines. Of course if new innovations take place in the advanced country, by the time comparative advantage is lost in production of one commodity innovations will provide comparative advantage in production of other commodities. The important point, however, is the extent of the aggregate imitation lag.

Hufbauer [11] tested this theory by correlating the average age of exports of twenty-four countries (explained in section 5.4) and the GDP per capita as the measure of industrial sophistication. He obtained significant Spearman and weighted rank correlation coefficients of 0.698 and 0.864,respectively,and considered the result a positive test of the theory.



t_0, Country I introduces the new commodity.

t_1, Export starts as a response to the newly created international demand.

t_2, Country II starts producing the commodity.

t_3, Country I loses its comparative advantage in the product and export declines to zero.

Source: Hufbauer [10, p. 24].

Figure 2-1

Imitation Lag and the Technological Gap Theory

2.3.5 Product Cycle

To the extent that the product cycle approach deals with the timing of innovations and the level of technological sophistication of economies, the theory is little different from the technological gap theory. However, the product cycle theory attempts to consider the elements which bring about the imitation gap and in this respect it is one step beyond the technological gap theory.

Hirsch [8] and Vernon [26] maintain that the more sophisticated economies can produce the new and differentiated product. The high income of the economy justifies the expectation of large profits through developing the new product. In the early stages of production the producer is confronted with the uncertainty concerning the dimension of the market, the specifications of the inputs, and the exact method of production. But once the product is introduced and its production expanded, a certain degree of standardization in the method of production and the product itself takes place. Before standardization, the innovator is the sole producer, and he therefore enjoys a comparative advantage on the international market.

But with standardization the product can be imitated, which is referred to as the maturing period for the product, and the first producer may lose his comparative advantage if the cost of production is less for other economies due to more favorable factor endowment positions.

Hirsch's study of the U.S. electronic industry [8] showed that between 1960 and 1964 the competitive position of the matured electronic products deteriorated while the industry maintained its lead in the growth (not yet matured) products.

Hufbauer [11] attempted to test the product cycle theory in a cross sectional study of exports of twenty-four nations by correlating the index of product differentiation (explained in section 5.5) embodied in exports and the GDP per capita. He obtained Spearman and weighted rank correlation coefficients of 0.724 and 0.763, respectively, and concluded that the result is a positive confirmation of the product cycle theory.

2.4 An Evaluation of Alternative Theories of Trade*

The neofactor and neotechnology theories of trade, as presented in this chapter, choose distinctly

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*By applying Hufbauer's measures, a recent study by the United States Tariff Commission [25] tested the scale economies, the technological gap, and the product cycle theories for U.S. trade during 1958/60 and for 1968. The results confirmed the technological gap and the product cycle theories for both periods. However, in the case of the scale economies hypothesis while the 1958/60 trade is consistent with the predicted pattern, inconsistency is observed in the 1968 trade.

different variables as the predominant forces in the determination of comparative advantage. For neofactor theories, the determining element is the relative endowment of factors of production in each country. Added to the traditional version of the H-O theory is the admission of differences in factor qualities through consideration of relative endowment of human capital. Thus, neofactor theories preserve the logical framework of the H-O model and its static characteristic.

In contrast neotechnology theories depart from the relative endowment of factors of production explanation of trade and seek to determine comparative advantage through relative differences in production functions. In this case, since the predominant variable is the relative technological advantages of economies, the theories are molded in a dynamic form which attempts to explain the effect of technological change and its uneven incidence on countries and commodities on the pattern of trade. The only exception to this generalization is the scale economies theory which is primarily concerned with the relative efficiency of production achieved as a result of the economic size of the country.

While stage of production, technological gap, and product cycle theories each give a different hypothesis for the commodity composition of trade, all three theories are essentially saying the same things: The more advanced economies will have comparative advantage in the production of the more sophisticated commodities. The level of sophistication of commodities is measured by its newness in the technological gap theory and by the degree of nonstandardization in the product cycle theory. However, since new products are also nonstandardized products,* there is little difference between the two theories.

While the stage of production theory differs in its explanation of comparative advantage from the other two theories, the underlying elements remain rather similar. Consumer goods are relatively more standardized both in commodity form** and in the production process and require less sophisticated methods of production which are available in the less advanced economies.

Given the degree of similarity between these three theories one should expect that they would perform similarly in a test of international trade flows. In fact, Hufbauer's study, as pointed out above, confirms all three theories, along with the scale economies and the human capital approach.

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*The correlation coefficient between the coefficient of product age and the product differentiation index of trade of twenty-three countries was found to be -0.710 in Table 6-4 Chapter 6 below.

**The correlation coefficient between the consumer good ratio and the index of product differention of trade of twenty-three countries was found to be -0.796, in Table 6-4, Chapter 6 below.

In addition to what was mentioned in section 2.2 about the shortcoming of Hufbauer's test of the human capital theory, his tests are open to another criticism. If one wants to verify the consistency of trade flows with the comparative advantage of countries, attention must be directed toward trade performances as reflect in import relative to export characteristics of each country and the country's national characteristics. Hufbauer instead based his conclusions on a series of correlations between export characteristics and national characteristics, as hypothesized by each theory. Thus he may conclude, for example, that country I has a comparative advantage over country II in the trade of skill intensive commodities if country I's exports contain a higher skill ratio than the exports of country II. However, this result amy be misleading if by inclusion of imports we find that country I is a net importer of skill intensive commodities while country II is a net exported of them.

In conclusion, despite several tests of alternative theories of trade presented in this chapter, there is no conclusive result with respect to their empirical validity.

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Chapter 3

EMPIRICAL TEST OF THE HECKSCHER-OHLIN THEORY: A BILATERAL TRADE STUDY

3.1 Introduction

This part of the study attempts to test the H-O theory by considering the commodity composition of trade of the United States, the United Kingdom and South Korea. In the case of the United States, the novelty of the test lies in the employment of a more recent, hitherto unused in this context, set of input-output tables for 1963 [24]. It provides a basis for a new look into the structure of American foreign trade.

In order to examine the generality of the H-O theory, it was considered desirable to test the hypothesis for a developed Western European economy and for a less developed economy. At the time of this study the United Kingdom was the only major Western European country for which the required data was available. The only other study of the U.K. pattern of trade was carried out by Hodd [11] for British trade during 1947-48. However, given the atypical nature of world trade in the immediate post war years, a study of the commodity composition of U.K. trade for recent years may well be in order.

In selecting a less developed economy for a test of the H-O theory, one encounters a dual problem. The detailed sectoral data required for an input-output study are seldom available for less developed countries. On the other hand, most less developed economies specialize in the export of primary commodities. However, the intent of this study is to consider the commodity composition of trade in manufactured goods as well as the total trade of each country. It was therefore necessary to select among the less developed economies one that had a considerable amount of manufactured exports. With these requirements the choice of a country becomes very limited, and South Korea was selected among the very few qualifying countries. No other study has examined the commodity composition of South Korean trade.

3.2 Methodology

Following Leontief [15,16], the H-O theory may be tested by estimating the total (direct plus indirect) capital and labor requirements of a representative bundle of the country's exports and the similar requirements for domestic production of an equivalent bundle of imports.

This may be done in the following manner.

Let the Matrix A,

$$A = \begin{bmatrix} a_{11} \cdots a_{1j} \cdots a_{1n} \\ \vdots \\ a_{i1} \cdots a_{ij} \cdots a_{in} \\ \vdots \\ a_{n1} \cdots a_{nj} \cdots a_{nn} \end{bmatrix}$$

represent the direct requirement input-output table of the economy.

Then the total (direct plus indirect) requirement input-output table of the economy is [18]

$$[I - A]^{-1} = \begin{bmatrix} r_{11} \cdots r_{1j} \cdots r_{1n} \\ \vdots \\ r_{i1} \cdots r_{ij} \cdots r_{in} \\ \vdots \\ r_{n1} \cdots r_{nj} \cdots r_{nn} \end{bmatrix}$$

where r_{ij} is the total requirement of industry j from industry i to produce one dollar of output.

Furthermore, let

k_i be capital input (in $1,000) per one million dollars of value added in industry i;and

l_i be labor input (in man years) per one million dollars of value added in industry i.

Then the total capital and labor requirement per million dollars of output of industry j are respectively

$$\bar{k}_j = \sum_{i=1}^{n} k_i \, r_{ij} \qquad (1)$$

$$\bar{l} = \sum_{i=1}^{n} l_i \, r_{ij} \qquad (2)$$

The proportional amount of each commodity in an average bundle of imports and exports is represented by m_j and x_j respectively, where

m_j = the value of the j commodity (industry j's output) in representative one million dollar bundle of the country's imports; and

x_j = the value of the j commodity (industry j's output) in representative one million dollar bundle of the country's exports.

Then the total capital and labor requirements per one million dollars of imports and exports will be

$$K_M = \sum_{j=1}^{n} \left(\sum_{i=1}^{n} k_i \, r_{ij}\right) m_j \qquad (3)$$

$$L_M = \sum_{j=1}^{n} \left(\sum_{i=1}^{n} l_i \, r_{ij}\right) m_j$$

$$K_X = \sum_{j=1}^{n} \left(\sum_{i=1}^{n} k_i \, r_{ij} \right) x_j$$

$$L_X = \sum_{j=1}^{n} \left(\sum_{i=1}^{n} l_i \, r_{ij} \right) x_j$$

where K_M and L_M connote the total capital and labor requirements for one million dollars of imports. K_X and L_X show similar measures of exports.

Now the Leontief coefficient of relative factor intensity, γ, is estimated by

$$\gamma = \frac{\sum_{j=1}^{n} \left(\sum_{i=1}^{n} k_i \, r_{ij} \right) m_j \Big/ \sum_{j=1}^{n} \left(\sum_{i=1}^{n} l_i \, r_{ij} \right) m_j}{\sum_{j=1}^{n} \left(\sum_{i=1}^{n} k_i \, r_{ij} \right) x_j \Big/ \sum_{j=1}^{n} \left(\sum_{i=1}^{n} l_i \, r_{ij} \right) x_j} \qquad (4)$$

or by substituting (1) and (2) into (4):

$$\gamma = \frac{\left(\sum_{j=1}^{n} \bar{k}_j \, m_j \right) \Big/ \left(\sum_{j=1}^{n} \bar{l}_j \, m_j \right)}{\left(\sum_{j=1}^{n} \bar{k}_j \, x_j \right) \Big/ \left(\sum_{j=1}^{n} \bar{l}_j \, x_j \right)} \; . \qquad (5)$$

Simply stated, γ represents the relative factor (K/L) intensity of imports compared to that of exports of a country. Therefore, for a relatively capital abundant country γ is expected to be less than one, and greater than one otherwise.

The input-output table of each country is obtained from national statistical sources. For the present context the ideal input-output table is one that separates the input requirements of each industry according to its domestic or imported origin. Unfortunately, few countries provide this level of disaggregation in their tables. The input-output tables of the U.S. and the U.K. list separate entries only for noncompetitive imports, and they include the input of competitive imports along with the input of similar domestic industries. As a result, to the extent that imported intermediate commodities may be used for production in some industries, the capital/labor ratio estimates of imports and exports, each considered separately, will be biased.

However, we are interested in the relative factor intensity of imports as compared to exports. While the imported intermediate inputs are included in the import side, the product for which the intermediate input is utilized is included in the export side. Therefore, the imported intermediate inputs are accounted for, indirectly, in the export bundle. Thus they net out in the capital/labor ratio of imports over that of exports.

As a measure of capital we used the net book value of industry's fixed assets plus inventories per million dollars of value added [3, 14]. Inventories include the value of finished and unfinished products as well as input materials inventories.

Labor input coefficients are the number of workers employed to produce one million dollars of value added. All workers receiving wages and salaries and unpaid family workers are included in this coefficient.

3.3 The Commodity Composition of U.S. Trade

Total capital and labor requirements of U.S. industries were estimated by applying the 1963 capital and labor coefficients for each industry (Table A-2 Appendix) to the 1963, eighty-two sector, total requirement input-output table of the United States [24]. The 1970 U.S. trade data reported according to the SITC classification [21] were grouped to match the output of the industry groups of the input-output table. Although the correspondence between the SITC and the SIC classifications is not exact, the detailed cross classification charts published by the U.S. Department of Commerce [23] make possible a relatively accurate groupings of commodities.

The relative factor intensity of U.S. trade is shown in Table 3-2. Capital and labor embodied per million dollars of U.S. imports are shown in columns i and ii, while columns iii and iv indicate similar figures for exports. The estimate of the relative factor intensity of U.S. trade, γ, is shown in column v.

For the H-O theory to hold, this ratio must be consistent with the relative factor endowment position of the country, thus for the U.S. which is relatively more capital abundant than any other country in the world with the exception of Canada, as Table 3-1 indicates, the ratio must be less then one in all cases except in trade with Canada.

The results shown in Table 3-2 indicate that the Leontief paradox prevails with respect to U.S.-world trade. Similarly, the bilateral patterns of U.S. trade with Japan, Australia and New Zealand, Africa, Latin America, and the centrally planned economies do not reflect the relative factor abundance of each country vis-à-vis the U.S. On the other hand, U.S. trade with various regions in Europe and with Canada affirms the H-O pattern.

Swerling [20] has argued that the service sectors, mainly wholesale trade and transportation, contributed to the relatively low capital/labor ratio embodied in U.S. exports. However, excluding inputs of the service sectors (Table 3-3) makes very little difference to the results.

It was pointed out in Section 1.4.3 that the critical assumption of similar production functions among countries may be most seriously violated in the case of non-manufactured commodities. Therefore, it should be expected that the H-O theory applied to the trade of only manufactured commodities would perform more satisfactorily.

Table 3-1

Capital/Labor Endowment Ratio of Selected Developed Economies (1964)

Country	Fixed Capital per manufacturing Employee (U.S. $)
U.S.	7950
Canada	8850
Japan	3100
EEC	
France	4900
Netherlands	4750
Belgium	4400
Germany	4250
Italy	2600
EFTA	
U.K.	4000
Norway	6100
Sweden	5400
Austria	4000
Denmark	2850
Portugal	1500
Australia	5300

Sources: Hufbauer [12], U.N. [22]. The estimates are the sum of current outlays for gross manufacturing investment between 1953 and 1964 divided by 1964 manufacturing employment.

Table 3-2

Capital and Labor Requirements Per Million Dollars of U.S. Exports and Competitive Import Replacements (All Commodities, All Inputs Included)

1970 U.S. TRADE WITH	IMPORTS		EXPORTS		
	i	ii	iii	iv	v
	K ($1000)	L (Man Year)	K ($1000)	L (Man Year)	$\gamma_{K/L}$[1]
WORLD	2732.09	187.03	2806.81	201.15	1.047
Developed Economies	2607.07	190.59	2800.08	208.24	1.017
EEC	2479.41	196.18	2909.49	199.17	0.865
EFTA	2670.86	196.58	2804.47	176.83	0.857
U.K.	2674.63	195.45	2786.23	172.06	0.845
Other Europe[2]	2878.65	209.59	2986.61	216.79	0.997
Japan	2368.41	198.78	3104.35	265.65	1.020
Australia and New Zealand	3558.75	189.28	2522.35	181.51	1.353
Canada	2691.69	179.49	2585.23	205.97	1.195
Less Developed Economies	3123.66	175.30	2817.96	182.86	1.156
Africa	3246.65	135.86	2909.95	181.69	1.493
Latin America	3379.52	145.30	2709.80	191.85	1.647
Asia	2768.77	218.52	3012.51	171.38	0.720
South Korea	2276.83	275.60	3232.58	156.97	0.401
Centrally Planned Economies	3077.13	196.89	3181.74	257.87	1.267
U.S.S.R.	3117.90	178.66	2682.39	176.11	1.146

[1] $\gamma_{K/L} = \frac{(K/L)_M}{(K/L)_X}$.

[2] Greece, Iceland, Ireland, Spain, and Yugoslavia.

Sources: Capital and labor coefficients presented in Table A-2, Appendix. U.S. input-output table from [24], trade data from [21].

Indeed the results (Table 3-4) indicate that the paradox no longer exists in the case of U.S.-world trade. Moreover, U.S. trade in manufactures with Japan and the centrally planned economies conforms with the theory. But the structure of trade with Africa, Latin America, Australia and New Zealand, and the U.S.S.R., still does not reveal the expected pattern.

However, by confining the H-O theory only to trade in manufactured commodities, a more accurate measure of factor intensity of trade will be obtained when the nonmanufactured inputs are excluded from the estimate of factor intensities. Once this is done the relative factor abundance of U.S. vis-à-vis the rest of the world becomes more pronounced. The coefficients fall in all cases in Table 3-5. But the paradox prevails in trade with the same countries and regions indicated in the previous case.

The U.S. results lend substantial support to a less generalized H-O theory which attempts to explain the pattern of trade among countries with similar levels of economic development. Whether the trade of all or only of manufactured commodities are included, Transatlantic and Canadian trade follow the H-O pattern.

When only manufactures trade is considered, the comparative advantage of the U.S. in the production and export of the relatively more capital intensive

Table 3-3

Capital and Labor Requirements Per Million Dollars of U.S. Exports and Competitive Import Replacements (Inputs of Service Sectors are Excluded)*

1970 U.S. TRADE WITH	IMPORTS K ($1000)	IMPORTS L (Man Years)	EXPORTS K ($1000)	EXPORTS L (Man Years)	$Y_{K/L}$ [1]
WORLD	2142.75	164.30	2191.17	178.85	1.064
Developed Economies	2049.67	168.00	2190.46	186.22	1.037
EEC	1946.87	173.72	2278.53	176.99	0.871
EFTA	2102.34	173.10	2173.11	154.65	0.864
U.K.	2097.36	172.00	2172.68	150.01	0.842
Other Europe [2]	2278.89	185.82	2308.49	194.27	1.032
Japan	1862.02	176.93	2450.10	243.85	1.047
Australia and New Zealand	2894.06	161.89	1931.70	159.51	1.476
Canada	2105.66	157.17	2036.22	184.20	1.212
Less Developed Economies	2432.02	152.21	2212.65	159.91	1.155
Africa	2517.63	114.20	2273.96	158.61	1.538
Latin America	2602.22	121.16	2119.98	169.01	1.712
Asia	2192.38	196.67	2381.86	148.23	0.694
South Korea	1759.57	254.30	2574.90	133.93	0.360
Centrally Planned Economies	2487.60	172.48	2576.25	234.66	1.314
U.S.S.R.	2570.99	156.56	2128.39	152.38	1.176

* Inputs of sectors 62-71, Table A-2 Appendix, are excluded.

Sources and other footnotes: See Table 3-2.

Table 3-4

Capital and Labor Requirements Per Million Dollars of
U.S. Exports and Competitive Import Replacements (Non-Manufacturing Trade is Excluded)*

1970 U.S. TRADE WITH	IMPORTS		EXPORTS		
	K ($1000)	L (Man Years)	K ($1000)	L (Man Years)	$\gamma_{K/L}$ [1]
WORLD	2546.85	195.25	2483.05	180.90	.950
Developed Economies	2476.05	193.57	2462.08	180.18	.936
EEC	2424.07	196.98	2519.11	177.36	.866
EFTA	2556.28	196.64	2482.52	180.06	.943
U.K.	2640.84	196.13	2488.44	179.73	.973
Other Europe[2]	2510.51	228.53	2643.25	180.66	.751
Japan	2332.59	198.70	2513.21	175.82	.821
Australia and New Zealand	2767.20	164.08	2445.63	181.07	1.249
Canada	2568.41	184.07	2386.89	183.68	1.074
Less Developed Economies	2854.61	202.56	2514.73	182.21	1.021
Africa	3057.22	198.47	2572.31	186.26	1.115
Latin America	3204.50	157.70	2489.97	183.36	1.496
Asia	2483.61	248.15	2551.89	182.87	.717
South Korea	2248.95	277.10	2454.14	181.67	.601
Centrally Planned Economies	2713.93	201.25	2483.48	173.71	.943
U.S.S.R.	3028.96	190.70	2647.60	180.91	1.085

* For the list of non-manufactured commodities see Table A-1, Appendix.
Sources and other footnotes: See Table 3-2.

commodities becomes more pronounced. In these cases, (Tables 3-4 and 3-5) the trade with Japan and the centrally planned economies also follows the H-O pattern.

It may be interesting to note that the so-called East-West trade, which is included in the category of the centrally planned economies, conforms to the forces of comparative advantage as explained by the H-O theory. Among the socialist countries, the U.S. trades only with the U.S.S.R. and Eastern European countries. Trade with the latter constitutes two-thirds of this category.

Although the less generalized H-O theory allows for divergence of trade pattern of the U.S. with the less developed countries (the cases of U.S.-Latin American and U.S.-African trade), the U.S.-Asian trade and in particular the U.S.-South Korean trade consistently conform to the theory.

3.4 The Commodity Composition of U.K. Trade

The estimates of capital and labor (1960) and the input-output table (1960) published by the Department of Applied Economics of Cambridge University [4,5] provide the data for estimating the total capital and labor requirements of British industries. The trade data as reported by the United Nations [21] were grouped to match the industry groupings of the input-output

Table 3-5

Capital and Labor Requirements Per Million Dollars of
U.S. Exports and Competitive Import Replacements (Non-Manufacturing Inputs and Trade are Excluded)*

1970 U.S. TRADE WITH	IMPORTS K ($1000)	IMPORTS L (Man Years)	EXPORTS K ($1000)	EXPORTS L (Man Years)	$\gamma_{K/L}$ [1]
WORLD	2309.31	181.91	2338.85	170.52	.926
Developed Economies	2276.94	180.52	2326.93	170.14	.922
EEC	2231.08	183.96	2374.97	167.00	.853
EFTA	2238.58	181.68	2340.48	170.14	.896
U.K.	2244.15	179.19	2355.31	169.00	.899
Other Europe[2]	2094.99	213.51	2498.80	168.22	.661
Japan	2176.78	185.60	2386.21	167.23	.822
Australia and New Zealand	2330.72	144.79	2322.90	171.71	1.190
Canada	2403.74	172.16	2259.55	173.23	1.071
Less Developed Economies	2446.96	187.95	2344.29	170.70	.948
Africa	2677.05	182.82	2404.79	174.57	1.063
Latin America	2777.73	142.30	2345.17	172.62	1.437
Asia	2099.74	234.59	2349.93	170.58	.650
South Korea	1992.55	266.98	2282.87	170.63	.558
Centrally Planned Economies	2503.36	188.93	2314.92	160.34	.918
U.S.S.R.	2839.60	179.61	2502.55	166.78	1.054

* Inputs of sectors 1-10, and 62-71, Table A-2 Appendix, are excluded. For the list of excluded commodities see Table A-1, Appendix.
Sources and footnotes: See Table 3-2.

table. In doing so, some difficulty was encountered in assigning commodities to industries since the detailed composition of each input-output sector was not reported. Thus the grouping of the commodities was based on the sectoral description of the input-output table which may be somewhat inexact.

Before considering the relative factor intensity of U.K. trade, the relative factor endowment of that country with respect to its several trading partners must be examined. It is reasonable to presume that the U.K. is capital abundant relative to the less developed, centrally planned, and "other European" economies. The relative factor endowment position of the U.K. with respect to the developed economies is shown in Table 3-6. The endowment position of the U.K. is not substantially different from the EEC (Italy excluded*), the EFTA (Portugal excluded**), and the Southern Dominion countries. However, the U.K. is definitely capital abundant relative to Japan and capital scarce relative to the U.S. and Canada.

The factor requirement of U.K. total trade is shown in Table 3-7. While the relative endowment position of the U.K. is somewhere in the middle of the spectrum with respect to the world as a whole, the U.K.'s imports are, on the average, more capital intensive than

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*Italy is excluded because its K/L endowment position of $2,600 makes it definitely capital scarce relative to the U.K.

**Similar to Italy.

its exports. However, the results in Table 3-7 indicate that U.K. exports to the relatively capital scarce economies of Japan and "other Europe" are more capital intensive than the country's imports from them. Conversely, its imports from the U.S. (contrary to Hodd's findings [11]), and Canada are more capital intensive than the U.K.'s exports to them. Both situations confirm the H-O theory.

While the trade pattern with the centrally planned economies is consistent with the H-O theory, the relative factor intensity of trade with the less developed countries, with the exception of South Korea, is contrary to the prediction of the model.

As in the U.S. case, little change in the pattern of trade is observed once the inputs of service sectors are excluded (Table 3-8).

Exclusion of non-manufactured inputs and commodities, Table 3-10, results in almost identical coefficients of relative factor intensity when compared with the case that only manufactured inputs are excluded, Table 3-9. In comparison with Tables 3-7 and 3-8 some minor changes are noted in the coefficients. However, the pattern remains unchanged with the only exception being that of trade with the U.S.S.R., which no longer conforms to the H-O theory.

Summing up, the inclusion or exclusion of manufactured inputs and trade does not alter the relative

Table 3-6

Capital/Labor Endowment Ratio of Selected Developed Economies (1964)

Country or Economic Region	Fixed Capital per Manufacturing Employee (U.S. $)
U.K.	4,000
Canada	8,850
U.S.	7,950
Japan	3,100
EEC (Excluding Italy)	4,440
EFTA(Excluding Portugal and the U.K.)	4,590
Southern Dominions	4,150
Australia	5,300
New Zealand	10,000[1,2]
South Africa	3,000[1]

[1]Fixed capital per employee in all sectors.

[2]The estimate is unreasonably high and is not included in the ratio for the region.

Source: See Table 3-1.

intensity pattern of U.K. trade significantly. U.K. trade with the U.S., Canada, "other Europe," and Japan, all developed economies, are consistent with the H-O pattern. On the other hand, U.K. trade with the less developed economies of Latin America, Africa, and Asia with the exception of South Korea, cannot be explained by the model.

Interestingly, the U.K. trade with Eastern Europe consistently conforms with the predicted pattern. Little may be said, however, about the trade with the EEC, EFTA, and Southern Dominion countries, given their similar relative factor endowment positions.

3.5 The Commodity Composition of South Korean Trade

Capital and labor input coefficients for South Korean mining and manufacturing industries (1966) were obtained from national statistical sources [6,19]. Unfortunately, similar data for agriculture and the service sectors were not available. The Japanese input coefficients for 1955 were substituted for the missing data [7,8,9,10,25]. Although this substitution may result in some errors, it is believed that the input coefficients of South Korean argiculture and service industries are substantially similar to that of Japan in 1955. The Japanese data were the closest substitute for the missing South Korean data.

South Korea is unquestionably less capital

Table 3-7

Capital and Labor Requirements Per Million Dollars of
U.K. Exports and Competitive Import Replacements (All Commodities, All Inputs Included)

1969 U.K. TRADE WITH	IMPORTS		EXPORTS		
	(US $1000's)	(Man Years)	(US $1000's)	(Man Years)	$\gamma_{K/L}$ [1]
WORLD	3688.81	878.18	3625.65	885.17	1.026
Developed Economies	3648.26	871.69	3790.17	882.58	0.975
U.S.	3163.19	828.20	3388.25	888.07	1.001
EEC [2]	4201.48	867.35	3534.45	881.00	1.207
EFTA [3]	3501.42	879.99	4430.24	911.52	0.819
Other Europe [4] plus Portugal	3591.58	936.55	3803.25	872.00	0.879
Japan	3428.34	937.97	3382.16	852.22	0.921
Canada	3232.49	805.15	3398.75	916.20	1.081
Southern Dominions [5]	3499.13	904.60	3432.42	883.63	0.996
Less Developed Economies	3990.99	905.26	3493.24	880.23	1.111
Latin America	3779.32	807.38	3373.31	843.93	1.171
Africa	3567.91	818.52	3486.73	876.57	1.096
Asia	4148.54	1031.82	3424.89	861.43	1.011
South Korea	3470.03	1040.84	3306.27	906.97	0.915
Centrally Planned Economies	3249.27	919.15	3361.95	852.43	0.896
U.S.S.R.	3122.28	907.28	3223.45	873.14	0.932
Eastern Europe	3496.31	912.41	3368.57	820.68	0.934

[1] $\gamma_{K/L} = \frac{(K/L)_M}{(K/L)_x}$. [2] Excluding Italy. [3] Excluding Portugal.

[4] Greece, Iceland, Ireland, Spain and Yugoslavia. [5] Australia, New Zealand and South Africa.

Sources: Capital and Labor Coefficients presented in Table A-3, Appendix. Input-Output Table from [5]. Trade data from [21].

Table 3-8

Capital and Labor Requirements Per Million Dollars of
U.K. Exports and Competitive Import Replacements (Inputs of Service Sectors are Excluded)*

1969 U.K. TRADE WITH	IMPORTS		EXPORTS		
	K (U.S. $1000)	L (Man Years)	K (U.S. $1000)	L (Man Years)	$\gamma_{K/L}$ [1]
WORLD	2810.87	730.96	2778.29	745.63	1.032
Developed Economies	2775.47	725.38	2930.96	739.86	0.966
U.S.	2411.86	704.57	2559.73	749.51	1.002
EEC [2]	3330.97	723.91	2678.97	740.85	1.272
EFTA [3]	2584.16	725.55	3585.06	772.48	0.768
Other Europe[4] plus Portugal	2741.39	786.51	2916.29	727.19	0.869
Japan	2567.20	793.14	2514.16	709.71	0.914
Canada	2288.03	650.43	2562.70	777.51	1.067
Southern Dominions[5]	2511.27	739.27	2569.12	741.08	0.980
Less Developed Economies	3087.66	754.94	2655.64	741.79	1.142
Latin America	2754.75	641.57	2539.83	708.12	1.197
Africa	2648.67	668.13	2631.57	733.79	1.105
Asia	3368.93	894.09	2597.93	725.26	1.052
South Korea	2560.73	894.43	2465.86	766.34	0.890
Centrally Planned Economies	2380.77	772.23	2514.33	713.91	0.875
U.S.S.R.	2290.61	769.45	2397.96	737.92	0.916
Eastern Europe	2540.43	748.82	2499.39	680.31	0.923

*Inputs of sectors 25-31 in Table A-3, Appendix are excluded.

Sources and other footnotes: See Table 3-7.

Table 3-9

Capital and Labor Requirements Per Million Dollars of
U.K. Exports and Competitive Import Replacements
(Non-Manufacturing Trade Excluded)*

1969 U.K. TRADE WITH	IMPORTS K (US $1000's)	IMPORTS L (Man Years)	EXPORTS K (US $1000's)	EXPORTS L (Man Years)	$\gamma_{K/L}$ [1]
WORLD	3840.47	857.66	3634.73	886.05	1.092
Developed Economies	3758.95	849.96	3849.95	875.62	1.006
U.S.	3114.81	814.54	3387.08	887.64	1.002
EEC [2]	4382.34	845.95	3553.17	886.18	1.292
EFTA [3]	3523.91	868.51	4476.23	916.45	0.831
Other Europe[4] plus Portugal	3921.56	946.31	3832.91	869.88	0.940
Japan	3427.29	932.94	3370.33	845.51	0.922
Canada	3125.56	758.54	3394.33	915.51	1.111
Southern Dominions[5]	3373.17	879.10	3430.87	883.00	0.988
Less Developed Economies	4245.15	903.22	3490.18	878.87	1.184
Latin America	4166.12	676.91	3371.86	843.33	1.539
Africa	3673.14	789.81	3480.54	874.89	1.169
Asia	4455.08	1068.35	3420.60	859.62	1.048
South Korea	3416.51	1163.74	3301.51	905.33	0.805
Centrally Planned Economies	3405.11	910.36	3357.06	850.36	0.947
U.S.S.R.	3367.96	900.65	3221.75	872.52	1.013
Eastern Europe	3426.23	888.72	3359.51	813.89	0.934

* For the list of non-manufactured commodities see Table A-1, Appendix.

Sources and other footnotes: See Table 3-7.

Table 3-10

Capital and Labor Requirements Per Million Dollars of
U.K. Exports and Competitive Import Replacements
(Non -Manufacturing Inputs and Trade are Excluded)*

1969 U.K. TRADE WITH	IMPORTS		EXPORTS		
	K (US $1000's)	L (Man Years)	K (US $1000's)	L (Man Years)	$\gamma_{K/L}$ [1]
WORLD	3804.04	847.03	3602.82	876.81	1.093
Developed Economies	3723.72	839.65	3819.15	865.91	1.006
U.S.	3087.36	806.82	3355.48	878.20	1.001
EEC [2]	4348.03	836.00	3520.30	876.82	1.295
EFTA [3]	3488.75	858.52	4444.32	907.17	0.829
Other Europe[4] plus Portugal	3884.81	934.49	3799.13	860.13	0.941
Japan	3390.82	921.78	3335.17	835.27	0.921
Canada	3077.05	745.18	3362.00	906.01	1.113
Southern Dominions[5]	3318.81	862.12	3400.13	874.22	0.990
Less Developed Economies	4205.98	891.94	3459.54	869.90	1.186
Latin America	4103.97	660.05	3340.91	834.37	1.553
Africa	3615.33	772.91	3449.78	865.87	1.174
Asia	4428.17	1059.93	3390.19	850.75	1.048
South Korea	3394.65	1157.00	3275.72	898.01	0.804
Centrally Planned Economies	3366.20	898.99	3320.50	840.27	0.948
U.S.S.R.	3333.11	891.02	3190.53	863.75	1.013
Eastern Europe	3376.41	873.40	3322.40	803.62	0.935

* Inputs of Sectors 1-3 and 25-31 in Table A-3, Appendix are excluded. For the list of excluded commodities see Table A-1, Appendix.

Sources and other footnotes: See Table 3-7.

abundant than any of the developed economies. The factor endowment position of South Korea relative to its less developed trading partners is shown in Table 3-11. Because the required capital and labor estimates were not available for many less developed economies in Africa and Latin America, the capital/labor endowment ratios of the major trading countries with South Korea are considered.

In the Middle East, among the three major trading countries with South Korea, the capital/labor endowment ratio of Iran could be estimated. However, it is reasonable to assume that Kuwait and Saudi Arabia are more capital abundant than Iran which in turn is relatively more capital abundant than South Korea. Similarly, although data are not available for Burma, India, Pakistan, and Indonesia, it is safe to assume that each of these countries, and four of them together, are more labor abundant than South Korea.

The estimates of relative factor intensity of South Korean trade (1969) indicates that the country, in its total trade, imports capital intensive and exports labor intensive commodities (Table 3-12).

In trade with developed economies the coefficients of South Korea-U.S. and South Korea-Australia and New Zealand indicate inconsistency with the predicted pattern. It is interesting to note that the relative factor

Table 3-11

Capital/Labor Endowment Ratio of Selected
Less Developed Countries
(1964)

Country or Economic Region	Fixed Capital per Employee (U.S. $)
South Korea	315
Latin America	950
Chile	
Mexico	
Panama	
Peru	
Africa	1950*
Ghana	
Moracco	
Nigeria	
Middle East	1100**
Iran	
Kuwait	
Saudi Arabia	
Burma, India, Pakistan, and Indonesia	Not Available
Taiwan and Thailand	400
Malaysia, Singapore, and Hong Kong	1200

*The estimate is unreasonably high.

**The given estimate is only for Iran.

Sources and method of estimation explained in the footnote to Table 3-1 except here the K/L ratios include capital and labor of all sectors since similar data for the manufacturing sectors were not available for the above countries.

intensity of trade between South Korea and U.S., estimated with the American coefficients and input-output table, was consistent with H-O pattern. However, using South Korean production conditions the results become inconsistent with the theory. It was shown in sections 1.4.2 and 1.4.3 that this form of results may be obtained if either the Samuelsonian factor intensity assumption or the assumption of equality of production functions among countries are violated.

Moreover, the relative factor intensity coefficients of South Korean trade with the less developed countries, each group considered separately, confirm the H-O pattern.

When non-manufactured commodities and inputs are excluded (Table 3-13), the relative factor intensity estimates of trade with all regions become consistent with the predicted pattern of the H-O theory.

3.6 Conclusion

The result of the study, as presented in this chapter, reveals that the H-O theory provides a rather powerful explanation for the bilateral trade of nations. The theory faces no serious empirical contradictions as long as the pattern of trade among either developed or less developed countries or regions are considered. The results improve even more if the analysis is confined to the trade of manufactured commodities.

Table 3-12

Capital and Labor Requirements Per Million Dollars of South Korean Exports and Competitive Import Replacements (All Commodities, All Inputs Included)

1969 SOUTH KOREAN TRADE WITH	IMPORTS		EXPORTS		
	K	L	K	L	$\gamma_{K/L}$ [1]
	(U.S. $1000)	(Man Years)	(U.S. $1000)	(Man Years)	
WORLD	2308.80	2079.42	2775.77	3168.45	1.267
Developed Economies	2260.57	2031.87	2728.70	3194.78	1.303
U.S.	1785.29	2159.18	2794.62	2977.36	0.881
Western Europe	2593.05	1683.02	2906.14	2949.49	1.564
U.K.	2502.79	1654.42	2689.62	2573.33	1.447
Japan	2558.51	1971.03	2405.18	3666.82	1.979
Australia & New Zealand	2009.79	5268.80	2858.63	2824.39	0.377
Less Developed Economies	2633.30	2370.40	3024.67	3026.59	1.112
Latin America	2517.44	3499.66	3007.09	3008.20	0.720
Africa	1494.54	1074.20	4150.10	3808.59	1.277
Middle East	2914.51	1661.62	3123.67	2969.26	1.667
Burma, India, Pakistan, and Indonesia	2624.05	2621.80	3476.20	3353.18	0.965
Taiwan and Thailand	3172.60	3721.21	2613.41	3575.13	1.166
Malaysia, Singapore, and Hong Kong	2591.98	2463.92	3270.07	3189.84	1.026

1 $\gamma_{K/L} = \frac{(K/L)_M}{(K/L)_X}$.

Sources: Capital and labor coefficients presented in Table A-4, Appendix. Input-output Table from [5]. Trade statistics from [21].

Table 3-13

Capital and Labor Requirements Per Million Dollars of South Korean Exports and Competitive Import Replacements (Non-Manufacturing Inputs and Trade are Excluded)*

1969 SOUTH KOREAN TRADE WITH	IMPORTS K (US $1000's)	IMPORTS L (Man Years)	EXPORTS K (US $1000's)	EXPORTS L (Man Years)	$\gamma_{K/L}$ [1]
WORLD	2237.24	1199.47	2408.06	1829.71	1.417
Developed Economies	2236.58	1188.02	2347.61	1876.09	1.504
U.S.	2237.72	1198.58	2194.81	1905.28	1.621
Western Europe	2189.03	1158.27	2753.35	1621.68	1.113
U.K.	2125.18	1132.59	2386.94	1381.31	1.086
Japan	2271.70	1208.68	2701.02	1708.18	1.189
Australia & New Zealand	3195.47	1929.65	2216.37	1500.04	1.121
Less Developed Economies	2033.88	1267.21	2706.45	1602.01	0.950
Latin America	2174.18	1065.38	2699.04	1717.74	1.299
Africa	2082.44	1164.19	3646.53	2348.30	1.152
Middle East	1893.94	701.87	2640.11	157.03	1.612
Burma, India, Pakistan, & Indonesia	2128.93	1668.76	3111.16	1998.58	0.820
Taiwan & Thailand	2416.42	1343.24	2596.26	1526.44	1.058
Malaysia, Singapore & Hong Kong	2401.77	1265.82	2898.93	1718.95	1.125

* Inputs of sectors 1-7 and 33-39 in Table A-4, Appendix are excluded. For a list of non-manufactured commodities see Table A-1, Appendix.

Sources and other footnotes: See Table 3-12.

Moreover, these findings are contrary to Linder's assertion [17] that countries with similar levels of economic development will tend to exchange manufactured commodities with similar characteristics among themselves.

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Chapter 4

THE HUMAN CAPITAL THEORY OF INTERNATIONAL TRADE: A BILATERAL TRADE STUDY

4.1 Introduction and Methodology

In this chapter the bilateral trade structure of the United State, the United Kingdom, and South Korea will be examined in an effort to test the human capital theory of international trade.

Following Keesing [4,5], the labor input requirement of each industry is classified into six categories:

1. Professionals and technicians.
2. Administrators and managers .
3. Clerical workers.
4. Sales workers.
5. Manual workers.
6. Service workers.

Let s_{ti} represent the number of workers of category t (t=1,2...6) required to produce one million dollars of value added in industry i. Then the total requirement of group t workers by the jth industry will be

$$\bar{s}_{tj} = \sum_{i=1}^{n} s_{ti}\, r_{ij} \qquad (1)$$

where r_{ij} is an element of the total requirement input-output table of the economy.

Morevoer, let m_j and x_j represent the value of the jth commodity (industry j's output) in a representative one million dollar bundle of manufactured imports and exports respectively. Then the total requirement of the t category of workers per one million dollars of imports and exports will be $(S_t)_M$ and $(S_t)_X$ respectively. Where:

$$(S_t)_M = \sum_{j=1}^{n} \left(\sum_{i=1}^{n} s_{ti}\, r_{ij} \right) m_j$$

$$(S_t)_X = \sum_{j=1}^{n} \left(\sum_{i=1}^{n} s_{ti}\, r_{ij} \right) x_j \qquad (2)$$

Substituting (1) into (2) the following relations may be obtained:

$$(S_t)_M = \sum_{j=1}^{n} \bar{s}_{tj}\, m_j$$

$$(S_t)_X = \sum_{j=1}^{n} \bar{s}_{tj}\, x_j \qquad (3)$$

However to determine the relative skill intensity of trade, the six categories of workers must be classified into skilled and unskilled groups. Here the following three measures of relative skill intensity of trade appear plausible:

$$\gamma_1^s = \frac{(S_1)_M \;/\; (S_5)_M}{(S_1)_X \;/\; (S_5)_X} \qquad (4a)$$

$$\gamma_2^s = \frac{(S_1)_M \;/\; \left[(S_4)_M + (S_5)_M + (S_6)_M\right]}{(S_1)_X \;/\; \left[(S_4)_X + (S_5)_X + (S_6)_X\right]} \qquad (4b)$$

$$\gamma_3^s = \frac{\left[(S_1)_M + (S_2)_M\right] \;/\; \left[(S_4)_M + (S_5)_M + (S_6)_M\right]}{\left[(S_1)_X + (S_2)_X\right] \;/\; \left[(S_4)_X + (S_5)_X + (S_6)_X\right]} . \qquad (4c)$$

Substituting (3) into the above equations, the coefficients may be estimated by:

$$\gamma_1^s = \frac{\sum_{j=1}^{n} \bar{s}_{1j}\, m_j \;/\; \sum_{j=1}^{n} \bar{s}_{5j}\, m_j}{\sum_{j=1}^{n} \bar{s}_{1j}\, x_j \;/\; \sum_{j=1}^{n} \bar{s}_{5j}\, x_j} \qquad (5a)$$

$$\gamma_2^s = \frac{\sum_{j=1}^{n} \bar{s}_{1j}\, m_j \;/\; \sum_{t=4}^{6} \sum_{j=1}^{n} \bar{s}_{tj}\, m_j}{\sum_{j=1}^{n} \bar{s}_{1j}\, x_j \;/\; \sum_{t=4}^{6} \sum_{j=1}^{n} \bar{s}_{tj}\, x_j} \qquad (5b)$$

$$\gamma_3^s = \frac{\left[\sum_{t=1}^{2} \sum_{j=1}^{n} \bar{s}_{tj}\, m_j\right] \;/\; \left[\sum_{t=4}^{6} \sum_{j=1}^{n} \bar{s}_{tj}\, m_j\right]}{\left[\sum_{t=1}^{2} \sum_{j=1}^{n} \bar{s}_{tj}\, x_j\right] \;/\; \left[\sum_{t=4}^{6} \sum_{j=1}^{n} \bar{s}_{tj}\, x_j\right]} \; . \qquad (5c)$$

The problem involved in selecting one definition of skill intensity over the other two concerns the variations in training and educaitonal requirement for different categories of workers in different industries and countries. Group 2 of skill categories (administrators and managers) contains the most notable variations in the level of training and education. The most consistent categories are the professionals and technicians (group 1) and manual workers (group 5). Therefore, γ_1^s is considered the most reliable and γ_3^s the least reliable index of relative factor intensities.

The skill coefficients of selected industries of the U.S. and the United Kingdom were obtained from a manpower study by Horowitz, Zymelman, and Hernstadt [1]. However, similar data was not available for South Korea, so as an approximation the Japanese data for 1950 were employed. The Japanese coefficients were the closest available substitute for the missing data. The input-output tables and the trade data were obtained from sources explained in Chapter 3.

4.2 The Commodity Composition of U.S. Trade

The United States may be considered relatively skill abundant compared to the less developed and to the centrally planned economies. The relative skill endowment of the U.S. with respect to the developed economies is shown in Table 4-1. Estimates indicate that the U.S.is skill abundant relative to any one of the developed countries except Sweden. However, taking the EFTA as one group, the U.S. is definately more skill abundant than any of its trading partners.

The coefficients of relative skill intensity of U.S. manufacturing trade is presented in Table 4-2. The estimates of γ_1^s and γ_2^s give almost identical results. U.S. exports are relatively more skill intensive than its imports in its trade with the world as a whole and with each economic region considered, except the U.S.S.R.

With γ_3^s as the index of relative skill intensity, U.S. exports remain more skill intensive

Table 4-1

Skill Endowment Ratio of Selected Developed Economies
(1961-1964)

Country or Economic Region	Skilled Employees as a Percentage of Total Labor Force
United States	0.108
Canada	0.106
Japan	0.049
EEC	0.081
France	0.083*
Netherlands	0.092
Belgium	0.080
Germany	0.100
Italy	0.046
EFTA	0.088
United Kingdom	0.095*
Norway	0.080
Sweden	0.129
Austria	0.068
Denmark	0.078
Portugal	0.027
Other Europe	0.047
Greece	0.034
Iceland	0.046
Ireland	0.071
Spain	0.041
Yugoslavia	0.056
Australia & New Zealand	0.101
Australia	0.103*
New Zealand	0.093

*Estimated by Hufbauer [2].

Source: The ratios indicate the percentage of professional, technical, and related workers, category "0" of ILO classification, in the total active population. Data from the International Labor Office [3] except those with asterisks.

Table 4-2

Coefficients of Relative Skill Intensity of Manufacturing Trade of the United States

1970 U.S. TRADE WITH	γ_1^s	γ_2^s	γ_3^s
WORLD	0.771	0.775	0.825
Developed Economies	0.801	0.806	0.842
EEC	0.789	0.790	0.796
EFTA	0.780	0.778	0.847
U.K.	0.938	0.932	0.958
Other Europe *	0.620	0.623	0.733
Japan	0.767	0.780	0.793
Australia & New Zealand	0.960	0.934	1.016
Canada	0.907	0.911	0.926
Less Developed Economies	0.628	0.629	0.744
Africa	0.713	0.711	0.818
Latin America	0.927	0.906	1.004
Asia	0.478	0.485	0.608
South Korea	0.349	0.359	0.547
Centrally Planned Economies	0.678	0.686	0.761
U.S.S.R.	1.304	1.310	1.201

* Greece, Iceland, Ireland, Spain, and Yugoslavia.

Sources: Table A-6, Appendix, Columns 9,10 and 11.

than imports in its trade with the world as a whole and with most of the economic regions. However, in two cases, Australia and New Zealand and Latin America, reversal occurs. This, and the fact that γ_3s coefficients are consistently larger in magnitude than γ_1s and γ_2s, indicates that the U.S. comparative advantage is less in the commodities which require relatively more administrative and managerial workers than those that require more professional and technical workers.

4.3 The Commodity Composition of U.K. Trade

The relative skill endowment of the U.K. is shown in Table 4-3. Relative to its trading partners the U.K. is less skill abundant compared to the United States and Canada, has an almost similar skill endowment ratio compared to the EFTA and the EEC, and is relatively more skill abundant vis-à-vis Japan, "other Europe," and the Southern Dominion countries. It is also presumed that the U.K.'s endowment ratio of skilled to unskilled workers is greater than any one of the less developed regions.

An examination of the relative skill intensity of U.K. trade in Table 4-4 reveals that the U.K. is an exporter of relatively skill intensive commodities in its trade with the world as a whole with "other Europe," Japan, the Southern Dominions, less developed, and

Table 4-3

Skill Endowment Ratio of Selected Developed Countries and Economic Regions (1961-1964)

Country or Economic Region	Skilled Employees as a Percentage of Labor Force
United Kingdom	0.095*
United States	0.108
Canada	0.106
Japan	0.049
EEC (Excluding Italy)	0.092
EFTA (Excluding Portugal and the U.K.)	0.091
Other Europe, plus Portugal	0.044
Southern Dominions	0.061
Australia	0.103*
New Zealand	0.093
South Africa	0.019

*Estimated by Hufbauer [2].

Source: The ratios indicate the percentage of professional, technical, and related workers, category "0" of ILO classification, in the total active population. Data from the International Labor Office [3] except those with asterisk.

Table 4-4

Coefficients of Relative Skill Intensity of Manufacturing Trade of the United Kingdom

1969 U.K. TRADE WITH	γ_1^s	γ_2^s	γ_3^s
WORLD	0.928	0.926	0.962
Developed Economies	0.927	0.925	0.956
U.S.	1.213	1.214	1.144
EEC [1]	1.070	1.064	1.046
EFTA [2]	0.992	0.989	1.010
Other Europe[3] plus Portugal	0.612	0.614	0.724
Japan	0.786	0.787	0.848
Canada	1.006	0.997	1.035
Southern Dominions[4]	0.737	0.736	0.860
Less Developed Economies	0.690	0.691	0.809
Latin America	0.898	0.893	0.941
Africa	0.801	0.795	0.897
Asia	0.441	0.444	0.588
South Korea	0.321	0.324	0.484
Centrally Planned Economies	0.763	0.765	0.874
U.S.S.R.	0.726	0.726	0.858
Eastern Europe	0.680	0.680	0.779

[1] Excluding Italy. [2] Excluding Portugal. [3] Greece, Iceland, Ireland, Spain, & Yugoslovia.

[4] Australia, New Zealand, & South Africa.

Source: Table A-8, Appendix.

centrally planned economies. On the other hand, the contrary is true for U.K. trade with the U.S. and Canada. Both situations confirm the human skill theory of trade.

The above relations prevail regardless of the coefficient of factor intensity that is used with the exception of Canada. Trade with Canada is consistent with the theory if the γ_1^s and γ_3^s definitions of relative skill intensity are used and is inconsistent with the γ_2^s coefficient.

However, given the similarity of skill endowment ratios of the U.K., the EEC, and the EFTA, no statement may be made with regard to the pattern of trade with these economic regions.

4.4 The Commodity Composition of South Korean Trade

The relative skill endowment of South Korea compared to other less developed economies is presented in Table 4-5. South Korea is less endowed with skilled workers than are Latin America, Malaysia, Singapore, and Hong Kong. However, skilled workers are more abundant in South Korea than in the Middle East, Burma, India, Pakistan, Indonesia, Taiwan, and Thailand. And the relative endowment position of South Korea is similar to that of Africa. A comparison of South Korean skill endowment with that of the developed countries, shown in Table 4-1 supports the presumption that the

Table 4-5

Skill Endowment Ratio of Selected Less Developed Countries and Economic Regions (1961-1964)

Country or Region	Skilled Employees as a Percentage of Labor Force
South Korea	0.022
Latin America	0.037
Chile	
Mexico	
Panama	
Peru	
Africa	0.022
Ghana	
Morocco*	
Nigeria	
Middle East	0.015
Iran	
Kuwait*	
Saudi Arabia*	
Burma, India, Pakistan, and Indonesia*	0.017
Taiwan and Thailand	0.016
Malaysia, Singapore and Hong Kong	0.035

*Data not available.

Source: See Table 4-3.

country is less skill abundant than any group of developed economics.

The commodity composition of South Korean trade showed in Table 4-6 indicates that its trade with all of the developed countries conforms to the human capital theory of trade. However, inconsistencies between the theory and empirical findings arise in the cases of trade with Africa, the Middle East and with Burma, India, Pakistan, and Indonesia. Among less developed countries, only the trade with Latin America and Taiwan and Thailand confirm the theory. The above situations exist with all three definitions of relative skill intensity of trade.

4.5 Conclusion

The human capital approach to the factor proportion theory of international trade performs rather satisfactorily in explaining the commodity composition of manufacturing trade. The results of the empirical tests concerning the bilateral trade of the U.S., the U.K., and South Korea reveal a general consistency between the theory and the actual flow of commodities. The bilateral trade of the U.S. and the U.K. with developed and less developed economies conforms with the predicted pattern of trade. The same hold true for the trade of South Korea with developed economies. However, the trade of South Korea with other less developed economies

Table 4-6

Coefficients of Relative Skill Intensity of
Manufacturing Trade of South Korea

1969 SOUTH KOREAN TRADE WITH	γ_1^s	γ_2^s	γ_3^s
WORLD	3.940	3.912	1.776
Developed Economies	4.281	4.254	1.835
U.S.	4.475	4.389	1.931
Western Europe	5.396	5.409	2.147
U.K.	3.277	3.307	1.821
Japan	4.263	4.254	1.735
Australia & New Zealand	1.179	1.181	1.069
Less Developed Economies	2.376	2.387	1.397
Latin America	4.426	4.322	1.450
Africa	13.229	13.258	2.069
Middle East	4.169	4.041	2.173
Burma, India, Pakistan & Indonesia	2.364	2.377	1.216
Taiwan & Thailand	0.628	0.598	0.929
Malaysia, Singapore & Hong Kong	1.997	1.837	1.372

Source: Table A-10, Appendix.

does not conform to expectations based on the human skill hypothesis.

The failure of the theory in cases of trade among less developed economies may be the result of significant variations in the definition of skill categories of workers in these countries. However, the problem may not be wholly a statistical one.

Skill intensity reversal may be an empirical reality among less developed economies. Some skill intensive commodities may be produced by highly capital intensive methods in a country lacking the required skills to the extent that modern machinery may be substituted for skilled workers. These variations in skill requirements of industries may not be substantial enough to change the pattern of trade between developed and less developed economies, yet they may be significant among less developed countries which have rather small differentials in their skill endowment ratios. In the absence of any serious empirical test of skill intensity reversal among less developed countries (essentially due to a lack of data), the above proposition remains speculative in nature.

Furthermore, this inconsistency between the prediction of the model and the actual flow of commodities may be, at least partially, a result of extensive trade restrictions in the less developed countries.

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Chapter 5

NEOTECHNOLOGY THEORIES OF INTERNATIONAL TRADE: A BILATERAL TRADE STUDY

5.1 Introduction

The distinct charactersitic of neotechnology theories of trade is their consideration of technological requirements of production as the predominant force in determining the commodity composition of trade in manufactured goods (see section 2.3). In this chapter the four neotechnology theories of trade will be tested through an examination of the trade structure of the U.S., the U.K., and South Korea.

5.2 Scale Economies

According to the scale economies hypothesis the main determinant of the comparitive advantage of a country is the extent of the scale economies enjoyed by its manufacturing industries [2]. Producers located in economies with large markets are able to take advantage of economies of scale and can therefore produce their outputs more cheaply than can producers in smaller markets. Thus the theory maintains that large economies will have a comparative advantage in the production of those commodities where production is characterized by increasing return to scale.

In testing the scale economies theory, however, economies of scale for various industries must be estimated. This may be done by measuring increasing return to scale as reflected in the production functions or by considering the cost functions directly [11].

Engineering data may be used to estimate the relationship between inputs and output. However, in this approach the nontechnical aspects of production are not considered. Thus, the plant or the process function, as Walters [11] calls this class of production functions, may not be relied upon in estimating economies of scale. Although it is possible to observe increasing return to scale in the plant, the producer may not realize economies of scale due to high cost in the nontechnical aspects of production.

Alternatively, the extent of increasing return to scale may be found by estimating the production function of an industry as a relationship between inputs and the value of output in a cross-sectional study of the firms in the industry. In this method output is measured by the value added of a firm in the industry, with capital and labor being considered as inputs. In addition to the specification problem and other econometric constraints, the most troublesome aspect in estimating production functions is the difficulty in considering various qualities of inputs in various firms within an industry. By taking the number of workers as a measure of labor input, labor quality as reflected in skill and age composition in different firms is not accounted for. A similar difficulty exists in estimating the capital input into the production process. The appropriate measure of capital input is the estimate of the flow of capital services. However, by taking the stock of capital of a firm as the capital input, not only is the degree of utilization of the factor not reflected in the measure, but the similarity of composition of stock of machinery, equipment, building, and land is also assumed. Consequently, to the extent that the larger plants may employ higher quality capital and labor than the smaller plants, the resulting efficiency observed may not be attributed to scale alone.

The difficulty in estimating the economies of scale directly from the cost function lies in determining the cost of production for various firms under imperfect market structure [11]. The cost of production is defined as the difference between total revenue and the return to entrepreneurial capacity. In perfect competition, where the return to entrepreneurial capacity is the opportunity cost of that factor, the price of the output may be considered as the long run average cost [11]. However, in a market characterized by monopolistic elements, where specialized factors are controlled by the firm and are not marketable, the true nature of the cost function may not be estimated.

In this study, however, an additional difficulty is encountered in estimating the scale economies. The test of the scale economies theory requires measures of economies of scale for over one hundred industries, a task beyond the limits of this study. Furthermore, no estimate exists of production functions or cost functions for such a large number of industries. Consequently, for the purpose of testing the scale economies theory of trade, two measures which approximate scale economies by methods other than those explained above will be utilized: scale elasticity and optimum plant size for a large number of U.S. industries as estimated by Hufbauer [3] and Saving [5], respectively.

Hufbauer estimated scale elasticity of U.S. industries based on 1963 Census of Manufacturing [9] by the following method.

Let V_i represent the ratio of value added per worker for a given size class of plant to the average value added per worker for all establishments in that industry, and let N represent the average number of workers employed per establishment in a given size class of plants. Then:

$$V_i = kN^{\alpha_i}$$

where k is a constant and α_i is the coefficient of scale elasticity for industry i. The coefficient α indicates the percentage change in output per worker as the result of a percentage change in the plant size.

However, to the extent that larger plants may employ more skilled workers or a higher ratio of capital per worker than the smaller plants, the above estimate of scale economies is exaggerated. With this deficiency in mind, Hufbauer's estimates of scale economies is applied to the trade structure of the U.S., the U.K. and South Korea. Although it is plausible that the scale coefficients may vary among countries, in the absence of similar estimates for the other two countries, it is reasonable to assume that the ranking of these coefficients is similar for manufacturing industries among countries.*

The scale coefficients are directly applied to a representative one million dollar bundle of manufacturing imports and exports of the above three countries in their trade with the world as a whole and with several economic

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*The same problem is encountered in applying the U.S. coefficients to the other two countries in tests of technological gap and product cycle theories, and using the Japanese coefficients for all three countries in the test of the stage of production theory.

Table 5-1

Total Manufacturing Output and Gross Domestic Product Per Capita for Selected Developed Economies (1964)

Country or Economic Region	Total Manufacturing Output in Billions of U.S. $ [1]		GDP/Capita U.S. $ [2]
U.S.	173.04		3000
Canada	10.55		2110
Japan	21.56		720
EEC	19.04	(95.20)	1464
EEC(Excluding Italy)	19.45	(77.80)	1640
France	27.53		1580
Netherlands	5.55		1430
Belgium	4.11		1460
Germany	40.61		1770
Italy	17.40		1030
EFTA	7.75	(46.49)	1557
EFTA (Excluding Portugal & U.K.)	3.18	(12.71)	1650
U.K.	32.22		1710
Norway	1.81		1880
Sweden	5.62		2100
Austria	2.90		1030
Denmark	2.38		1680
Portugal	1.56		420
Southern Dominions	3.72		1454
Australia	5.63		1810
New Zealand	N.A.		2046
South Africa	1.88		507

[1] The figure for each region is the simple average of the manufacturing output of the principal trading countries in that region. EFTA and the EEC may be considered as unified markets, the figures in parentheses which are the total market size represent this alternative measure.

[2] The figure represents the GDP per capita of the principal trading countries in the region.

Sources: U.N. [8].

Table 5-2

Total Manufacturing Output and Gross Domestic Product Per Capita for Selected Less Developed Economies (1964)

Country or Economic Region	Total Manufacturing Output in Billions of U.S. $[1]	GDP/Capita In U.S. $[2]
South Korea	0.51	140
Latin America Chile Mexico Panama Peru	0.91	409
Africa Ghana Morocco Nigeria	0.14	160
Middle East[3] Iran Kuwait Saudi Arabia	1.54	224
Burma, India, Pakistan & Indonesia	2.65	75
Thailand & Taiwan	0.36	117
Malaysia, Singapore, and Hong Kong	1.055	301

[1,2]See Table 5-1.

[3]The estimates are only for Iran.

Sources: U.N. [8].

regions. These results are presented in Part A of Tables 5-3, 5-4, and 5-5.

However, since the α coefficient for industries may be either positive or negative, the measures of scale economies emboided in imports and exports may also be either positive or negative. In order to obtain a consistent estimator of the relative scale intensity of trade, the coefficients of scale economies of imports and exports were transformed in the following manner:

$$\gamma_{sc} = (C+\alpha_M) \ / \ (C+\alpha_X)$$

where γ_{sc} is the coefficient of relative scale intensity of trade, and α_M and α_X are the measures of scale economies embodied in imports and exports, respectively. The constant c is selected such that its absolute value is larger than any estimates of α_M and α_X, and thus the numerator and the denominator always remain positive. In the following tests 0.2 will be the value of the c constant.

The estimates of manufacturing output, as reported by the U.N. [8] and presented in Tables 5-1 and 5-2 for selected economies, are considered the relevant measure for domestic market size. The U.S., according to this measure, is the largest single market in the world. It is therefore expected that the U.S. would enjoy a comparative advantage in the production of scale intensive

Table 5-3

The Coefficients of Scale Economies of U.S. Exports and Imports of Manufactured Commodities

1970 U.S. TRADE WITH	A-HUFBAUER'S METHOD IMPORTS α_M	A-HUFBAUER'S METHOD EXPORTS α_X	γ_{sc1}*	B-SAVING'S METHOD IMPORTS (i)	B-SAVING'S METHOD EXPORTS (ii)	γ_{sc2} (i):(ii)
WORLD	0.0334	0.0652	0.8801	17.250	22.789	0.757
Developed Economies	0.0473	0.0641	0.9364	20.011	23.026	0.869
EEC	0.0477	0.0666	0.9291	20.669	22.800	0.907
EFTA	0.0515	0.0676	0.9398	12.502	20.685	0.604
U.K.	0.0518	0.0590	0.9722	13.356	17.497	0.763
Other Europe[1]	0.0432	0.0928	0.8156	5.383	27.032	0.199
Japan	0.0431	0.0686	0.9051	16.468	20.839	0.790
Australia and New Zealand	-0.0302	0.0698	0.6294	25.814	22.867	1.129
Canada	0.0588	0.0550	1.0149	26.994	24.720	1.092
Less Developed Economies	-0.0293	0.0604	0.6555	5.620	19.233	0.292
Africa	-0.0811	0.0720	0.4371	4.827	21.630	0.223
Latin America	-0.0345	0.0557	0.6472	8.908	19.419	0.459
Asia	-0.0198	0.0666	0.6759	2.183	17.751	0.123
South Korea	-0.0120	0.0478	0.7587	0.893	15.162	0.059
Centrally Planned Economies	-0.0439	0.0394	0.6520	9.247	21.921	0.422
U.S.S.R.	-0.1895	0.0264	0.0464	6.473	25.696	0.252

*$\gamma_{sc1} = (0.2 + \alpha_M)/(0.2 + \alpha_X)$.

[1] Greece, Ireland, Iceland, Spain, Portugal, and Yugoslavia.

Sources: Tables A-11, and A-12, Appendix, and U.N. [7].

commodities.

The results shown in Table 5-3 indicate that U.S. exports are scale intensive relative to U.S. imports in its trade with the world and with all economic regions, except Canada.

Similar results are shown for U.K. trade in Table 5-4. The indications are that the U.K. is a net exporter of scale intensive commodities to all economies with the exception of the U.S., the EFTA, and Japan. However, considering the total manufacturing output of the U.K. relative to its trading partners, the pattern of trade with the EFTA and Japan appears inconsistent with the theory. Furthermore, U.K. trade with the EEC countries is in harmony with the prediction of the scale economies hypothesis only if the EEC countries are assumed as separate economies. This, however, is not a realistic assumption given the extent of mobility of resources and the lack of trade barriers among the member countries. By considering the EEC countries as a unified market the indicated trade pattern becomes contrary to the prediction of the theory.

The South Korean trade pattern, shown in Table 5-5, conforms to the theory in trade with all developed economies. However, several contradictions are encountered in South Korean trade with less developed economies. Trade with Latin America, Africa, and the Middle East is

Table 5-4

The Coefficients of Scale Economies of U.K. Exports and Imports of Manufactured Commodities

1969 U.K. TRADE WITH	A-HUFBAUER'S METHOD IMPORTS α_M	A-HUFBAUER'S METHOD EXPORTS α_X	A-HUFBAUER'S METHOD γ_{scl}*	B-SAVING'S METHOD IMPORTS (i)	B-SAVING'S METHOD EXPORTS (ii)	B-SAVING'S METHOD γ_{sc2} (i):(ii)
WORLD	0.0286	0.0461	0.9289	14.245	16.928	0.842
Developed Economies	0.0429	0.0422	1.0028	15.809	16.345	0.967
U.S.	0.0845	0.0556	1.1131	27.431	16.487	1.664
EEC[1]	0.0343	0.0388	0.9812	15.601	15.957	0.978
EFTA[2]	0.0328	0.0308	1.0087	10.718	15.613	0.686
Other Europe[3] plus Portugal	0.0410	0.0433	0.9905	4.983	15.676	0.318
Japan	0.0379	0.0280	1.0434	13.510	9.964	1.356
Canada	0.0222	0.0485	0.8942	9.513	16.488	0.577
Southern Dominions[4]	0.0126	0.0489	0.8542	6.906	19.749	0.350
Less Developed Economies	-0.0422	0.0662	0.5928	5.793	21.040	0.275
Latin America	-0.0669	0.0680	0.4966	7.288	19.165	0.380
Africa	-0.0624	0.0501	0.5502	4.208	17.872	0.235
Asia	-0.0241	0.0704	0.6505	4.096	21.647	0.189
South Korea	-0.0627	0.0477	0.5543	1.951	27.012	0.072
Centrally Planned Economies	-0.0019	0.0111	0.9384	6.606	10.994	0.601
U.S.S.R.	-0.0341	0.0226	0.7452	5.450	6.990	0.780
Eastern Europe	0.0255	0.0344	0.9620	7.582	15.083	0.503

*$\gamma_{scl} = (0.2 + \alpha_M)/(0.2 + \alpha_X)$

[1] Excluding Italy.

[2] Excluding Portugal.

[3] Greece, Iceland, Ireland, Spain, and Yugoslavia.

[4] Australia, New Zealand, and South Africa.

Table 5-5

The Coefficients of Scale Economies of South Korean Exports and Imports of Manufactured Commodities

1969 SOURTH KOREAN TRADE WITH	A-HUFBAUER'S METHOD IMPORTS α_M	EXPORTS α_X	γ_{scl}*	B-SAVING'S METHOD IMPORTS (i)	EXPORTS (ii)	γ_{sc2} (i):(ii)
WORLD	0.0413	-0.0121	1.2842	14.163	2.464	5.748
Developed Economies	0.0448	-0.0157	1.3283	14.466	1.631	8.869
U.S.	0.0578	-0.0056	1.3261	14.780	1.354	10.915
Western Europe	0.0451	-0.0597	1.7470	12.008	2.342	5.127
U.K.	0.0407	-0.0672	1.8125	25.806	0.993	25.988
Japan	0.0411	-0.0447	1.5525	15.975	2.333	6.847
Australia and New Zealand	0.0362	-0.0053	1.2131	1.782	0.439	4.059
Less Developed Economies	-0.0325	0.0038	0.8219	11.037	6.170	1.789
Latin America	-0.0120	-0.0033	0.9558	1.046	1.463	0.715
Africa	0.0778	-0.0181	1.5272	13.078	1.483	8.819
Middle East	-0.0054	0.0293	0.8487	7.421	5.605	1.324
Burma, India, Pakistan, and Indonesia	0.0184	-0.0140	1.1742	13.746	1.024	13.423
Taiwan and Thailand	-0.1111	0.0104	0.4225	2.018	18.786	0.107
Malaysia, Singapore, and Hong Kong	0.0384	-0.0050	1.2226	12.300	2.603	4.725

*$\gamma_{scl} = (0.2 + \alpha_M)/(0.2 + \alpha_X)$.

Sources: Tables A-11, and A-12, Appendix, and U.N. [7].

inconsistent with the theory, as the relative market size of these economies in Table 5-2 indicates.

An alternative measure of scale economies, the optimum size of a plant within an industry, may be utilized for testing the scale economies theory of trade. Saving [5] applied the survival technique, as introduced by Stigler [6], to measure the optimum size of a plant within an industry. The method is based on the assumption that "those sizes of plants which have minimum average cost will be the sizes of plants which will survive the best in the market place" [5, pp. 572-3]. Therefore, if it is observed over time that a larger share of an industry's total output is produced by a certain plant size, it may be concluded that size of plant is within the range of optimum size.

By considering the size distribution of plants within an industry at two or more points in time and observing systematic changes in these distributions, the optimum size of plant may be recognized, assuming that the plants will move toward the size with minimum average cost. The optimum size of plants for 92 U.S. industries was estimated by Saving [5] for 1954 by the above method. These estimates may be applied to the trade structure of more recent years only on the assumption that the ranking of the optimum plant sizes have remained the same for different industries over time. This assumption is not unrealistic since Saving assumes that the observed changes in the size distribution of plants between two points in time are persistent in the future, in order to estimate optimum plant sizes [5, p.576].

Saving's estimates are matched with the 3-digit SITC groupings of imports and exports. In cases where more than one industry corresponds to one trade category, the weighted average of optimum plant sizes was computed by using the Industries' 1954 value added as the weight. These measures, as reported in Table A-12, are applied to the trade structure of the U.S., the U.K., and South Korea. The results are presented in Part B of Table 5-3, 5-4, and 5-5.

The pattern of U.S. trade (Table 5-3) indicates that this country is a net exporter of scale intensive commodities to the world as a whole and to all economic regions except Canada and Australia and New Zealand. These latter two trade flows are inconsistent with the scale economies hypothesis.

Examination of the structure of U.K. trade in Table 5-4 reveals that the flow of commodities is in harmony with the pattern indicated by the scale economics theory in all cases except with the EEC and Japan. As pointed out above, the direction of trade with the EEC may be considered contrary to the expected pattern when all EEC countries are considered as one unified market.

The South Korean trade as considered according to the scale economies model (Table 5-5) conforms to the predicted pattern except in Latin American and African trade relations.

In comparing the two methods of testing applied here it is interesting to note the similarity of the results of the scale economies theory (Table 5-15) as tested with the two alternative measures.

5.3 Stage of Production

The stage of production approach to trade theory explains comparative advantage in terms of the level of technological development. Technologically sophisticated economics will enjoy a comparative advantage in the production of producer goods, while less advanced economies will have comparative advantage in the production of consumer goods.

Following Hufbauer [3] the coefficient of consumer goods ratio for each industry, Rcg, is the proportion of the total sales of the industry going to the final demand, directly or indirectly:*

$$R_{cg} = \frac{H_i + \sum_j S_{ij} \; (H_j/S_j)}{S_i}$$

*This estimate takes only two rounds of production. For difficulties in estimating the more comprehensive statistic see Hufbauer [3].

where H_i and H_j are the sales by industries i and j to the final consumers (households, government), and S_i and S_j are the total sales of industries i and j. The sales of industry i to industry j are represented by S_{ij}.

This ratio is estimated by Hufbauer [3] based on 1960 Japanese experience for the three-digit SITC, and is reported in Table A-11, Appendix.* In the following tests, the consumer goods ratio, R_{cg}, will be applied directly to the trade structure of the U.S., the U.K, and South Korea to obtain the proportion of consumer goods in a one million dollar representative bundle of exports and imports of each country in its trade with the world and with several economic regions.

The national characteristic which determines a country's comparative advantage relative to its trading partners, according to the theory, is the level of technological development. In this study, Gross Domestic Product (GDP) per capita is selected as an index of the level of economic development which is assumed to be the determinant of the state of technology in an

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*Hufbauer [3] obtains a rank correlation coefficient of 0.8 between the two-digit (SITC) Japanese ratios and their two-digit (SITC) American counterparts (estimated from the 1958 input-output table). The American ratios were not used because they do not provide the three-digit SITC classification detail.

economy. The estimates of GDP per capita for a group of selected economies are indicated in Tables 5-1 and 5-2.

The comparative advantage of the U.S. in the production and export of producer goods is revealed in Table 5-6. U.S. imports contain relatively more consumer goods than do its exports in its trade with the world and with all the economic regions considered, except with the U.S.S.R. and Canada. Since the U.S. has the largest GDP per capita in the world, the structure of its trade with these two countries is inconsistent with the stage of production theory, while the rest conforms to the theory.

The structure of U.K. trade, Table 5-7, conforms to the theory in its trade with U.S. and Canada, since the U.K. imports more producer goods from these countries than it exports to them. On the other hand in its trade with those economies having lower GDP per capita than the U.K. (i.e. "other Europe", Japan, Southern Dominions, Asia and Eastern Europe) the pattern is consistent with the theory.

However, the patterns of trade with Latin America, Africa, and the U.S.S.R. are contrary to the prediction of the theory. The level of economic development of the U.K. is not substantially different from that of EEC and EFTA countries to make the pattern of U.K. trade with these economies a meaningful test of the theory.

Table 5-6

The Coefficients of Consumer Goods Ratio of
U.S. Exports and Imports of Manufactured Commodities

1970 U.S. TRADE WITH	IMPORTS i	EXPORTS ii	γ_{cg} i:ii
WORLD	0.2901	0.2031	1.4284
Developed Economies	0.2518	0.1960	1.2847
EEC	0.2939	0.2018	1.4564
EFTA	0.3577	0.2111	1.6945
U.K.	0.3693	0.1907	1.9365
Other Europe [1]	0.6050	0.1961	3.0852
Japan	0.2617	0.2093	1.2504
Australia & New Zealand	0.2432	0.2089	1.1642
Canada	0.1550	0.1775	0.8732
Less Developed Economies	0.4340	0.2286	1.8985
Africa	0.3106	0.2034	1.5270
Latin America	0.3805	0.2223	1.7117
Asia	0.5248	0.2418	2.1704
South Korea	0.5219	0.2041	2.5571
Centrally Planned Economies	0.3088	0.1707	1.8090
U.S.S.R.	0.1281	0.1440	0.8895

Sources and Footnotes: See Table 5-3.

Table 5-7

The Coefficients of Consumer Goods Ratio of
U.K. Exports and Imports of Manufactured Commodities

1969 U.K. TRADE WITH	IMPORTS	EXPORTS	γ_{cg}
	i	ii	i:ii
WORLD	0.2876	0.2665	1.0791
Developed Economies	0.2660	0.2743	0.9697
U.S.	0.1926	0.3224	0.5974
EEC[1]	0.2539	0.2494	1.0180
EFTA[2]	0.2530	0.3159	0.8009
Other Europe[3] plus Portugal	0.4386	0.2621	1.6734
Japan	0.3279	0.3277	1.0006
Canada	0.2065	0.2833	0.7289
Southern Dominions[4]	0.4250	0.2411	1.7628
Less Developed Economies	0.4156	0.2567	1.6190
Latin America	0.1863	0.2187	0.8519
Africa	0.2034	0.2731	0.7448
Asia	0.5760	0.2543	2.2550
South Korea	0.6547	0.1602	4.0868
Centrally Planned Economies	0.2725	0.2160	1.2516
U.S.S.R.	0.1308	0.2545	0.5139
Eastern Europe	0.3579	0.1938	1.8567

Sources and footnotes: See Table 5-4.

In the South Korean case, Table 5-8, the patterns of trade with all economies, except with the Burma, India, Pakistan, and Indonesia group, are consistent with the stage of production theory of comparative advantage.

5.4 Technological Gap

The commodity composition of trade in manufactured goods is determined, according to the technological gap theory, by the relative technological advantage of a country vis-à-vis other economies. The theory asserts that the more technologically advanced country will enjoy a comparative advantage in the production and export of newer products, while the less advanced country will have comparative advantage in the export of older products.

To the extent that technological advances are the result of a systematic and costly process of research and development, the level of economic development, as measured by Gross Domestic Product per capita, may be considered as the index of the relative technological sophistication of economies.

The relevant commodity characteristic is its age, and it is measured by the date of its first appearance in the export market [4]. Hufbauer [3] estimated the date of the first appearance of commodities in the export schedule of the U.S. These estimates, as reported in Table A-11, Appendix, are applied to the trade structure of the U.S., the U.K. and South Korea.

Table 5-8

The Coefficients of Consumer Goods Ratio of
South Korean Exports and Imports of Manufactured Commodities

1969 SOUTH KOREAN TRADE WITH	IMPORTS i	EXPORTS ii	γ_{cg} i:ii
WORLD	0.2299	0.5157	0.4458
Developed Economies	0.2171	0.5157	0.4048
U.S.	0.2852	0.4965	0.5744
Western Europe	0.1318	0.7204	0.1830
U.K.	0.0967	0.6861	0.1409
Japan	0.2337	0.6550	0.3568
Australia and New Zealand	0.0265	0.3167	0.0837
Less Developed Economies	0.4188	0.4230	0.9901
Latin America	0.3999	0.5137	0.7785
Africa	0.0169	0.5875	0.0288
Middle East	0.3279	0.4988	0.6574
Burma, India, Pakistan, and Indonesia	0.3923	0.5387	0.7282
Taiwan and Thailand	0.6299	0.2163	2.9122
Malaysia, Singapore, and Hong Kong	0.2867	0.5242	0.5469

Sources: See Table 5-5.

In order to magnify the differences between the ratios the "first trade date" coefficients of a representative one million dollar bundle of imports and exports are transformed to portray the average "product age" of each country's trade by subtracting it from 1969 (considered as a point of reference). Thus the figures in the first two columns of Tables 5-9, 5-10, and 5-11 are the "product age" coefficients of the country's trade with several economic regions. Column three of the tables indicates the relative "product age" of imports to that of exports.

The U.S. results (Table 5-9) indicate that the country enjoys a definite comparative advantage in the export of relatively "younger" products in its trade with the world as a whole and with all the ecocomic regions considered. These results conform to the pattern predicted by the theory.

In the case of U.K. trade (Table 5-10), the pattern indicates that the U.K. exports relatively "younger" products to other Europe, the Southern Dominions, and to less developed countries as a group than it imports from them; imports from the U.S., Canada, and Japan are relatively "younger" than the country's exports to them. Among the above cases the pattern of trade with Japan is inconsistent with the prediction of the technological gap theory. Similarly, in the case of U.K. trade with South Korea the outcome does not strictly support the hypothesis.

Table 5-9

The Product Age Coefficients of U.S. Exports and Imports of Manufactured Commodities

1970 U.S. TRADE WITH	IMPORTS i	EXPORTS ii	γ age i:ii
WORLD	22.97	20.85	1.10
Developed Economies	22.19	20.65	1.07
EEC	23.00	21.01	1.09
EFTA	24.55	20.94	1.17
U.K.	25.55	20.91	1.22
Other Europe [1]	29.19	20.81	1.40
Japan	21.47	21.23	1.01
Australia & New Zealand	25.01	20.41	1.23
Canada	20.82	20.13	1.03
Less Developed Economies	26.38	21.23	1.24
Africa	23.44	20.50	1.14
Latin America	28.56	21.04	1.36
Asia	23.97	21.73	1.10
South Korea	22.81	21.54	1.06
Centrally Planned Economies	26.53	21.61	1.23
U.S.S.R.	26.15	21.30	1.23

Sources and footnotes: See Table 5-3.

Table 5-10

The Product Age Coefficients of U.K. Exports and Imports of Manufactured Commodities

1969 U.K. TRADE WITH	IMPORTS i	EXPORTS ii	γ_{age} i:ii
WORLD	23.42	22.29	1.05
Developed Economies	22.70	22.37	1.01
U.S.	20.83	24.53	0.85
EEC [1]	22.94	22.27	1.03
EFTA [2]	21.93	22.68	0.97
Other Europe [3] plus Portugal	24.82	21.72	1.14
Japan	21.95	23.40	0.93
Canada	21.82	22.38	0.98
Southern Dominions [4]	26.22	20.75	1.26
Less Developed Economies	27.38	22.04	1.24
Latin America	29.40	21.89	1.34
Africa	28.90	21.56	1.34
Asia	25.11	21.72	1.15
South Korea	22.24	22.16	1.00
Centrally Planned Economies	24.06	23.11	1.04
U.S.S.R.	23.21	22.45	1.03
Eastern Europe	24.80	22.46	1.10

Sources and footnotes: See Table 5-4.

Table 5-11

The Product Age Coefficients of South Korean Exports and Imports of Manufactured Commodities

1969 SOUTH KOREAN TRADE WITH	IMPORTS i	EXPORTS ii	γ_{age} i:ii
WORLD	21.60	23.22	0.93
Developed Economies	21.35	23.21	0.92
U.S.	22.65	23.39	0.97
Western Europe	21.36	22.57	0.95
U.K.	22.04	23.46	0.94
Japan	20.92	23.25	0.90
Australia and New Zealand	19.79	21.87	0.90
Less Developed Economies	25.84	23.25	1.11
Latin America	25.75	29.06	0.89
Africa	25.23	22.15	1.14
Middle East	29.63	20.27	1.46
Burma, India, Pakistan & Indonesia	24.33	22.69	1.07
Taiwan and Thailand	29.98	20.18	1.49
Malaysia, Singapore, and Hong Kong	22.36	22.73	0.98

Sources: See Table 5-5.

The South Korean trade pattern, as indicated by Table 5-11 reveals that the theory in its trade with all developed economies. However, inconsistencies are encountered in its trade with Africa and the Middle East.

5.5 Product Cycle

Similar to the stage of production and the technological gap theories, the product cycle model attempts to explain the commodity composition of trade through the comparative technological advantage of trading countries. However, the product cycle theory considers product differentiation as the relevant commodity characteristic in the pattern of trade.

According to the product cycle approach [1,10], the more advanced economies will have a comparative advantage in the production and export of more differentiated products relative to the less advanced economies.

Assuming that the more differentiated a product is the greater the price variation will be in the exports to different countries, Hufbauer [3] introduced the following method for estimating the degree of product differentiation of a product group. Let U_i represent the standard deviation of a country's export price (f.o.b.) of product i to different countries, and let V_i represent the unweighted mean of these prices. Then the Index of Product Differentiation, d, is estimated by

$$d_i = \frac{U_i}{V_i} .$$

The more differentiated the product is, the higher d_i will be. Hufbauer's estimates of d for the U.S. experience (1965), as reported in Table A-11, Appendix, are applied to the U.S., the U.K. and South Korean trade of manufactured commodities.

According to Table 5-12, U.S. exports are more differentiated than its imports in trade with the world as a whole and with all the economic regions under consideration in this study. This pattern of trade confirms the product cycle theory. Similarly, the trade pattern of the U.K. with all economic regions except with Canada is consistent with the predicted pattern (Table 5-13).

In the South Korean case (Table 5-14), the outcome is in harmony with the theory in the trade with developed economies except in the case of trade with Australia and New Zealand. However, among less developed economies the patterns of trade with the Middle East, Burma, India, Pakistan, and Indonesia are inconsistent with the theory.

5.6 Conclusion

Neotechnological theories of comparative advantage are similar to each other in their selection of the technological requirement of production as the predominant variable shaping the manufactured commodity composition of international trade.

Table 5-12

The Product Differentiation Coefficients of U.S.
Exports and Imports of Manufactured Commodities

1970 U.S. TRADE WITH	IMPORTS i	EXPORTS ii	Y_{pd} i:ii
WORLD	0.7532	0.9330	0.8073
Developed Economies	0.7850	0.9381	0.8368
EEC	0.7661	0.9606	0.7975
EFTA	0.8474	0.9720	0.8718
U.K.	0.8244	0.9462	0.8712
Other Europe[1]	0.7225	0.9604	0.7523
Japan	0.8598	1.0052	0.8554
Australia & New Zealand	0.7196	0.9608	0.7490
Canada	0.7215	0.8807	0.8192
Less Developed Economies	0.6148	0.9302	0.6609
Africa	0.7061	0.9521	0.7416
Latin America	0.5684	0.9304	0.6109
Asia	0.6620	0.9222	0.7178
South Korea	0.6839	1.0522	0.6500
Centrally Planned Economies	0.7102	0.8805	0.8066
U.S.S.R.	0.5905	0.8764	0.6738

Sources and footnotes: See Table 5-3

Table 5-13

The Product Differentiation Coefficients of U.K. Exports and Imports of Manufactured Commodities

1969 U.K. TRADE WITH	IMPORTS i	EXPORTS ii	γ_{pd} i:ii
WORLD	0.8101	0.8580	0.9442
Developed Economies	0.8533	0.8455	1.0092
U.S.	1.0001	0.8012	1.2483
EEC [1]	0.8516	0.8614	0.9886
EFTA [2]	0.8883	0.7822	1.1356
Other Europe[3] plus Portugal	0.7200	0.8432	0.8539
Japan	0.8640	0.8661	0.9977
Canada	0.7882	0.8846	0.8910
Southern Dominions[4]	0.5704	0.9055	0.6299
Less Developed Economies	0.5782	0.8678	0.6663
Latin America	0.5685	0.9260	0.6139
Africa	0.5619	0.8805	0.6381
Asia	0.5956	0.8960	0.6647
South Korea	0.5814	0.8196	0.7094
Centrally Planned Economies	0.6934	0.8839	0.7874
U.S.S.R.	0.6707	1.0224	0.6560
Eastern Europe	0.7283	0.9324	0.7811

Sources and footnotes: See Table 5-4.

Table 5-14

The Product Differentiation Coefficients of South Korean Exports and Imports of Manufactured Commodities

1969 SOUTH KOREAN TRADE WITH	IMPORTS i	EXPORTS ii	γ_{pd} i:ii
WORLD	0.9549	0.6872	1.3896
Developed Economies	0.9686	0.6756	1.4337
U.S.	0.9500	0.7019	1.3535
Western Europe	1.1533	0.5667	2.0351
U.K.	0.9407	0.5518	1.7048
Japan	0.9337	0.6122	1.5251
Australia & New Zealand	0.5511	0.6400	0.8611
Less Developed Economies	0.7317	0.7389	0.9903
Latin America	0.7296	0.5344	1.3653
Africa	0.6668	0.5707	1.1684
Middle East	0.5302	0.5473	0.9688
Burma, India, Pakistan & Indonesia	0.7245	0.6167	1.1748
Taiwan & Thailand	0.4984	0.9393	0.5306
Malaysia, Singapore & Hong Kong	1.0142	0.7983	1.2704

Sources: See Table 5-5.

The scale economies theory is concerned with the technological advantage derived from the domestic market size. However, two alternative approaches to testing the theory resulted in equally unsatisfactory results. The outcome of the test is troublesome in the cases of the U.S. and U.K. trade with other developed economies. Similarly, several contradictions are encountered between the actual commodity composition of trade and the predicted pattern in the trade of South Korea with other less developed countries.

The other three theories--stage of production, technological gap, and product cycle--consider the relative level of technological development of economies as the determinant of the commodity composition of world trade. The variation in these theories is the commodity characteristic which can differentiate a technologically advanced and sophisticated commodity from a less advanced and less sophisticated one.

Variation in the performances of these theories is, therefore, the outcome of the discriminating quality of the index of the commodity characteristic. Furthermore, since the commodity coefficients of a single country are applied to all three countries in these tests the other determining element in the performance of each theory is the universality of the index of the commodity characteristic among countries.

An overview of the results of these three models in Table 5-15 indicate that all three theories are equally suited for explaining the trade of manufactured goods among developed countries. However, while the stage of productions theory fails to explain the flow of commodities between developed and less developed countries, the other two theories reveal no serious deficiency in this respect. Nevertheless none of the three theories could explain the commodity composition of trade among the LDC's.

In conclusion, only the technological gap theory and the product cycle theory are capable of providing a framework for explaining the bilateral commodity composition of trade of manufactures. Even these theories fail to explain the pattern of trade among less developed economies.

The poor performance of the neotechnology theories to explain the commodity composition of the trade of less developed countries may be attributed, at least partly, to the effect of foreign investment in these countries. Although a country's level of technological achievement is closely related to its level of economic development, the availability of new technology through the flow of direct foreign investment may disturb this relationship. Thus a country at a lower level of economic development may have a comparative advantage in producing technically sophisticated products as the result of the availability of technology acquired through foreign investment. While this effect may not be substantial enough to disturb the pattern of trade between developed and less developed countries, it may yet be significant among less developed countries which have small differentials in their level of economic development as reflected in their GDP per capita.

Table 5-15

Summary of Performance of Neotechnology Theories of Trade: Trade Flows Inconsistent with the Predicted Pattern

Scale Economies Theory
A--Hufbauer's Method

Trade of	U.S.	U.K.	South Korea
With	Canada	EEC EFTA Japan	Latin America Africa Middle East

Scale Economies Theory
B--Saving's Method

Trade of	U.S.	U.K.	South Korea
With	Canada Australia New Zealand	EEC Japan	Latin America Africa

Stage of Production Theory

Trade of	U.S.	U.K.	South Korea
With	Canada U.S.S.R.	Latin America Africa U.S.S.R.	Burma, India, Pakistan, & Indonesia

Technological Gap Theory

Trade of	U.S.	U.K.	South Korea
With		Japan	Africa Middle East

Product Cycle Theory

Trade of	U.S.	U.K.	South Korea
With		Canada	Australia, New Zealand Middle East, Burma, India, Pakistan, Indonesia

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Chapter 6

THEORIES OF INTERNATIONAL TRADE: A STUDY OF TRADE PATTERNS OF TWENTY-THREE COUNTRIES

6.1 Introduction

The H-O theory and alternative theories of trade have been empirically tested for the bilateral trade relations of the U.S., the U.K., and South Korea. The generality of these theories will now be tested further for the existence of a systematic relationship between the national characteristics and the commodity composition of trade in manufactured goods only, as hypothesized by each theory, for a significantly large number of countries.

6.2 Selection of Countries

In selecting countries for the following tests, the aim has been to include the major exporters of manufactured goods. On the other hand, to test for applicability of the theories in explaining the commodity composition of trade of countries with varying degrees of economic development, inclusion of a number of less developed countries in the sample was considered necessary. But since the following tests are confined to the flow of manufactured commodities, many less developed economies had to be excluded.

Only those countries with a significant size of manufactured export relative to their total exports were selected.

To provide a basis for comparison with a similar study by Hufbauer [2], his criteria for selecting countries was adopted, and the twenty-three countries presented in Table 6-1 are considered for this study. The only departure from Hufbauer's list of countries is the exclusion of Israel. The significant inflow of capital and highly skilled workers into Israel during the last two decades, along with the very rapid rate of economic transformation during this period, required special attention for the study of its trade structure outside the scope of this study, (for example see [1]).

6.3 Methodology

The relative factor intensity of trade of each country is estimated by applying the appropriate measure of the commodity characteristic, as developed and explained in the previous chapters, to the country's representative bundle of exports and imports of manufactured goods. However, application of coefficients of commodity characteristics estimated for one country to the trade of all countries implies the assumption of non-reversal of the proper characteristic among countries. The ideal method would have been to estimate the coefficients based on each country's experience. However, given the limitation of this study, only minor refinements may be undertaken in this context to improve the testing procedure.

Table 6-1

National Characteristics

Country	Fixed Capital Per Manufacturing Employee (In U.S. $)	Skilled Employees as a % of Total Work Force	Manufacturing Output (In Billions of U.S. $)	GDP per Capita (In U.S.$)
Group I				
United States	7950	0.108	173.04	3000
Canada	8850	0.106	10.55	2110
Group II				
Sweden	5400	0.129	5.62	2100
Norway	6100	0.080	1.81	1880
Australia	5300	0.103	5.63	1810
Germany	4250	0.100	40.61	1770
United Kingdom	4000	0.095	32.22	1710
Denmark	2850	0.078	2.38	1680
France	4900	0.083	27.53	1580
Belgium	4400	0.080	4.11	1460
Netherlands	4750	0.092	5.55	1430
Austria	4000	0.068	2.90	1030
Italy	2600	0.046	17.40	1030
Japan	3100	0.049	21.56	720
Group III				
Spain	1700	0.041	4.44	550
Mexico	2000	0.036	4.75	430
Portugal	1500	0.027	1.56	420
Yugoslavia	2500	0.056	1.95	250
Hong Kong	1200	0.046	0.37	200
South Korea	850	0.022	0.51	140
Taiwan	1150	0.031	0.32	130
Pakistan	500	0.014	0.78	80
India	500	0.017	6.84	80

Sources: Tables 5-1 and 5-2.

In the cases of the H-O theory and the human capital approach, the above estimation problem may be reduced by dividing the countries in the sample into three groups based on similarities in their level of economic development. Taking Gross Domestic Product per capita as an index of the level of economic development, countries are classified, arbitrarily, into the three following groups: The U.S. and Canada constitute Group I; the major industrialized economies of Europe plus Japan form Group II; and the other economies in the sample (characterized by a Gross Domestic Product per capita of $500 or less) are placed into a third group (Table 6-1).

For each group of countries, a representative country was selected. For Group I the U.S., for Group II the U.K., and for Group III South Korea. The total capital, labor, and skill requirements of the industries of each representative country, estimated from its industry data and input-output table, are applied to a representative one million dollars of imports and exports of each country in the group. Assuming that there are less variations in each group than among the countries in the whole sample, this method is one step toward using each one of the twenty-three countries' own national statistics.

For neotechnology theories this refinement in estimating the factor intensity of trade of each country was not possible, since only one set of production coefficients are available. Therefore, for these tests the same set of coefficients* are applied to the exports and imports of each country. Although the assumption of similarity of technical conditions of production among countries may not appear realistic, it may be considered satisfactory for manufactured goods, especially for the coefficients of scale economies and product age.

The scale economies theory assumes similarity of capital and labor input requirements in the production process of goods among countries. Therefore, it is plausible to assume that the coefficients of scale economies, which are essentially a technological characteristic of production and are estimated by assuming that the capital/labor ratio and skill compositions are constant for different industries, remain invariant among countries, given the widespread diffusion of technology and the standardized methods of production of manufactured goods.

The product age coefficients may not be the same in all countries. In fact there is little reason to believe that they are. However, what is relevant in the technological gap theory is the age of the product on the international market from the date of its first appearance. On this basis the age of each product

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* U.S. coefficients for scale economies, technological gap, and product cycle theories, and Japanese coefficients for the stage of production theory were applied.

is best estimated by the date of the product's first appearance in the U.S. export schedule. This will be true on the assumption that the U.S. has been the innovator in production of all manufactured commodities, an assumption which is not all too unrealistic.

The assumption of similarity of the estimates of consumer goods ratios and the product differentiation index is, however, less realistic. But in the absence of alternative estimates, the same set of coefficients will be used to find the commodity composition of each country's trade.

The test for the existence of a systematic relationship between the commodity composition of trade and the national characteristics for each theory will be carried out by the method of least square regression analysis. This will be discussed in detail in the following section.

6.4 Results and Conclusion

The characteristics of the commodity composition of trade in manufactured products (1969)* of twenty-three countries are shown in Table 6-2. Each set of γ coefficients reflects the relative factor intensity of imports to that of exports according to the corresponding theory.

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* Except U.S. (1970), Mexico (1968), Pakistan (1968), India(1966).

Table 6-2

Commodity Composition of Trade in Manufactured Goods of Twenty-three Countries According to the Heckscher-Ohlin and the Alternative Theories of Trade

	$\gamma_{K/L}$	γ_1^s	γ_2^s	γ_3^s	γ_{sc1}	γ_{sc2}	γ_{cg}	γ_{age}	γ_{pd}
Group I									
United States	0.926	0.771	0.775	0.825	0.8801	0.757	1.4284	1.102	0.8073
Canada	0.989	1.043	1.041	1.033	0.9952	0.902	1.4461	0.993	1.1414
Group II									
Sweden	1.259	0.907	0.904	0.939	0.9476	1.047	1.5653	1.079	0.9378
Norway	0.994	0.996	0.995	0.981	1.0972	2.117	1.5871	0.996	0.9971
Australia	0.816	1.098	1.101	1.051	1.2438	1.241	0.8809	0.847	1.3314
Germany	1.120	0.761	0.760	0.844	1.1089	0.732	1.3721	1.096	0.8670
United Kingdom	1.093	0.927	0.926	0.961	0.9289	0.842	1.0791	1.051	0.9442
Denmark	1.236	0.957	0.958	0.965	0.9967	1.634	0.8522	0.996	0.8937
France	0.968	1.034	1.035	1.032	0.9905	0.823	0.8738	0.992	1.0146
Belgium	0.876	1.127	1.126	1.070	0.9403	0.971	1.1094	0.973	1.0880
Netherlands	0.717	0.925	0.932	0.940	1.0358	1.011	0.9455	0.966	1.0191
Austria	1.110	1.165	1.163	1.241	0.9603	1.509	1.0683	1.026	0.9393
Italy	1.031	1.257	1.231	1.168	1.0172	0.816	1.0153	1.004	1.0052
Japan	1.354	1.222	1.213	1.167	0.8926	0.840	0.9755	1.137	0.9645
Group II									
Spain	1.142	1.426	1.439	1.243	1.0472	1.783	0.5252	0.839	1.2093
Mexico	0.925	2.036	2.086	1.462	1.7080	2.097	0.4959	0.804	1.4854
Portugal	1.217	3.214	3.209	1.645	1.0515	4.942	0.4211	0.824	1.2733
Yugoslavia	1.074	1.490	1.490	1.250	1.1285	1.989	0.6754	0.910	1.0740
Hong Kong	1.178	1.684	1.679	1.217	1.2105	4.941	0.6914	0.982	1.1667
South Korea	1.417	3.940	3.972	1.776	1.2842	5.748	0.4458	0.930	1.3896
Taiwan	1.238	2.754	2.778	1.608	1.1184	2.998	0.4087	0.924	1.4012
Pakistan	1.210	7.014	7.007	2.049	1.2774	6.796	0.2732	0.955	1.5912
India	1.310	5.343	5.338	2.055	1.3418	4.298	0.2532	0.918	1.6491

Sources: Tables A-13, A-14, and A-16, Appendix.

To test the explanatory power of each theory, the designated γ coefficients of the twenty-three countries are regressed on their national characteristics (Table 6-1), as postulated by the theory. The independent variable is the national characteristic and the dependent variable is the coefficient of commodity composition of trade. Then the regression equation for each test will be

$$y_i = a + b X_i + e$$

where y_i is the coefficient of commodity composition of trade and X_i is the national characteristic for country i. The stochastic error term is e, and a and b are the parameters.

The least square regression method is applied to each set of variables indicated in Table 6-3 for each theory. The following results are obtained:

(1) Heckscher-Ohlin:

$$\gamma_{K/L} = 1.2520 - \underset{(0.000014)}{0.000045} (\bar{\bar{K}}/\bar{\bar{L}}) \qquad R^2 = 0.3342$$

(2) Human Capital:

$$\gamma_1^s = 4.2144 - \underset{(6.9201)}{35.7273} (SK) \qquad R^2 = 0.5592$$

$$\gamma_2^s = 4.2140 - \underset{(6.9020)}{35.7162} (SK) \qquad R^2 = 0.5604$$

$$\gamma_3^s = 1.8550 - \underset{(1.1375)}{9.3854} (SK) \qquad R^2 = 0.7642$$

(3) Scale Economies:

Hufbauer's Scale Coefficients

$$\gamma_{scl} = 1.1235 - \underset{(0.00107)^*}{0.00171} (MF) \qquad R^2 = 0.1092$$

Table 6-3

The Measures of Commodity Composition of Trade and the Determining National Characteristics According to the H-O Theory and the Alternative Theories of Trade

Theory	The Measure of Commodity Composition of Trade		National Characteristics	
1 Heckscher-Ohlin	Relative capital and labor intensity of trade	$\gamma_{K/L}$, $\gamma_{K/L}$	Relative capital and labor endowment of the country	$\bar{\bar{K}}/\bar{\bar{L}}$
2 Human Skill Approach	Relative skill intensity of trade	γ_1^s, γ_2^s, γ_3^s	Relative skill endowment of the country	SK
3 Scale Economies	Scale economies embodied in imports relative to exports	γ_{sc1}, γ_{sc2}	Size of domestic market, measured by the size of manufacturing output	MF
4 Stage of Production	The ratio of consumer goods embodied in imports to that of exports	γ_{cg}	The level of economic development measured by the size of manufacturing output or by GDP per capita	MF $\overline{GDP}$
5 Technological Gap	The average age of imports to that of exports	γ_{age}	The level of technological sophistication of the country, measured by GDP per capita	$\overline{GDP}$
6 Product Cycle	The ratio of product differentiation of imports to that of exports	γ_{pd}	Similar to (5)	

Saving's Scale Coefficients

$$\gamma sc_2 = 2.4755 - \underset{(0.01049)^*}{0.01639} (MF) \qquad R^2 = 0.1041$$

(4) Stage of Production:

$$\gamma cg = 0.8146 + \underset{(0.00230)^*}{0.00444} (MF) \qquad R^2 = 0.1504$$

$$\gamma cg = 0.4061 + \underset{(0.000053)}{0.000432} (\overline{GDP}) \qquad R^2 = 0.7611$$

(5) Technological Gap:

$$\gamma age = 0.9072 + \underset{(0.000020)}{0.000058} (\overline{GDP}) \qquad R^2 = 0.2856$$

(6) Product Cycle:

$$\gamma pd = 1.3642 - \underset{(0.000044)}{0.000203} (\overline{GDP}) \qquad R^2 = 0.5018$$

where R^2 is the coefficient of determination of the regression equation, and the numbers in parentheses are the standard errors of estimated coefficients. Those designated by an asterisk (*) are not significant at the 99 percent probability level.

Among the regression equations the scale economies and the stage of production (with the size of manufacturing output as the explanatory variable) do not perform satisfactorily. The level of significance is below the 99 percent probability level, and the coefficients of determination are very low compared to others.

The poor performance of the scale economies hypothesis as tested by both methods of measuring economies of scale may be attributed to the unrealistic assumption inherent in the theory that small nations cannot rely on international markets in producing commodities with economies of scale. Considering that production and trade often take place simultaneously it appears more realistic to assume that development of large scale production depends more on the technical capability of the economy than on its absolute size. To the extent that large scale production often involves more advanced methods of production and management and a higher degree of industrial integration, it is more persuasive to consider comparative advantage in production of scale intensive commodities as a function of the level of economic development.

To test this alternative hypothesis to the scale economies theory of trade, the following two regressions were tested:

$$(7)\quad \gamma_{sc1} = 1.2308 - \underset{(0.001197)}{0.000099}(MF) - \underset{(0.000052)}{0.000120}(\overline{GDP}) \qquad R^2=0.2976$$

$$\gamma_{sc2} = 4.0351 - \underset{(0.00969)}{0.00712}(MF) - \underset{(0.00042)}{0.00174}(\overline{GDP}) \qquad R^2=0.5198$$

where the dependent variables, γ_{sc1} and γ_{sc2}, are the relative scale intensity of trade of the twenty-three countries under this study, as measured by Hufbauer's and Saving's methods. Manufacturing size (MF) and Gross Domestic Product per capita ($\overline{GDP}$) of these countries are considered as the independent variables.

The results indicate that while manufacturing size is not statistically significant in either regressions, $\overline{GDP}$ is significant at 95 and 99 percent probability levels in the two equations, respectively. Although both relations appear satisfactory with $\overline{GDP}$ as the explanatory variable, the scale economies estimated by Saving's method indicates a stronger performance.

Therefore, it may be pointed out that although the scale economies theory, as hypothesized by Hufbauer, does not explain the commodity composition of trade, it can provide the basis for an alternative explanation of the commodity composition of trade, as suggested above.

In all other cases, however, the regression equations indicate a systematic relationship between the dependent and the independent variables as each theory hypothesizes. In each case the relationship is highly significant and the high coefficients of determination indicate the ability of the national characteristic to explain the commodity composition of trade. These results may seem to point to a difficulty of interpretation of the explanatory power of each theory.

The results, however, may be explained by considering the interrelation between the proposed alternative theories. As an attempt in this direction we may separate the six alternative hypotheses into two groups of factor proportion theories (Hypotheses 1 and 2) and neotechnology theories (Hypotheses 3 through 6).

The first hypothesis in the factor proportion group selects relative intensity of physical capital in production and its endowment in the economy as the relevant measure. The second hypothesis, while assuming that physical capital is highly mobile, considers human capital as the predominant force in determining comparative advantage. However, examination of Tables 6-4 and 6-5 reveals that the capital and skill endowment of countries on the one hand, and capital and skill intensities of traded commodities on the other hand, are highly correlated. Therefore, although the two theories look at comparative advantage from different angles, significant similarities between their selected variables give rise to almost equally powerful theories. However, if the size of R^2, that is the closeness of the sample regression line to the sample observation points, is chosen as a criterion for distinguishing the "better" theory from the other, the human capital approach has an edge over the H-O hypothesis.

Similar situations exist for the three remaining hypotheses in the second group. The stage of production, technological gap, and product cycle theories all perform satisfactorily in the test. However, this is not surprising. All three theories consider the level of technological development of the economy as the relevant national characteristic, measured by GDP per capita. On the commodity side the comparative advantage is reflected, according to these theories, in the level of technical sophistication of the products.

Table 6-4

Simple Correlations Between the Coefficients of Commodity Composition of Trade For Twenty-Three Countries

	$\gamma_{K/L}$	γ_1^s	γ_2^s	γ_3^s	γ_{sc1}	γ_{sc2}	γ_{cg}	γ_{age}	γ_{pd}
Capital/Labor Ratio									
$\gamma_{K/L}$	1.000	0.479	0.477	0.527	0.032	0.530	-0.368	0.130	0.237
Skill Ratios									
γ_1^s		1.000	0.999	0.941	0.509	0.868	-0.731	-0.363	0.825
γ_2^s			1.000	0.942	0.514	0.867	-0.733	-0.367	0.828
γ_3^s				1.000	0.578	0.846	-0.838	-0.512	0.883
Scale Economies									
γ_{sc1}					1.000	0.507	-0.578	-0.650	0.767
$\gamma sc2$						1.000	-0.709	-0.421	0.723
Consumer Goods Ratio									
γ_{cg}							1.000	0.682	-0.796
Product Age									
γ_{age}								1.000	-0.710
Product Differentiation									
γ_{pd}									1.000

Source: Table 6-2.

Table 6-5

Simple Correlations Between National Characteristics
of Twenty-Three Countries

		$\bar{\bar{K}}/\bar{\bar{L}}$	SK	MF	$\overline{GDP}$
Capital/Labor Ratio	$\bar{\bar{K}}/\bar{\bar{L}}$	1.000	0.875	0.486	0.915
Skill Endowment Ratio	SK		1.000	0.378	0.919
Size of Manufacturing	MF			1.000	0.583
GDP Per Capita	$\overline{GDP}$				1.000

Source: Table 6-1.

The difference between the three theories is the various ways of measuring the concept of product sophistication. One would expect, a priori, that the three measures--namely the ratio of consumer goods, the age of product, and the index of product differentiation would be very closely related. Indeed Table 6-4 shows a high degree of correlation between the measures. Even if the coefficient R^2 is selected as the criterion for discrimination, the stage of production and the product cycle theories perform equally well.

However, the more interesting aspect of the results is that both groups of theories can explain the commodity composition of trade despite significant differences in their approach. Once again this outcome can be explained in light of the interrelationship between the selected variables.

The level of technological development of a country is closely related to its level of economic development, to the extent that technological achievements can be obtained through costly processes of research and development. On the other hand, physical and human capital are both forms of society's savings. The higher the level of economic development (measured by GDP per capita) the higher is the ability of the country to channel its productive resources into physical and human stock of "waiting"--that is, investment. As Table 6-5 shows there are very high correlations between GDP per capita and capital/labor endowment ratio (0.9153) and relative skill endowment ratio (0.9194) of countries in the sample.

Similarly, among the commodity characteristics, the coefficients of skill intensity are highly correlated with the coefficients of consumer goods ratio and with the product differentiation index. This implies that the producer goods and the less standardized products are those that require highly skilled workers in their production process, and a country having comparative advantage in its trade according to one theory will also have comparative advantage according to the other two theories.

To conclude, it may be pointed out that all the alternative theories of trade, except the scale economies, can explain the commodity composition of trade of manufactured goods on a global scale. The fact that they are all powerful in explaining trade should cause no difficulties since the variables selected by each theory are a close approximation of those selected by the other theories.

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Chapter 7

SUMMARY AND CONCLUSIONS

The theory of international trade attempts to determine the relationship between the national economic structure and the commodity characteristics of the country's trade. According to the orthodox version of the Heckscher-Ohlin theory this relationship is between the relative endowment of capital and labor of the economy and the relative intensity of these factors in the production of different commodities. Thus the hypothesis of the theory is that a country will have a comparative advantage in the production of the commodity which uses the country's more abundant factor more intensively.

The Leontief studies of the structure of U.S. trade for the years 1947 and 1951 presented results contrary to the prediction of the H-O hypothesis. These and the subsequent empirical studies of the theory casted serious doubt over the validity of the H-O model. Dissatisfaction with the performance of the H-O theory has led to the development of several alternative theories of international trade.

Within the logical framework of the H-O theory, the human capital approach seeks to explain the commodity composition of trade through differential skill requirement of industries and the relative abundance of a country's skilled to unskilled workers.

However, a new breed of theories, the so-called neotechnology theories, have set aside the relative factor abundance and factor intensity concepts. These theories maintain instead that the commodity composition of trade in manufactured goods is determined primarily by the relative technological advantage of a country in producing various commodities.

For the scale economies theory this technological advantage is derived from the economies of large-scale production which may be enjoyed by producers who are located in economies with a large domestic market.

On the other hand, for the other neotechnology theories--stage of production, technological gap and product cycle--the predominant national characteristic is the level of the country's technological achievement. That is, the more technologically advanced economies will have a comparative advantage in the production of technologically more sophisticated products. The difference among these three theories lies in variations in defining the technological sophistication of commodities.

This study has tested the H-O theory and alternative theories of international trade. Through a reconsideration of the H-O theory it was shown that the failure of the theory to explain the commodity composition of trade was caused by the theory's restrictive assumptions in the face of the generality of its scope. It was pointed out that although the theory may not hold at the level of generality presented by Ohlin, it is still capable of explaining the commodity composition of trade under certain restricted conditions.

It was thus hypothesized that trade structure will tend to conform to the H-O pattern between countries that are not very disproportionate in their level of economic development. Furthermore, it was suggested that the theory would perform even more satisfactorily if it was restricted to the flow of manufactured goods.

The basis for this hypothesis was the presumption that the critical assumptions of identical demand patterns, similar production functions, and unique factor intensity ranking of commodities would hold more strongly under the above stated conditions.

Applying the most recent input-output tables and industry input requirements of the U.S., the U.K., and South Korea, the test of the H-O theory revealed that the less generalized version of the theory provides a powerful explanation for the bilateral trade among either developed or less developed countries. The results were even more pronounced when trade only in manufactured goods was considerd. However, the theory was not verified in the case of trade between developed and less developed economies. The results were contrary to Linder's hypothesis that the commodity composition of trade in manufactured goods tends to be similar among countries with similar levels of economic development.

The Keesing method was applied to test the human capital approach to the theory of international trade. The total requirement of workers of various skill categories was estimated for a representative one million dollar bundle of imports and exports of the U.S., the U.K., and South Korea based on their national statistics. The result indicated the ability of the theory to explain trade of developed countries among themselves and with less developed countries. However, in several cases the theory was inconsistent with the existing pattern of trade among less developed countries.

In an attempt to test neotechnology theories, Hufbauer's estimates of commodity characteristics, and Saving's estimates of optimum plant size were applied to the bilateral trade structure of the same three countries. Although capable of explaining the composition of trade among developed countries, all four theories failed seriously in their attempt to explain trade among less developed countries.

Generalizing the result of the bilateral study of these three countries, it may be concluded that various existing theories are useful in explaining different segments of the international flow of commodities. The orthodox version of the H-O theory, with physical capital and homogeneous labor as explanatory variables, is well suited for the trade within the two groups of developed and less developed economies. In fact it is the only one. Although the human capital approach and neotechnology theories fail to explain trade among less developed countries, they provide a satisfactory explanation of trade of manufactured goods among the developed countries (a summary of performance of the theories is presented in Table 7-1).

While the above tests were concerned with the consistency of the pattern of trade flows between economies according to various theories, it is also relevant to verify the existence of a systematic relationship between national characteristics and the commodity composition of trade for a large number of countries. This aspect of the study improves upon Hufbauer's similar work by introducing two methodological changes.

The commodity composition of trade for the H-O theory and the human capital approach were estimated for twenty-three countries from the total factor requirements of the representative country of each three

Table 7-1

Summary of Performance of Theories of Trade:
Bilateral Trade Flows

+ Flows Consistent with the Theory
- Flows Inconsistent with the Theory
0 Indeterminate Case

A--U.S. Trade

Theory	H-O all Inputs & Commodities	H-O Manufactured input & Trade	Human Capital (γ_1^s)	Scale Economies A Hufbauer Method	Scale Economies B Saving Method	Stage of Production	Technological Gap	Product Cycle
TRADE WITH:								
WORLD	-	+	+	+	+	+	+	+
Developed Economies	-	+	+	+	+	+	+	+
EEC	+	+	+	+	+	+	+	+
EFTA	+	+	+	+	+	+	+	+
U.K.	+	+	+	+	+	+	+	+
Other Europe	+	+	+	+	+	+	+	+
Japan	-	+	+	+	+	+	+	+
Australia & New Zealand	-	-	+	+	-	+	+	+
Canada	+	+	+	-	-	-	+	+
Less Developed Economies	-	+	+	+	+	+	+	+
Africa	-	-	+	+	+	+	+	+
Latin America	-	-	+	+	+	+	+	+

Table 7-1 (cont'd)

Theory	H-O all Inputs & Commodities	H-O Manu-factured input & Trade	Human Capital (γ_1^s)	Scale Economies A Hufbauer Method	Scale Economies B Saving Method	Stage of Produc-tion	Technolo-gical Gap	Product Cycle
Asia	+	+	+	+	+	+	+	+
South Korea	+	+	+	+	+	+	+	+
Centrally Planned Economies	-	+	+	+	+	+	+	+
U.S.S.R.	-	+	-	+	+	-	+	+

B-- U.K. TRADE

TRADE WITH								
WORLD	0	0	0	0	0	0	0	0
Developed Economies	0	0	0	0	0	0	0	0
U.S.	+	+	+	+	+	+	+	+
EEC	0	0	0	-	-	0	0	0
EFTA	0	0	0	-	+	0	0	0
Other Europe Plus Portugal	+	+	+	+	+	+	+	+
Japan	+	+	+	-	-	+	-	+
Canada	+	+	+	+	+	+	+	-
Southern Dominions	0	0	+	+	+	0	0	0

Table 7-1 (cont'd)

Theory	H-O all Inputs & Commodities	H-O Manufacturing Input & Trade	Human Capital (γ_1^s)	Scale Economies A Hufbauer Method	Scale Economies B Saving Method	Stage of Production	Technological Gap	Product Cycle
Less Developed Economies	-	-	+	+	+	+	+	+
Latin America	-	-	+	+	+	-	+	+
Africa	-	-	+	+	+	-	+	+
Asia	-	-	+	+	+	+	+	+
South Korea	+	+	+	+	+	+	-	+
Centrally Planned Economies	+	+	+	+	+	+	+	+
U.S.S.R.	+	-	+	0	0	-	+	+
Eastern Europe	+	+	+	+	+	+	+	+

C--South Korean Trade

TRADE WITH								
WORLD	0	0	0	0	0	0	0	0
Developed Economies	+	+	+	+	+	+	+	+
U.S.	-	+	+	+	+	+	+	+
Western Europe	+	+	+	+	+	+	+	+
U.K.	+	+	+	+	+	+	+	+

Table 7-1 (cont'd)

Theory	H-O all Inputs & Commodities	H-O Manufacturing Input & Trade	Human Capital (γ_1^s)	Scale Economies A Hufbauer Method	Scale Economies B Saving Method	Stage of Production	Technological Gap	Product Cycle
Japan	+	+	+	+	+	+	+	+
Australia & New Zealand	-	+	+	+	+	+	+	-
Less Developed Economies	0	0	0	0	0	0	0	0
Latin America	-	+	+	-	-	+	+	+
Africa	+	+	-	-	-	+	-	+
Middle East	+	+	-	-	+	+	-	-
Burma, India, Pakistan & Indonesia	+	+	-	+	+	-	+	-
Taiwan & Thailand	+	+	+	+	+	+	+	+
Malaysia Singapore & Hong Kong	+	+	+	+	+	+	+	+

groups of countries. The estimates of the relative factor intensity of trade obtained by this method are more appropriate for a study of this nature than are those found by applying the direct input requirements of industries based on one country's experience to the trade of all countries--the method used by Hufbauer. Moreover, the relationship sought here is between the commodity composition of trade (the coefficient of commodity characteristic of imports relative to exports), instead of export characteristics alone (as done by Hufbauer) and the national characteristic for each theory.

The results of the regression analysis indicated that, with the exception of the scale economies theory all theories perform satisfactorily. However, among them, the human capital approach, the stage of production theory, and the product cycle theory make the strongest showing.

Bilateral tests of the trade of the three countries and the regression tests of the world trade of twenty-three countries provide measures of the explanatory power of the existing theories from different view points.

In the test of the world trade of twenty-three countries, the sample included countries with a significant share of manufacturing exports in their total export basket. Consequently only a small number of less developed countries pass this requirement. Even among the countries included in the third groups, over half are the so-called semi-developed countries: Spain, Portugal, Yugoslavia, and Hong Kong. However, trade in manufactured goods among these twenty-three countries constitutes the significant portion of the total world trade. Therefore, the latter test covers most of the world trade. If this criterion is selected for choosing one theory over another, then the above test is the relevant one. However, if the criterion for the selection of a "good" theory is the theory's ability to explain the network of trade flows for any group of countries, then the results of the bilateral tests are the measure against which the theories must be evaluated.

Of course an ideal theory would perform well according to both criteria. But as pointed out before, the result of the bilateral tests of the trade structure of the U.S., the U.K., and South Korea showed that no single theory is capable of explaining the flow of trade among and between the two groups of developed and less-developed economies. While the H-O theory was shown applicable to trade among less developed countries, it fails most seriously in explaining trade flows between developed and less developed countries. It is in this direction that the alternative theories reveal their own comparative advantage. Therefore it should not be surprising to see in the regression tests of the trade

of twenty-three countries, which capture most of the trade among developed countries and trade between these and less developed countries, that the H-O theory does not perform as well as the human capital approach, the stage of production, and the product cycle theories.

However, the varying performances of theories in different spheres raises the relevant question of the level of generality expected from a theory of international trade and the adequacy of the existing theories.

A theory of trade is expected to be capable of explaining the structure of commodity flows across all national boundaries. One clear conclusion of this study is that none of the existing theories fulfill this expectation, and in this respect none can be regarded as an adequate theory of international trade.

This deficiency may be attributed to the simplistic nature of the explanation that these theories provide. Each theory singles out one economic factor as the predominant force in determining the commodity composition of world trade. The factor proportion theories consider the endowment of resources as the determining variable by assuming the same level of technological development in all countries. On the other hand, the neotechnology theories assume the contrary. And both groups assume identical demand in all countries. However, while there is some truth in each theory's proposition, and each of the proposed variables can explain a part of reality, none can provide a complete explanation. These variables, namely capital and skill endowment of the country, the size of the market, national income, and the level of technological achievements, all play a significant role in determining the pattern of trade. Yet despite their deep interrelations, none may be considered as proxy for the rest.

The most challenging task in developing a general theory of trade is the consideration of the interrelation between these variables in an effort to formulate an operationally meaningful theory. However, as Professor Keesing pointed out [1], the most striking characteristic of these variables is that "they are intimately related to the growth and development process." Consideration of the problems of economic development and technological change along with the endowment of resources within a dynamic framework, thus, appears to be the inevitable path for the development of a general theory of trade. In addition, the inclusion of the structure of trade preferences, trade barriers, and transportation costs within the context of the theory may prove fruitful.

Alternatively, an effort may be made to sharpen the focus of the existing theories in explaining different segments of international trade. This may be done by incorporating the various theories into two or three models for different commodity flows distinguished according to the commodity types (e.g.,homogeneous, non-homogeneous) or the economic structure of the trading countries (e.g., developed, less developed). A possible method will be to construct composite measures of commodity characteristics by incorporating various measures employed in this study.

REFERENCE

[1] Keesing, D. Comments on G. Hufbauer's paper "The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods." In R. Vernon (ed.), The Technology Factor in International Trade. New York: NBER, Columbia University Press, 1970, p. 275.

APPENDIX

Table A-1

A List of Non-Manufactured Commodities

SITC	Description of the Commodity
00	Live animals
01	Meat and preparations
02	Dairy products and eggs
03	Fish and preparations
041	Wheat, unmilled
042	Rice
043	Barley, unmilled
044	Maize, unmilled
045	Cereal, nes., unmilled
051	Fruits, fresh, and nuts, fresh or dry
052	Dried fruits
054	Vegetables, fresh, frozen, or simply preserved
0611	Raw sugar, beet and cane
0616	Natural honey
07	Coffee, tea, cocoa, spices
08	Feeding stuff for animals
09	Miscellaneous food preparations
121	Tobacco, unmanufactured
21	Hides, skins, and fur skins
22	Oil seeds, oil nuts, and oil kernels
23 (except 2312)	Crude rubber (except synthetic rubber)
24	Wood, lumber, and cork
25	Pulp and waste paper
26 (except 2662)	Textile fibers (not manufactured into yarn, thread or fabrics) and their waste (except synthetic fibers)
27	Crude fertilizers and crude minerals (excluding coal petroleum, and precious stones)
28	Metalliferrous ores and metal scrap
29	Crude animal and vegetable materials, nes.
321	Coal, coak, and briquettes
331	Petroleum, crude and partly refined for further refining
341	Gas, natural and manufactured
4	Animal and vegetable oils and fats

Table A-2

Capital and Labor Coefficients Per Million Dollars of Value Added for U.S. Industries (1963)

NO.	Description of Industries	Capital Co-efficients ($1000's)	Labor Co-efficients (Man Years)
1	Livestock & livestock products	2552.57	76.41
2	Other agricultural products	2729.98	48.70
3	Forestry and fishery	2424.65	89.35
4	Agricultural, forestry & fishery services	1070.00	118.36
5	Iron & ferroalloy ore mining	1587.89	45.47
6	Non-ferrous metal ores mining	1573.68	67.22
7	Coal mining	2087.50	1035.62
8	Crude petroleum & natural gas	1796.15	31.70
9	Stone & clay mining & quarry	1583.87	64.72
10	Chemical & fertilizer mineral mining	1603.83	41.54
11	Food & kindered products	792.11	82.14
12	Tobacco manufactures	1647.53	52.94
13	Broad & narrow fabrics, yarn & thread mills	955.69	153.28
14	Misc. textile good & floor coverings	968.53	103.44
15	Apparel	398.98	167.35
16	Misc. fabricated textile products	812.49	140.98
17	Lumber & wood products, excluding containers	939.74	167.14
18	Wooden containers	1119.74	229.88
19	Household furniture	647.44	143.62
20	Other furniture & fixtures	671.70	116.66
21	Paper & allied products, excluding containers	1252.89	78.84
22	Paper board containers & boxes	1320.45	97.88
23	Printing & publishing	505.05	96.40
24	Chemicals & selected chemical products	922.20	51.11
25	Plastics & synthetic materials	934.93	61.08
26	Drugs, cleaning & toilet preparations	899.70	38.95
27	Paints & allied products	1110.89	56.65
28	Petroleum refining & related industries	2048.48	50.90
29	Rubber & misc. plastic products	917.88	90.24
30	Leather tanning & industrial leather	686.44	111.11
31	Footwear & other leather products	466.73	179.35
32	Glass & glass products	1032.46	91.21
33	Stone & clay products	990.29	86.54

Table A-2 (cont'd)

NO.	Description of Industries	Capital Co-efficients ($1000's)	Labor Co-efficients (Man Years)
34	Primary iron & steel manufacturing	1478.46	75.42
35	Primary nonferrous metal manu-facturing	1561.86	82.27
36	Metal containers	984.89	73.60
37	Heating, plumbing & structure metal products	1004.05	106.23
38	Stamping, screw machine products and belts	859.42	118.44
39	Other fabricated metal products	931.61	100.18
40	Engines & turbines	852.98	76.30
41	Farm machinary & equipment	948.12	92.62
42	Construction, mining & oil field machinery	944.55	79.41
43	Material handling machinery & equipment	758.45	71.97
44	Metal working machinery & equipment	622.55	92.54
45	Special industry machinery & equipment	869.43	91.28
46	General industrial machinery & equipment	1126.10	85.31
47	Machine shop products	625.06	139.82
48	Office, computing & accounting machinery	982.27	99.75
49	Service industry machinery	889.52	74.50
50	Electrical industrial equipment & apparatus	687.90	96.19
51	Household appliances	712.27	74.35
52	Electrical lighting & wiring equipment	641.41	98.07
53	Radio, television & communication equipment	694.66	86.07
54	Electronic components & accessories	634.48	104.46
55	Misc. electrical machinery, equipment & supplies	619.81	95.00
56	Motor vehicles & equipments	567.21	58.05
57	Aircrafts & parts	790.95	81.35
58	Other transportation equipments	979.41	109.11
59	Scientific & controling instruments	1084.51	99.80
60	Optical, ophthalmic & photography equipment	1036.07	72.78
61	Miscellaneous manufacturing	793.64	116.36
62	Transportation & warehousing	1900.86	123.01

Table A-2 (cont'd.)

No.	Description of Industries	Capital Co-efficients ($1000's)	Labor Co-efficients (Man Years)
63	Communication, excluding radio & T.V.	3762.77	101.13
64	Radio & T.V. broadcasting	4560.40	98.89
65	Electricity, gas, water & sanitation services	1566.93	65.16
66	Wholesale & retail trade	1181.88	51.45
67	Finance and insurance	37.88	83.67
68	Real estate & rental	4625.00	21.83
69	Hotels, personal & repair services	899.00	185.68
70	Business services	1855.60	121.65
71	Medical & educational services	2798.57	123.02

Sources: Bureau of Labor Statistics, Patterns of U.S. Economic Growth. Bulletin 1672, U.S. Department of Labor, Washington, 1970. J.W. Kendrick, Industrial Composition of Income and Product. Brooking 1968, pp. 151-75.

Capital stock of Industries estimated by Gort and Goddy and used to find the Capital Coefficient of U.S. industries by Z. Iqbal in The Comparative Advantage of Developing Countries in the Manufacturing Industries and the Effect of Generalized Tariff Preferences. Ph.D. Thesis, Michigan State University, 1970. pp. 186-188.

Table A-3

Capital and Labor Coefficients per Million Dollars of Value Added for U.K. Industries (1960)

NO.	Description of Industry	Capital Co-efficients (US $1000's)	Labor Co-efficients (Man Years)
1	Agriculture, forestry & fishery	1347.30	527.74
2	Coal mining	703.45	213.03
3	Mining & quarry, nes.	1487.18	370.88
4	Food processing	1367.06	444.30
5	Drink & tobacco	1142.86	286.21
6	Coke ovens and coke	4294.18	199.58
7	Mineral oil refining	11884.62	563.19
8	Chemicals	1822.73	261.36
9	Iron & steel (melting, rolling & casting)	2071.11	335.71
10	Iron & steel (tin plates & tubes)	1195.88	690.72
11	Non-ferrous metals	1155.69	314.37
12	Engineering & electrical goods	835.30	415.96
13	Ship building & marine engineering	832.40	566.64
14	Motors & cycles	1135.39	408.89
15	Air crafts	975.00	380.10
16	Railway locomotives & rolling stocks	1328.13	820.31
17	Metal goods, nes.	822.03	414.65
18	Textiles	1847.25	562.04
19	Leather, clothing & footwear	551.72	612.68
20	Building materials	1175.82	429.75
21	Pottery & Glasses	860.87	440.99
22	Timber & furniture	751.27	536.62
23	Paper & printing	1192.79	391.25
24	Other manufactures	1181.00	491.27
25	Construction	399.22	447.54
26	Gas	6239.58	502.23
27	Electricity	13412.56	363.55
28	Water	20543.48	295.03
29	Transport & Commerce	4233.64	429.60
30	Distributive trades	878.50	430.94
31	Services, nes.	937.37	565.00

Source: Department of Applied Economics, Cambridge University, A Program For Growth: Production, Capital & Labor. Cambridge, Mass.: MIT Press, 1966.

Table A-4

Capital and Labor Coefficients Per Million Dollars of Value Added for South Korean Industries (1966)

NO.	Description of Industry	Capital Co-efficients (US $1000's)	Labor Co-efficients (Man Years)
1	Rice, barley & wheat*	1430.00	5600.00
2	Other agriculture*	1430.00	5600.00
3	Forestry*	433.00	2100.00
4	Fishery*	691.00	2400.00
5	Coal	744.75	903.61
6	Other minerals	989.11	942.01
7	Processed food	2058.19	1140.36
8	Beverages & tobacco	933.87	310.81
9	Fiber spining	2103.40	997.02
10	Textile fabrics	2681.43	1847.30
11	Finished textile products	1433.70	923.22
12	Saw mills and phywoods	2191.89	880.43
13	Wood products & furniture	549.55	1996.60
14	Paper & paper products	1428.20	630.11
15	Printing & publishing	2037.67	1096.82
16	Leather & leather products	1885.67	1673.62
17	Rubber products	2079.29	1912.77
18	Basic chemicals	2512.81	719.37
19	Intermediate Chemicals	2512.81	719.37
20	Finished chemical products	1474.30	650.14
21	Fertilizers	2751.13	323.64
22	Petroleum & coal products	1597.81	539.56
23	Cement	2546.53	182.87
24	Ceramic, clay, & stone products	1493.50	1323.89
25	Iron & steel	1632.52	665.10
26	Steel products	1632.52	665.10
27	Non-ferrous metal products	2822.16	944.13
28	Finished metal products	2271.54	1690.15
29	Machinery excepts electrical	2646.40	1381.81
30	Electrical machinery	1671.37	870.30
31	Transport equipment	1689.26	980.87
32	Misc. manufacturing	1357.13	1771.23
33	Electricity*	3304.00	438.00
34	Banking, insurance, & realestate*	774.00	699.00
35	Water & sanitation*	3304.00	438.00
36	Communication*	2610.00	714.00
37	Transportation & storage*	2610.00	714.00
38	Trade*	556.00	1390.00
39	Other services*	1736.00	2760.00

Table A-4 (cont'd.)

Sources: Economic Planning Board and Korean Reconstruction Bank, Report on Mining and Manufacturing Census, Series I- Basic Tables, 1966. Seoul, Korea, 1967.

Bank of Korea, Economic Statistics Year Book 1968. Seoul, Korea, 1969.

*Data obtained from 1955 Japanese experience from the following sources:

T. Watanabe, "Approaches to the Problem of Intercountry Comparison of Input-Output Relations." In U.N., A Survey: International Comparison of Interindustry Data, New York, 1969, pp. 187-210.

Economic Research Institute and Economic Planning Agency, National Income Accounts. 1957, Economic Bulletin No.1, February, 1959, Capital Structure of Japanese Economy, Tokyo, Japan.

Table A-5

Skill Requirements Per Million Dollars of Value Added
For U.S. Industries (In Man Years)

No.*	Professionals & Technicians	Administrators & Managers	Clerical Workers	Sales Workers	Manual Workers	Service Workers
1	0.54	45.39	0.46	0.15	29.35	0.15
2	0.34	28.93	0.29	0.10	18.70	0.10
3	5.36	3.75	1.52	0.54	70.85	0.71
4	7.10	4.97	2.01	0.71	93.86	0.95
5	2.82	1.27	2.36	0.05	36.92	0.91
6	0.13	1.88	3.50	0.07	54.58	1.34
7	12.43	29.00	31.07	3.10	931.02	5.18
8	4.34	2.82	3.90	0.16	19.59	0.22
9	2.07	4.40	3.62	0.45	52.23	0.91
10	3.07	2.37	3.03	0.17	31.61	0.37
11	1.72	6.08	8.46	5.59	56.10	1.72
12	0.95	2.12	3.97	2.17	39.92	1.54
13	2.61	4.29	11.19	1.84	125.69	2.76
14	1.03	4.14	7.45	2.48	85.34	1.14
15	1.67	6.69	12.05	4.02	138.06	1.84
16	1.41	5.64	10.15	3.38	116.31	1.55
17	1.84	10.20	9.36	2.01	137.39	2.17
18	2.53	14.02	12.87	2.76	188.96	2.99
19	2.73	7.76	13.21	4.16	110.16	1.87
20	2.22	6.30	10.73	3.38	89.49	1.52
21	3.86	3.47	8.59	2.21	57.40	1.34
22	4.80	4.31	10.67	2.74	71.26	1.66
23	8.68	7.23	17.74	19.67	39.91	1.06
24	7.82	3.48	7.82	2.86	26.37	1.07
25	9.35	4.15	9.35	3.42	31.52	1.28
26	5.96	2.65	5.96	2.18	20.10	0.82
27	8.76	3.85	8.67	3.17	29.23	1.19
28	7.53	2.95	9.21	1.27	27.64	0.71
29	5.23	4.06	11.10	2.25	62.72	1.53
30	1.00	6.56	9.00	2.22	86.78	1.11
31	1.08	4.82	16.14	3.05	147.61	1.79
32	4.29	5.47	8.76	2.10	66.40	1.00
33	3.89	5.97	8.22	2.25	62.74	0.87
34	3.62	1.73	7.42	0.60	58.68	1.43
35	6.01	3.46	9.46	1.56	58.25	1.40
36	6.99	4.12	9.79	1.47	48.06	0.96
37	10.09	5.95	14.13	2.12	69.37	1.38
38	11.25	6.63	15.75	2.37	77.34	1.54
39	9.52	5.61	13.32	2.00	65.42	1.30
40	7.02	4.27	10.22	1.67	49.98	0.99
41	8.52	5.19	12.41	2.04	60.67	1.20

Table A-5 (cont'd.)

No.*	Professionals & Technicians	Administrators & Managers	Clerical Workers	Sales Workers	Manual Workers	Service Workers
42	7.31	4.45	10.64	1.75	52.01	1.03
43	6.62	4.03	9.64	1.58	47.14	0.94
44	8.51	5.18	12.40	2.04	60.61	1.20
45	8.40	5.11	12.23	2.01	59.79	1.19
46	7.85	4.78	11.43	1.88	55.89	1.11
47	12.86	7.83	18.74	3.08	91.58	1.82
48	9.18	5.59	13.37	2.19	65.34	1.30
49	6.85	4.17	9.98	1.63	48.80	0.97
50	14.33	4.14	14.04	1.44	58.10	1.25
51	11.08	3.20	10.86	1.12	44.91	0.97
52	14.61	4.22	14.32	1.47	59.23	1.27
53	12.82	3.70	12.57	1.29	51.99	1.12
54	15.56	4.49	15.25	1.57	63.09	1.36
55	14.16	4.09	13.87	1.43	57.38	1.23
56	7.89	1.56	7.95	0.35	37.84	0.99
57	9.68	2.28	10.58	0.49	54.83	1.46
58	12.98	3.06	14.18	0.65	73.54	1.96
59	15.87	5.19	16.97	2.20	65.47	1.10
60	11.57	3.78	12.37	1.60	47.74	0.80
61	9.89	7.45	16.64	3.49	74.00	1.28
62	4.06	7.13	21.16	0.86	83.65	4.31
63	10.82	7.79	51.27	1.62	26.09	1.62
64	10.58	7.61	50.14	1.58	25.51	1.58
65	5.15	3.52	12.90	0.65	40.14	1.04
66	1.08	9.78	7.10	15.28	10.24	7.05
67	2.59	14.56	38.74	18.66	2.93	4.77
68	0.68	3.80	10.11	4.87	0.76	1.24
70	47.08	10.10	36.98	3.65	13.02	7.30
71	71.23	2.46	15.75	0.25	5.04	25.71

*The numbers in this table correspond to description of industries in Table A-2.

Sources: Data is calculated from the number of employees in each category per 1000 employment in each industry for 1960, from M.A. Horowitz, M.Zymelman, I.L. Hernstadt, Manpower Requirement for Planning: An International Comparison Approach, Vol.II. Boston: Northeastern University Press, 1966, and employment per industry for 1963 from : U.S. Department of Labor, BLS, Pattern of U.S. Economic Growth. Washington, D.C., 1970, p. 98.

Table-A-6

Skill Requirements Per Million Dollars of U.S. Manufacturing Exports and Competitive Import Replacements

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 + 6)	S_{Y_1} (1:5)	S_{Y_2} (1:8)	S_{Y_3} (7:8)
WORLD	M	15.08	9.32	24.14	5.56	118.83	3.69	24.40	128.08	0.771	0.775	0.825
	X	17.42	9.04	24.67	5.32	105.82	3.51	26.46	114.65			
Developed Economies	M	15.67	9.10	24.27	5.33	117.27	3.67	24.77	126.27	0.801	0.806	0.842
	X	17.57	9.04	24.72	5.32	105.35	3.49	26.61	114.16			
EEC	M	15.34	9.12	24.45	5.40	120.69	3.69	24.46	129.78	0.789	0.790	0.796
	X	17.38	9.04	24.45	5.29	107.85	3.46	26.42	111.60			
EFTA	M	15.20	9.99	24.67	6.38	116.41	3.72	25.19	126.51	0.780	0.778	0.847
	X	17.61	9.19	24.85	5.41	105.13	3.47	26.80	114.01			
U.K.	M	16.97	10.01	24.57	6.74	113.85	3.75	26.98	124.34	0.938	0.932	0.958
	X	16.76	9.17	24.37	5.48	105.52	3.45	25.93	114.45			
Other Europe*	M	11.73	10.87	25.32	7.18	147.93	4.02	22.60	159.13	0.620	0.623	0.733
	X	13.93	8.89	22.74	5.40	108.85	3.57	22.82	117.82			
Japan	M	16.13	9.01	24.44	4.99	122.10	3.66	25.14	130.75	0.767	0.780	0.793
	X	17.57	9.37	24.83	5.58	102.09	3.40	26.94	111.07			
Australia and New Zealand	M	13.68	9.01	21.09	6.52	86.52	3.44	22.69	96.48	0.960	0.934	1.016
	X	17.52	9.19	24.95	5.54	106.35	3.50	26.71	115.39			

Table A-6 (cont'd.)

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 + 6)	S_{Y_1} (1:5)	S_{Y_2} (1:8)	S_{Y_3} (7:8)
Canada	M	16.14	8.61	23.80	4.90	110.10	3.62	24.75	118.62	0.907	0.911	0.926
	X	17.52	8.89	24.74	5.26	108.44	3.55	26.41	117.25			
Less Developed Countries	M	12.53	10.30	23.58	6.56	125.56	3.80	22.83	135.92	0.629	0.629	0.744
	X	16.90	9.14	24.42	5.40	106.37	3.50	26.04	115.32			
Africa	M	12.97	10.17	23.56	6.29	120.46	3.82	23.14	130.57	0.713	0.711	0.818
	X	16.64	9.16	24.68	5.27	110.23	3.61	25.80	119.11			
Latin America	M	12.51	8.82	21.23	6.01	85.98	3.25	21.33	95.24	0.927	0.906	1.004
	X	16.97	9.14	24.56	5.33	108.12	3.56	26.11	117.01			
Asia	M	12.65	11.80	26.03	7.11	165.88	4.36	24.45	177.35	0.478	0.485	0.608
	X	16.91	9.19	24.48	5.49	105.97	3.57	26.10	115.03			
South Korea	M	11.95	15.71	27.20	7.15	195.12	4.52	27.66	206.79	0.349	0.359	0.547
	X	18.22	9.43	25.03	5.63	103.92	3.50	27.65	113.05			
Centrally Planned Economies	M	13.62	10.04	24.41	5.87	125.64	3.71	23.66	135.22	0.678	0.686	0.761
	X	15.86	8.97	23.29	5.53	99.13	3.39	24.83	108.05			
U.S.S.R.	M	14.96	10.01	24.82	5.67	115.13	3.62	24.97	124.42	1.304	1.310	1.201
	X	11.08	9.06	21.25	5.82	111.18	3.57	20.14	120.57			

Table A-6 (cont'd.)

*Including Greece, Iceland, Ireland, Spain, and Yugoslavia.

Sources: Table A-5, and U.S. Department of Commerce, OBE, "Input-Output Structure for 1963," in _Survey of Current Business_. November 1969, Table 3, pp. 16-47.

Table A-7

Skill Requirements Per Million Dollars of Value Added for U.K. Industries (in Man Years)

No.*	Professionals and Technicians	Administrators and Managers	Clerical Workers	Sales Workers	Manual Workers	Service Workers
1	2.11	220.60	7.39	0.53	292.90	0.0
2	4.05	2.13	9.16	0.0	193.86	3.20
3	5.19	5.19	17.43	0.37	333.05	5.19
4	10.66	20.88	55.09	30.21	293.24	13.32
5	4.29	6.30	58.67	9.73	192.91	10.59
6	17.16	8.18	32.93	2.99	126.13	7.78
7	48.43	23.09	92.93	8.45	355.94	21.96
8	27.70	12.55	42.86	10.19	148.45	10.98
9	17.12	10.41	32.56	2.35	253.15	8.39
10	34.54	16.58	63.55	3.45	535.76	17.27
11	16.35	11.32	37.10	2.83	228.55	7.86
12	47.00	12.89	81.94	9.15	262.47	8.32
13	52.70	11.33	66.86	2.27	390.98	11.90
14	40.48	9.00	50.70	1.63	276.41	9.00
15	37.63	8.36	47.13	1.52	256.95	8.36
16	76.29	16.41	96.80	3.28	566.01	17.23
17	23.22	14.93	39.81	2.90	310.57	10.34
18	5.62	20.80	37.09	6.18	464.81	31.47
19	3.06	22.06	43.50	5.51	520.78	6.74
20	23.64	21.49	66.18	11.60	292.66	10.31
21	13.23	16.76	40.13	5.73	347.06	8.38
22	6.44	25.76	41.86	7.51	426.61	5.37
23	21.91	19.56	60.25	10.56	268.83	9.39
24	25.55	26.53	65.34	11.79	338.49	10.32
25	15.22	37.59	24.17	1.34	359.37	2.69
26	33.65	18.58	95.93	16.57	313.89	16.57
27	24.36	13.45	69.44	12.00	227.19	12.00
28	19.77	10.92	56.35	9.74	184.39	9.74
29	26.21	10.74	67.45	3.44	281.82	34.80
31	139.56	13.00	87.58	7.91	89.27	86.45

*The numbers correspond to description of industries in Table A-3.

Sources: Data is calculated from the number of employees in each category per 1000 employment in each industry for 1960, from M.A. Horowitz, M. Zymelman, I.L. Hernstadt, Manpower Requirement for Planning: An International Comparison Approach, Vol. II. Boston: Northeastern University Press, 1966, and employment per industry for 1960 from Department of Applied Economics, Cambridge University, A Program for Growth: Production, Capital and Labor. Cambridge, Mass.: MIT Press, 1966.

Table A-8

Skill Requirements Per Million Dollars of U.K. Manufacturing Exports and Competitive Import Replacements

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 + 6)	S_{γ_1} (1:5)	S_{γ_2} (1:8)	S_{γ_3} (7:8)
WORLD	M	64.09	30.79	110.51	14.51	546.58	34.57	94.88	595.66	0.921	0.926	0.961
	X	71.08	30.27	117.24	14.26	562.26	35.28	101.35	611.80			
Developed Economies	M	66.41	30.15	112.42	14.62	536.86	34.01	96.56	585.49	0.927	0.925	0.956
	X	73.22	29.84	119.75	14.46	548.73	3 .34	103.06	597.53			
U.S.	M	72.99	26.91	114.53	12.97	508.19	30.02	99.90	551.18	1.213	1.214	1.144
	X	67.20	30.41	116.21	14.29	567.57	34.43	97.61	616.29			
EEC (ex. Italy)	M	70.00	29.66	115.48	14.69	526.65	34.86	99.66	576.20	1.070	1.064	1.046
	X	69.86	31.32	116.75	14.63	562.45	34.99	101.18	612.07			
EFTA (ex. Portugal)	M	63.69	31.38	110.68	14.41	556.67	35.48	95.07	606.56	0.992	0.989	1.010
	X	68.43	31.66	115.20	13.91	593.20	37.61	100.09	644.72			
Other Europe* plus Portugal	M	52.65	34.77	106.49	16.02	638.31	39.12	87.42	693.45	0.612	0.614	0.724
	X	73.15	29.84	117.88	14.44	542.98	34.08	102.99	591.50			
Japan	M	64.88	34.75	116.05	17.13	604.93	37.78	99.63	659.84	0.786	0.787	0.848
	X	71.00	30.67	118.67	16.32	520.64	33.82	101.67	570.78			
Canada	M	56.34	27.56	96.33	12.55	469.45	31.66	83.90	513.66	1.006	0.997	1.035
	X	70.52	30.68	117.36	14.08	591.25	35.95	101.20	641.28			

Table A-8 (cont'd.)

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 + 6)	S_{Y_1} (1:5)	S_{Y_2} (1:8)	S_{Y_3} (7:8)
Southern Dominions **	M	57.99	35.25	108.44	18.70	551.24	30.02	93.24	599.96	0.0737	0.736	0.860
	X	78.30	29.44	122.82	14.31	548.30	33.64	107.74	596.25			
Less Developed Economies	M	54.39	34.75	104.67	14.61	597.47	37.32	89.14	649.40	0.690	0.691	0.809
	X	73.13	29.13	117.83	14.04	554.41	34.48	102.26	602.93			
Latin America	M	52.74	23.02	86.52	9.61	404.48	29.13	75.76	443.22	0.898	0.893	0.941
	X	75.62	27.49	120.66	14.22	520.66	32.59	103.11	567.47			
Africa	M	53.96	30.11	97.42	14.40	489.99	32.03	84.07	536.42	0.801	0.795	0.897
	X	75.28	28.69	118.60	13.61	547.71	33.45	103.97	594.77			
Asia	M	48.66	39.22	106.92	14.80	762.11	45.40	87.88	822.31	0.441	0.444	0.588
	X	77.45	28.19	118.93	13.76	535.20	32.51	105.64	581.47			
South Korea	M	43.22	42.06	104.78	14.43	860.48	50.30	85.28	925.21	0.321	0.324	0.484
	X	87.23	27.77	130.92	13.36	558.09	33.01	115.00	604.46			
Centrally Planned Economies	M	56.23	36.13	106.47	16.03	596.19	36.40	92.36	648.62	0.763	0.765	0.874
	X	66.79	29.22	111.92	13.67	540.37	34.99	96.01	589.03			
U.S.S.R.	M	56.74	37.38	108.10	15.72	586.08	34.96	94.12	636.76	0.726	0.726	0.858
	X	73.54	29.68	122.87	15.15	550.54	33.76	103.22	599.45			
Eastern Europe	M	56.84	32.77	103.98	16.24	575.76	35.73	89.61	627.73	0.680	0.680	0.779
	X	72.47	27.28	115.10	13.58	499.09	31.44	99.75	544.11			

Table A-8 (cont'd.)

*Other Europe includes Greece, Iceland, Ireland, Spain, and Yugoslavia.
**Australia, New Zealand, and South Africa.

Sources: Table A-7, and Department of Applied Economies, Cambridge University, A Program for Growth: British Input-Output Relations 1954-1966. Cambridge, Mass.: MIT Press, 1963.

Table A-9

Skill Requirements Per Million Dollars of Value Added for South Korean Industries (In Man Years)

No.*	Professionals & Technicians	Administrators & Managers	Clerical Workers	Sales Workers	Manual Workers	Service Workers
1	5.60	1848.00	33.60	5.60	3701.60	0.0
2	5.60	1848.00	33.60	5.60	3701.60	0.0
3	10.50	18.90	100.80	4.20	1938.30	12.60
4	45.60	12.00	24.00	2.40	2304.00	2.40
5	18.07	9.04	94.88	6.33	747.28	20.78
6	34.86	24.49	123.41	5.65	730.07	29.20
7	3.42	38.77	77.54	100.35	907.73	7.98
8	16.47	10.88	83.30	5.28	177.78	18.03
9	3.99	29.91	66.80	10.97	879.36	14.96
10	1.85	62.81	112.68	60.96	1594.22	9.24
11	0.92	31.39	56.32	30.47	796.73	4.62
12	0.0	33.45	61.63	16.73	762.45	2.64
13	0.0	63.89	115.80	35.94	1766.99	5.99
14	7.56	23.94	71.83	13.23	500.93	10.71
15	122.84	75.68	205.11	57.03	622.99	6.58
16	3.35	56.90	100.42	90.38	1410.86	10.04
17	28.69	86.08	267.79	43.99	1444.14	51.64
18	33.09	35.97	135.96	20.14	471.91	19.42
19	33.09	35.97	135.96	20.14	471.91	19.42
20	29.90	32.51	122.87	18.20	426.48	17.55
21	14.84	16.18	61.17	9.06	212.32	8.74
22	15.10	30.76	104.13	14.03	353.94	16.72
23	0.73	6.04	12.80	2.20	157.82	1.28
24	0.53	43.69	92.67	15.89	1142.52	9.27
25	11.97	24.61	75.82	7.98	533.39	11.30
26	11.97	24.61	75.82	7.98	533.39	11.30
27	16.99	34.93	107.63	11.33	757.20	16.05
28	8.45	70.99	138.59	30.42	1418.03	11.83
29	48.36	77.38	196.21	22.11	1017.01	23.49
30	50.48	44.38	176.67	16.54	554.37	14.79
31	39.24	28.44	107.28	6.87	743.51	20.60
32	21.25	61.99	125.76	56.68	1486.06	7.08
34	3.50	70.60	470.43	125.82	18.87	7.69
36	189.92	29.27	94.96	2.14	404.84	19.28
37	29.27	34.99	168.50	2.14	456.96	18.56
38	5.56	382.25	115.37	600.48	193.21	86.18
39	894.24	88.32	601.68	24.84	477.48	662.40

Table A-9 (cont'd.)

*The numbers correspond to description of industries in Table A-4.

Sources: Data is calculated from the number of employees in each category per 1000 employment in each industry based on Japanese Data for 1950, from M.A. Horowitz, M. Zymelman, I.L. Hernstadt, Manpower Requirement for Planning: An International Comparison Approach, Vol. II. Boston: Northeastern University Press, 1966, and employment per industry from Economic Planning Board, and Korean Reconstruction Bank, Report on Mining and Manufacturing Census, Series I, Basic Tables. 1966. Seoul, Korea, 1967.

Table A-10

Skill Requirements Per Million Dollars of South Korean Manufacturing Exports and Competitive Import Replacements

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 + 6)	γ_1^S (1:5)	γ_2^S (1:8)	γ_3^S (5:8)
WORLD	M	30.39	51.46	140.65	27.13	926.73	18.13	81.85	971.99	3.940	3.912	1.776
	X	12.91	63.66	136.26	49.90	1551.20	14.14	76.57	1615.24			
Developed Economies	M	31.02	51.49	141.56	24.92	915.92	18.35	82.51	959.19	4.281	4.254	1.835
	X	12.61	65.13	137.50	51.28	1593.79	13.60	77.74	1658.67			
U.S.	M	33.86	53.81	147.76	35.78	904.51	17.42	87.67	957.71	4.475	4.389	1.931
	X	13.55	66.21	139.51	49.64	1619.75	12.85	79.76	1682.24			
Western Europe	M	36.09	54.18	151.61	19.47	870.95	19.34	90.27	909.76	5.396	5.409	2.147
	X	10.51	55.72	125.97	47.82	1368.72	16.42	66.23	1432.96			
U.K.	M	37.03	48.62	144.89	16.93	852.16	20.35	85.65	889.44	3.277	3.307	1.821
	X	15.01	48.04	127.44	42.04	1132.03	18.29	63.05	1192.36			
Japan	M	28.88	50.49	137.95	23.40	945.47	18.54	79.37	987.41	4.263	4.254	1.735
	X	10.41	59.74	126.10	46.97	1452.73	14.36	70.15	1514.06			
Australia, New Zealand	M	16.46	68.38	153.71	52.30	1624.52	17.43	84.84	1694.25	1.179	1.181	1.069
	X	10.82	50.80	123.54	40.06	1258.90	16.32	61.62	1315.28			

Table A-10 (cont'd.)

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 + 6)	Y_1^S (1:5)	Y_2^S (1:8)	Y_3^S (5:8)
Less Developed Economies	M	25.74	48.63	130.13	34.07	1003.74	15.57	74.37	1053.38	2.376	2.387	1.397
	X	14.42	56.41	130.17	42.88	1342.27	16.79	70.83	1401.94			
Latin America	M	18.67	36.98	106.33	40.36	839.17	16.28	55.65	895.81	4.426	4.322	1.450
	X	7.42	58.50	115.49	50.25	1476.04	12.49	65.92	1538.78			
Africa	M	39.63	38.26	129.68	12.21	891.80	22.56	77.89	926.57	13.229	13.258	2.069
	X	6.80	78.83	154.23	65.41	2024.34	18.12	85.63	2107.87			
Middle East	M	18.95	37.59	121.63	17.87	478.71	19.47	56.54	516.05	4.169	4.041	2.173
	X	12.53	56.99	139.47	37.06	1319.74	22.05	69.52	1378.85			
Burma, India, Pakistan, and Indonesia	M	27.97	58.18	140.78	52.48	1356.99	15.25	86.15	1424.72	2.364	2.377	1.216
	X	14.43	72.33	175.59	53.54	1664.45	27.13	86.76	1745.12			
Taiwan and Thailand	M	6.81	47.13	98.97	102.45	1072.10	10.73	53.94	1174.55	0.628	0.598	0.929
	X	12.92	53.14	127.21	41.63	1278.02	16.95	66.06	1336.60			
Malaysia, Singapore, & Hong Kong	M	24.64	51.44	139.62	31.96	998.51	17.56	76.08	1048.03	1.997	1.837	1.372
	X	19.20	60.15	142.69	44.58	1437.22	18.14	79.35	1499.94			

Sources: Table A-19, and Research Department, The Bank of Korea, Input-Output, Interindustry Relations Tables for 1963. Table 4.

Table A-11

The Technology Coefficients of Commodities

SITC	Commodity Description	Scale Economies	Consumer Goods Ratio	First Trade Date	Product Differentiation
046	Meal, flour, of wheat, maslin	0.170	0.976	1933.9	0.2198
047	Meal, flour, of cerials, nes.	0.244	0.976	1938.9	0.2620
048	Cereal preparations	0.135	0.976	1934.5	0.4364
053	Preserved fruit	0.121	1.000	1941.3	0.2617
055	Preserved vegetables	0.119	1.000	1938.8	0.4571
061	Sugar and honey	-0.135	0.715	1937.7	0.4667
062	Sugar confectionary	0.144	1.000	1924.4	0.6005
111	Nonalcoholic	0.089	0.999	1939.3	0.3705
112	Alcoholic beverages	0.142	0.996	1925.6	0.4948
122	Tobacco manufactures	0.153	1.000	1935.3	0.1780
231.2	Synthetic rubber	0.000	0.252	1954.6	0.4298
332	Petroleum products	-0.014	0.335	1939.2	0.4583
512	Organic chemicals	0.086	0.136	1947.2	0.9175
513	Inorganic chemicals, elements, etc.	-0.074	0.035	1943.0	0.7741
514	Other inorganic chemicals	-0.058	0.035	1943.2	1.1162
515	Radioactive materials	0.000	0.035	1953.4	2.4360
521	Mineral tar and crude chemicals from coal, petroleum, natural gas	0.027	0.301	1940.0	0.8008
531	Synthetic organic dyestuffs, etc.	0.086	0.048	1945.7	0.9505
532	Dying and tanning extracts	0.047	0.048	1945.1	0.4875
533	Pigments, paints, varnishes	0.047	0.138	1935.3	0.9093
541	Medicinal and pharmaceutical products	0.083	0.804	1950.5	1.4745

Table A-11 (cont'd.)

SITC	Commodity Description	Scale Economies	Consumer Goods Ratio	First Trade Date	Product Differentiation
551	Essential oils, perfume, flavor materials	0.194	0.804	1948.6	0.7454
553	Perfumery and cosmetics	0.240	0.804	1930.1	0.2990
554	Soaps, cleansing, polishing preparations	0.158	0.804	1943.0	0.7618
561	Manufactured fertilizers	0.076	0.141	1933.2	0.4791
571	Explosives and pyrotechnic products	-0.079	0.170	1942.6	1.2713
581	Plastic materials, regenerated cellulose and artificial resins	0.009	0.257	1954.6	0.9093
599	Chemical materials and products, nes.	0.059	0.505	1945.5	0.7512
611	Leather	-0.058	0.767	1935.3	0.5896
612	Manufactures of leather	0.060	0.860	1931.9	0.5896
621	Materials of rubber	0.011	0.316	1949.0	0.8769
629	Articles of rubber	0.011	0.316	1947.5	0.7106
631	Veneers, plywood boards, etc.	0.029	0.058	1947.9	0.6834
632	Wood manufactures, nes.	0.006	0.482	1946.2	0.9511
633	Cork manufactures	0.006	0.482	1934.3	0.8320
641	Paper and paper board	0.101	0.215	1949.2	0.8279
642	Articles made of paper pulp, paper or paper board	0.018	0.272	1946.5	0.9943
651	Textile yarn and thread	0.066	0.677	1950.9	0.4592
652	Cotton fabrics, woven	-0.050	0.677	1952.6	0.4774
653	Other textile fabrics, woven	-0.034	0.677	1946.9	0.5954
654	Tulle, lace, embroidery, etc.	-0.004	0.677	1941.4	0.6057
655	Special textile fabrics	0.011	0.440	1945.9	0.6167

Table A-11 (cont'd.)

SITC	Commodity Description	Scale Eco-nomies	Consumer Goods Ratio	First Trade Date	Product Differen-tiation
656	Made-up textile articles	-0.014	0.634	1943.6	0.5873
657	Floor coverings, tapestries, etc.	0.052	0.449	1936.9	0.5132
661	Lime, cement, building materials	-0.055	0.022	1936.1	0.6718
662	Clay construction materials	0.023	0.008	1945.3	0.7651
663	Mineral manufactures, nes.	0.051	0.043	1945.2	0.7681
664	Glass	0.039	0.209	1946.4	0.9109
665	Glassware	0.112	0.242	1945.9	0.6279
666	Pottery	0.034	0.242	1944.7	0.6015
671	Pig iron, sponge iron, ferroalloys, etc.	0.082	0.004	1942.2	0.6917
672	Ingots and other primary forms	0.035	0.027	1949.4	0.5479
673	Bars, rods, angles, shapes	0.058	0.027	1941.5	0.6916
674	Universals, plates, and sheets	0.124	0.027	1951.0	0.5159
675	Hoop and strip	0.124	0.027	1949.3	0.6101
676	Rails and track construction materials	0.058	0.027	1945.2	0.5494
677	Wire, excluding wire rod	0.019	0.027	1941.6	0.6908
678	Tubes, pipes, and fittings	0.039	0.027	1950.4	0.8713
679	Casting and forgings, unworked	-0.004	0.027	1939.5	1.3266
681	Silver, platinum	-0.298	0.042	1938.6	0.3357
682	Copper	-0.067	0.101	1938.6	0.5598
683	Nickel	-0.104	0.042	1951.1	0.6729
684	Aluminum	-0.032	0.142	1947.0	0.7498
685	Lead	-0.022	0.042	1945.7	0.6040
686	Zinc	-0.024	0.042	1946.9	0.7365

Table A-11 (cont'd.)

SITC	Commodity Description	Scale Economies	Consumer Goods Ratio	First Trade Date	Product Differentiation
687	Tin	-0.068	0.042	1947.8	0.3390
688	Uranium and thorium	-0.298	0.042	1958.1	0.2650
689	Miscellaneous nonferrous metals	-0.298	0.042	1951.3	0.9489
691	Finished structural parts and structures	0.005	0.017	1944.2	0.9489
692	Metal containers for storage and transport	0.041	0.017	1948.6	1.3287
693	Wire products and fencing grills	-0.008	0.334	1945.4	0.8969
694	Nails, screens, nuts, bolts, rivits	-0.023	0.334	1931.3	2.0906
695	Tools for hand or machine	0.071	0.334	1949.2	1.2815
696	Cutlery	0.174	0.334	1941.9	0.5900
697	Household equipments	0.011	0.334	1941.3	0.5870
698	Metal manufactrues, nes.	0.011	0.334	1946.5	1.0341
711	Power generating machines	0.084	0.039	1949.8	0.9855
712	Agricultural machinery	0.062	0.039	1950.7	0.5654
714	Office machines	0.030	0.039	1946.1	0.5958
715	Metalworking machinery	0.031	0.003	1948.6	1.3156
717	Textile and leather machinery	0.003	0.026	1939.0	1.1986
718	Machines for special industries	0.030	0.018	1948.3	1.2200
719	Machinery and appliances, nes.	0.036	0.245	1950.8	1.2075
722	Electric power machinery, switchgear	0.081	0.033	1951.4	1.7492
723	Equipment for distributing electricity	0.031	0.033	1948.1	0.8825
724	Telecommunication apparatus	0.031	0.033	1948.7	0.9608
725	Domestic Electrical equipments	0.096	0.527	1948.8	0.5320

Table A-11 (cont'd.)

SITC	Commodity Description	Scale Economies	Consumer Goods Ratio	First Trade Date	Product Differentiation
726	Electrical apparatus for medical purposes	0.073	0.071	1944.7	0.5320
729	Other electrical machinery apparatus	0.064	0.071	1945.6	1.5192
731	Railway vehicles	0.011	0.118	1948.6	0.8476
732	Road motor vehicles	0.058	0.077	1951.1	0.5504
733	Road vehicles, nonmotor	0.110	0.236	1948.5	0.5108
734	Aircrafts	0.304	0.086	1951.7	1.0225
735	Ship and boats	0.006	0.106	1949.5	1.3093
812	Sanitary, plumbing, heating and lighting fixtures	0.065	0.242	1946.0	0.9592
821	Furniture	0.032	0.326	1947.3	0.5360
831	Travel goods, handbags, and similar articles	0.031	0.860	1936.6	0.6300
841	Clothing except fur	-0.097	0.878	1945.7	0.5137
842	Fur clothing	0.032	0.834	1928.8	1.0717
851	Footwear	0.052	0.985	1927.7	0.6060
861	Scientific, medical, optical instruments	0.034	0.689	1948.7	1.2224
862	Photographic supplies	0.060	0.800	1948.6	1.9434
863	Developed cinema film	0.060	0.800	1958.1	1.0325
864	Watches and clocks	-0.013	0.662	1943.8	1.1907
891	Musical instruments, sound recorders	0.089	0.527	1950.9	1.5929
892	Printed matters	0.034	0.512	1947.1	1.3470
893	Plastic articles	0.078	0.527	1950.6	0.5983

Table A-11 (cont'd.)

SITC	Commodity Description	Scale Economies	Consumer Goods Ratio	First Trade Date	Product Differentiation
894	Perambulators, toys, sporting goods	0.090	0.527	1947.5	0.7867
895	Office and stationery supplies	0.066	0.527	1944.4	0.9424
899	Manufactured articles, nes.	0.055	0.527	1944.2	0.7360

Source: Hufbauer, G.C., "The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods." Table A-2 in Vernon, R. (ed.), _The Technology Factor in International Trade_. New York: NBER, Columbia University Press, 1970.

Table A-12

Estimates of Optimum Plant Size in U.S. Industries
(1954)

Commodity Classification (SITC)	Optimum Plant Size (Millions of $'s)	Commodity Classification (SITC)	Optimum Plant Size (Millions of $'s)
332	9.392	665	9.861
512	69.806	666	1.705
513	69.806	671	4.587
514	69.806	672	1.714
531	1.536	673	26.534
532	1.411	674	26.534
533	1.536	675	26.534
541	48.874	676	26.534
551	0.105	677	26.534
553	0.105	678	26.534
554	0.105	679	26.534
581	69.806	681	4.067
		682	40.67
611	1.282	683	4.067
612	1.282	684	4.067
629	1.282	685	4.067
631	0.230	686	4.067
632	0.160	687	4.067
641	0.497	689	6.750
642	0.497	691	2.183
651	0.512	692	2.183
652	1.162	693	2.183
653	1.162	694	0.564
654	0.311	695	0.433
655	0.311	696	0.433
656	0.143	697	0.564
657	5.141	698	0.564
661	0.329		
662	0.815	711	2.183
663	0.704	712	5.320
664	26.333	714	1.900

Table A-12 (cont'd)

Commodity Classification (SITC)	Optimum Plant Size (Millions of $'s)	Commodity Classification (SITC)	Optimum Plant Size (Millions of $'s)
715	8.084	734	93.900*
717	0.533		
718	0.895	812	6.166
719	4.204	821	0.160
722	10.867	831	1.283
723	1.006	841	0.683
724	10.867	851	1.283
725	1.006	864	0.387
726	2.263	891	6.064
729	2.273	892	2.329
731	41.600*	894	1.474
733	1.140	895	0.560

* Estimates not provided by Saving.

Source: Saving, T.R. "Estimation of Optimum Size of Plant by the Survival Technique." Quarterly Journal of Economics. November, 1961, pp. 598-602.

Table A-13

Skill Requirements Per Million Dollars of Manufacturing Exports and Imports of Twenty-three Countries

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 + 6)	S_{Y_1} (1:5)	S_{Y_2} (1:8)	S_{Y_3} (7:8)
Group I												
United States	M	15.08	9.32	24.14	5.56	118.83	3.69	24.40	128.08	0.771	0.775	0.825
	X	17.42	9.04	24.67	5.32	105.82	3.51	26.46	114.64			
Canada	M	17.10	9.03	24.87	5.38	113.35	3.63	26.13	122.36	1.043	1.041	1.033
	X	16.18	8.74	23.96	4.97	111.90	3.67	24.92	120.54			
Group II												
Sweden	M	46.76	27.69	95.68	12.49	529.37	21.81	74.45	563.67	0.907	0.904	0.939
	X	48.17	25.60	94.28	11.47	494.68	18.30	73.77	524.72			
Norway	M	44.64	25.93	89.47	11.56	507.45	20.58	70.64	539.59	0.996	0.995	0.981
	X	34.94	21.15	71.81	9.03	395.71	15.36	56.09	420.10			
Australia	M	50.56	27.12	98.05	12.59	524.20	22.29	77.68	559.08	1.098	1.101	1.050
	X	39.76	24.27	81.50	12.99	452.57	18.40	64.03	483.96			
Germany	M	41.12	27.70	89.46	12.36	534.65	22.41	68.82	569.42	0.761	0.760	0.844
	X	52.40	26.59	98.80	12.27	518.68	20.63	78.99	551.58			
United Kingdom	M	64.09	30.79	110.51	14.52	546.58	34.57	94.88	595.67	0.927	0.926	0.961
	X	71.08	30.27	117.24	14.26	562.26	35.28	101.35	611.80			
Denmark	M	46.17	27.71	94.14	12.24	532.67	22.17	73.88	567.08	0.957	0.958	0.965
	X	45.62	26.91	95.27	13.40	503.64	19.93	72.53	536.97			

Table A-13 (cont'd.)

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 +66)	S_{Y_1} (1:5)	S_{Y_2} (1:8)	S_{Y_3} (7:8)
France	M	46.51	26.70	93.82	12.31	511.55	20.51	73.21	544.37	1.034	1.035	1.032
	X	46.52	26.91	94.09	12.58	529.22	21.88	73.43	563.68			
Belgium	M	46.28	26.95	92.75	11.87	525.86	21.52	72.23	559.25	1.127	1.126	1.070
	X	41.68	26.79	86.18	10.87	533.60	22.54	68.47	567.01			
Netherlands	M	45.78	28.14	94.57	12.70	544.50	22.68	73.92	579.88	0.925	0.932	0.940
	X	45.75	27.47	93.86	13.47	503.35	23.17	73.22	539.99			
Austria	M	47.27	38.34	96.40	12.86	546.14	23.40	85.61	582.40	1.165	1.163	1.241
	X	41.84	29.12	92.34	12.34	563.42	23.57	70.96	599.33			
Italy	M	47.63	25.71	92.90	12.31	490.45	20.24	73.34	523.00	1.257	1.231	1.168
	X	45.38	29.53	97.56	12.71	587.56	23.75	74.91	624.02			
Japan	M	45.12	25.26	90.68	13.39	454.98	19.10	70.38	487.47	1.222	1.213	1.167
	X	44.41	27.59	91.02	11.52	457.45	22.93	72.00	581.90			
Group III												
Spain	M	28.72	50.52	139.82	25.44	886.50	17.62	79.24	929.56	1.426	1.439	1.243
	X	25.51	55.96	142.53	46.64	1123.27	17.90	81.47	1187.81			
Mexico	M	33.45	51.16	145.32	22.87	883.73	18.44	84.61	925.04	2.036	2.086	1.462
	X	17.65	46.04	116.82	54.43	949.45	14.39	63.71	1018.27			

Table A-13 (cont'd.)

		(1) Professionals and Technicians	(2) Administrators and Managers	(3) Clerical Workers	(4) Sales Workers	(5) Manual Workers	(6) Service Workers	(7) Skilled Workers (1 + 2)	(8) Unskilled Workers (4 + 5 + 6)	S_{Y_1} (1:5)	S_{Y_2} (1:8)	S_{Y_3} (7:8)
Portugal	M	29.69	49.17	140.11	23.93	891.94	18.54	78.86	934.41	3.214	3.209	1.645
	X	14.29	59.75	135.22	47.35	1379.72	16.01	74.04	1443.08			
Yugoslavia	M	27.69	51.56	140.16	26.36	966.38	18.26	79.25	1011.00	1.490	1.490	1.250
	X	21.34	51.51	132.68	34.81	1109.70	16.82	72.85	1161.33			
Hong Kong	M	21.50	54.79	138.12	39.45	1167.35	16.78	76.29	1223.58	1.684	1.679	1.217
	X	17.18	66.92	145.71	55.92	1570.85	15.17	84.10	1641.94			
South Korea	M	30.39	51.46	140.65	27.13	926.73	18.13	81.85	971.99	3.940	3.912	1.776
	X	12.91	63.66	136.26	49.90	1551.20	14.14	76.57	1615.24			
Taiwan	M	30.48	48.91	139.97	21.87	862.02	18.31	79.39	902.20	2.754	2.778	1.608
	X	16.60	58.12	137.19	55.43	1293.06	16.61	74.72	1365.10			
Pakistan	M	28.14	48.26	134.40	22.04	836.37	17.37	76.40	875.78	7.014	7.007	2.049
	X	8.66	71.74	144.06	65.55	1805.40	17.57	80.40	1888.52			
India	M	27.00	43.40	122.58	18.73	705.92	15.70	70.40	740.35	5.343	5.338	2.055
	X	11.77	67.96	144.16	61.23	1644.13	17.55	79.73	1722.91			

Table A-13 (cont'd.)

Sources: Total skill requirements for each industry is estimated for Group I from Table A-5, and U.S. Department of Commerce, OBE, "Input-Output Structure for 1963," in Survey of Current Business. November 1969, pp. 16-47, Table 3. For Group II from Table A-7, and Department of Applied Economics, Cambridge University, A Program for Growth, Input-Output Relations 1954-1966. Cambridge, Mass.: MIT Press, 1963. For Group III from Table A-9, and Research Department, The Bank of Korea, Input-Output, Interindustry Relations, Tables for 1963. 1966, Table 4.

Table A-14

Capital and Labor Embodied in One Million Dollars of Manufacturing Exports and Imports of Twenty-three Countries

Country	IMPORTS K (U.S. $1000)	IMPORTS L (Man Years)	EXPORTS K (U.S. $1000)	EXPORTS L (Man Years)	$\gamma_{K/L}$*
Group I					
United States	2309.31	181.91	2338.85	170.52	0.926
Canada	2267.26	178.41	2240.93	174.44	0.989
Group II					
Sweden	3403.28	745.58	2550.38	703.55	1.259
Norway	2956.81	712.14	2337.28	559.35	0.994
Australia	2730.53	745.55	2899.99	646.40	0.816
Germany	3061.06	739.57	2742.72	741.89	1.120
United Kingdom	3804.04	874.03	3602.82	876.81	1.093
Denmark	3278.65	747.32	2533.27	713.57	1.236
France	2750.01	723.15	2923.81	744.23	0.968
Belgium	2857.89	738.62	3250.86	736.15	0.876
Netherlands	2876.59	759.99	3788.83	717.51	0.717
Austria	3029.60	765.38	2752.29	772.17	1.110
Italy	2794.75	701.08	3124.05	807.62	1.031
Japan	3237.78	660.68	2735.68	756.40	1.354
Group III					
Spain	2185.21	1151.84	2354.66	1417.08	1.142
Mexico	2137.29	1162.64	2389.82	1202.18	0.925
Portugal	2181.00	1159.43	2554.22	1651.94	1.217
Yugoslavia	2263.84	1235.23	2342.60	1372.23	1.074
Hong Kong	2402.10	1439.52	2652.99	1873.60	1.178
South Korea	2237.24	1199.47	2408.06	1829.71	1.417
Taiwan	2149.25	1126.60	2430.21	1577.54	1.238
Pakistan	2089.01	1091.10	3331.71	2105.71	1.210
India	1983.88	936.13	3144.74	1944.02	1.310

* $\gamma_{K/L} = \frac{(K/L)_M}{(K/L)_X}$.

Sources: Total capital and labor requirement of industries are estimated for Group I from Table A-2 and U.S. "Input-Output Structure for 1963." op. cit., for Group II from Table A-3 and U.K. Input-Output Relations op. cit., for Group III from Table A-4 and South Korea Input-Output, Interindustry Relation Tables for 1963, op. cit. Trade data from Commodity Trade Statistics.

Table A-15

Scale Intensity of Manufacturing Trade of Twentry-three Countries

COUNTRY	HUFBAUER'S METHOD IMPORTS	HUFBAUER'S METHOD EXPORTS	γ_{sc1}*	SAVING'S METHOD IMPORTS	SAVING'S METHOD EXPORTS	γ_{sc2}
Group I						
United States	0.0334	0.0652	0.8801	17.250	22.789	0.757
Canada	0.0487	0.0499	0.9952	22.141	24.542	0.902
Group II						
Sweden	0.0313	0.0441	0.9476	13.506	12.902	1.047
Norway	0.0336	0.0129	1.0972	16.662	7.869	2.117
Australia	0.0525	0.0030	1.2438	18.818	15.161	1.241
Germany	0.0251	0.0030	1.1089	13.146	17.959	0.732
United Kingdom	0.0286	0.0461	0.9289	14.245	16.928	0.842
Denmark	0.0415	0.0423	0.9967	15.692	9.601	1.634
France	0.0393	0.0416	0.9905	14.529	17.645	0.823
Belgium	0.0333	0.0481	0.9403	17.132	17.650	0.971
Netherlands	0.0399	0.0316	1.0358	15.191	15.021	1.011
Austria	0.0320	0.0416	0.9603	15.501	10.275	1.509
Italy	0.0431	0.0390	1.0172	13.484	16.515	0.816
Japan	0.0160	0.0420	0.8926	11.854	14.094	0.840
Group II						
Spain	0.0461	0.0350	1.0472	15.907	8.923	1.783
Mexico	0.0492	-0.0541	1.7080	20.637	9.843	2.097
Portugal	0.0409	0.0291	1.0515	18.905	3.825	4.942
Yugoslavia	0.0389	0.0117	1.1285	14.802	7.442	1.989
Hong Kong	0.0300	-0.0100	1.2105	9.471	1.917	4.941
South Korea	0.0413	-0.0121	1.2842	14.163	2.464	5.748
Taiwan	0.0400	0.0146	1.1184	12.998	4.336	2.998
Pakistan	0.0436	-0.0093	1.2774	13.076	1.924	6.796
India	0.0450	-0.0174	1.3418	12.691	2.953	4.298

* $\gamma_{sc1} = (0.2 + \alpha_M)/(0.2 + \alpha_X)$.

Sources: Table A-11 and A-12, Appendix and U.N. Commodity Trade Statistics.

Table A-16

Consumer Goods Ratio, Coefficient of Product Age, and Product Differentiation Index Embodied in One Million Dollars of Exports and Imports of Trade of Manufactured Goods for Twenty-three Countries

Theory of Trade	Stage of Production			Technological Gap			Product Cycle		
Country	Imports	Exports	γ_{cg}	Imports	Exports	γ_{age}	Imports	Exports	γ_{pd}
Group I									
United States	0.2901	0.2031	1.4284	22.97	20.85	1.102	0.7532	0.9330	0.8073
Canada	0.2282	0.1578	1.4461	20.93	21.07	0.993	0.8410	0.7368	1.1414
Group II									
Sweden	0.3018	0.1928	1.5653	22.62	20.96	1.079		0.8925	0.9378
Norway	0.2640	0.1663	1.5875	22.14	22.24	0.996	0.8370	0.8704	0.9971
Australia	0.2618	0.2972	0.8809	21.06	24.85	0.847	0.9167	0.6885	1.3314
Germany	0.3068	0.2236	1.3721	23.27	21.24	1.096	0.7839	0.9042	0.8670
United Kingdom	0.2876	0.2665	1.0791	23.42	22.29	1.051	0.8101	0.8580	0.9442
Denmark	0.2826	0.3316	0.8522	22.22	22.31	0.996	0.8283	0.9268	0.8937
France	0.2653	0.3036	0.8738	22.47	22.65	0.992	0.8413	0.8292	1.0146
Belgium	0.2708	0.2441	1.1094	22.34	22.96	0.973	0.8013	0.7365	1.0880
Netherlands	0.2982	0.3154	0.9455	21.81	22.58	0.966	0.8663	0.8501	1.0191
Austria	0.2957	0.2768	1.0683	22.39	21.82	1.026	0.8057	0.8578	0.9393
Italy	0.2524	0.2486	1.0153	22.41	22.33	1.004	0.8739	0.8694	1.0052
Japan	0.2707	0.2775	0.9755	24.06	21.17	1.137	0.8387	0.8696	0.9645
Group III									
Spain	0.2353	0.4480	0.5252	22.12	26.35	0.839	0.9304	0.7694	1.2093
Mexico	0.1898	0.3827	0.4959	20.83	25.90	0.804	0.9780	0.6584	1.4854
Portugal	0.2470	0.5865	0.4211	21.45	26.04	0.824	0.8662	0.6803	1.2733
Yugoslavia	0.2295	0.3398	0.6754	21.91	24.07	0.910	0.8748	0.8145	1.0740
Hong Kong	0.4346	0.6286	0.6914	22.96	23.37	0.982	0.8117	0.6957	1.1667
South Korea	0.2299	0.5157	0.4458	21.60	23.22	0.930	0.9549	0.6872	1.3896
Taiwan	0.2026	0.4957	0.4087	21.64	23.43	0.924	0.9562	0.6824	1.4012
Pakistan	0.1779	0.6512	0.2732	22.52	23.57	0.955	0.9135	0.5741	1.5912
India	0.1575	0.6220	0.2532	22.33	24.33	0.918	0.9865	0.5982	1.6491

Sources: Tables A-11 and A-12, Appendix and U.N. Commodity Trade Statistics.

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