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ABSTRACT

DETERMINANTS OF THE STRUCTURE OF U.S. FOREIGN TRADE IN MANUFACTURING 1963-1980

by

Farhang Niroomand

The objective of this dissertation is to investigate the determinants of U.S. trade in manufactured goods and to analyze changes in these determinants over the time period of 1963-1980. It tests a modified multi-factor proportions model by measuring the simultaneous impact of human capital (H), physical capital (K), and labor (L) on U.S. net exports in manufacturing, (categories 5-8 of the SITC). Additionally, a measure of economies of scale in production within industries is introduced and tested in a multiple regression model.

The model is applied to U.S. manufacturing trade in the aggregate as well as to bilateral trade with six economically distinctive countries and regions of the world. Using ordinary least squares (OLS) estimation technique, the correlation between net exports of U.S. industries and different economic characteristics is examined for each of four years (1963, 1967, 1977, and 1980).

Regression results in most cases and especially in earlier years (1963 and 1967) confirm both the Leontief Paradox and his explanation for it, which emphasize the role of human capital as a source of U.S.

comparative advantage. The multi-factor proportions theory performs well in explaining U.S. trade patterns with the NICs in all four years, Japan, and DC_{II} (in 1963 and 1967). But it does not receive much support in explaining United States trade with DC_1 (for all four years), Japan and DC_{II} for 1977 and 1980. It is hypothesized that in the latter cases intraindustry trade tends to predominate.

Indeed, when inter- versus intra-industry trade is tested directly with our data set, the results confirmed that trade between the United States and Europe is mainly intraindustry. It is also found that intraindustry trade between the U.S. and Japan has increased substantially between 1963 and 1980.

The dummy variable technique is employed to investigate and analyze structural changes in the United States' manufacturing trade between 1963 and 1980. Such changes are detected in the U.S.-global trade as well as in the U.S.-bilateral trade with Japan, Canada, and Newly Industrializing Countries. Japan and the NICs have grown in importance as trade partners of the United States' between 1963 and 1980.

TO MY PARENTS

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CHAPTER ONE

INTRODUCTION

The main objective of this dissertation is to investigate the determinants of U.S. trade patterns in manufactured goods and to analyze changes in these determinants over the period 1963-1980. Empirical studies in the early 1970s indicate that since the early 1960s the United States has been a net exporter of capital goods and chemicals and a net importer of consumer goods and other nonagricultural industrial supplies and materials. In automotive products, the United States had a surplus every year until 1968 but since then has had an increasing deficit (Table 1.1). This presumably results from underlying comparative advantages the United States has in the production of capital goods and chemical goods and disadvantage in production of consumer goods and other industrial supplies and materials. According to the notion of comparative advantage, the United States should be a net exporter of goods in which it has a comparative advantage--whether it derives from resource endowment, technological advantage, scale economy, or education embodied in human capital--and a net importer of goods in which it is at a disadvantage. The question is, therefore, what is the source of the U.S. comparative advantage?

Most previous studies such as those by Hufbauer (1970), Baldwin (1971), Branson and Junz (1971), and Harkness and Kyle (1975) have

TABLE 1.1

Net U.S. Exports in Manufactures by End-Use Categories, 1958-1981
Millions of Dollars f.o.b.

YEAR	CAPITAL GOODS	CONSUMER GOODS	AUTOMOTIVE GOODS	FUELS & LUBRICANTS	CHEMICALS	OTHERS
1958	4292	119	568	-544	829	-1413
1959	4026	-261	343	-699	914	-2516
1960	4949	-505	633	-739	1128	-1229
1961	5217	-448	805	-933	1133	-1099
1962	5685	-821	780	-1080	1187	-2021
1963	5781	-831	882	-956	1313	-2010
1964	6424	-943	962	-1069	1627	-1791
1965	6581	-1506	990	-1264	1504	-2989
1966	6756	-1877	444	-1270	1627	-3633
1967	7531	-2102	150	-1127	1729	-3360
1968	8292	-3041	-842	-1457	2075	-4575
1969	9129	-4020	-1454	-1645	2032	-3531
1970	10584	-4806	-2303	-1467	2223	-3040
1971	11020	-5713	-3549	-2194	2029	-5322
1972	11030	-7864	-4206	-3219	2098	-6552
1973	13928	-8481	-4543	-6368	3138	-5916
1974	20370	-8538	-4190	-21801	4975	-6527
1975	25608	-7306	-2083	-21793	5145	-5002
1976	27127	-10601	-5592	-29836	5465	-7621
1977	25545	-12977	-6535	-40304	5583	-12137
1978	26771	-17894	-9853	-38416	6597	-13906
1979	32976	-17838	-9061	-54352	9969	-9802
1980	42985	-18207	-11205	-71147	12561	-4950
1981	45680	-22864	-11750	-71334	11996	-14182

Source: U.S. Department of Commerce, Office of Business Economics, U.S. Exports and Imports Classified by OBE End-Use Commodity Categories, 1958-1968. A Supplement to the Survey of Current Business (1970), Tables 5, 6, and U.S. Bureau of the Census, Highlights of U.S. Export and Import Trade, Report FT 990, December 1970, and; December 1972, Tables E9, I10; December 1974, and December 1976, Tables E9, I5, and December 1978, December 1979, December 1980 and December 1981, Tables E9, I7.

focused on the determinants of trade in only one particular year. Besides Branson and Monoyios (1977), who checked their results against data for 1967, there is only one other study, by Stern and Maskus (1981), which analyzes changes in the determinants of the structure of U.S. foreign trade over an extended period (1958-1976).

These and other related studies will be reviewed in Chapter II. This survey of the literature will indicate what theories of international trade have been found valid in explaining the composition of U.S. foreign trade. We shall start with the simple H-O model and continue with a summary of new theories and their empirical verification.

Chapter III begins by considering the theoretical specifications and the implications of a modified factor-proportions model. Specifically, it measures the simultaneous effect of a variety of factor intensities on the comparative advantage (net exports) of U.S. manufactures, classified by the Standard International Trade Classification. The chapter begins with a three-factor input version of the Heckscher-Ohlin model, with physical capital (K), human capital (H), and labor (L) being the direct inputs. The model is expanded to include scale economy as another explanatory variable.

The major concern of this study is not only to investigate the determinants of the commodity composition of U.S. foreign trade with the world as a whole, but also to provide a regional breakdown of that trade, thereby uncovering additional information on the factors influencing the commodity pattern of U.S. bilateral trade flows. Thus, the factor proportions model is tested with respect to U.S. trade with Western Europe, Japan, Canada, newly industrializing countries, and less developed countries with regionally disaggregated data. The last section of Chapter III uses the same data set to test directly the extent to which U.S. trade in the aggregate as well as its bilateral flows are intra- rather than interindustry in nature.

Chapter IV analyzes the structural determinants of U.S. trade with different regions of the world at different times and for a long enough period (1963-1980) to detect what changes, if any, might have occurred, especially since the introduction of generalized floating exchange rates.

Chapter V summarizes the empirical findings of the dissertation. It also offers a broader interpretation of the main findings with regard to methodology and economic policy.

CHAPTER TWO

INTERNATIONAL TRADE THEORIES AND THEIR EMPIRICAL VERIFICATION: SURVEY OF THE LITERATURE

The Simple H-O Theorem

The Heckscher-Ohlin (H-O) theorem can be derived from a two-good, two-factor, two-country model under the following simplifying assumptions: (1) identical production functions (for each commodity) among countries, linearly homogeneous in capital and labor; (2) identical and homothetic tastes among countries; (3) no factor intensity reversal; (4) competitive markets for factors and commodities; and (5) factors completely immobile among countries while commodities are traded freely without transport cost. In the case of two countries trading two commodities with each other, the H-O theorem states that the relatively capital-intensive commodity is the exportable of the country with relatively abundant capital, while the relatively labor-intensive commodity is the exportable of the country with relatively abundant labor.[1]

A commodity's capital intensity is defined as the capital-labor ratio employed in the production process. Under an assumption of no factor intensity reversal, the capital intensity of one commodity is always greater than that of the other commodity for all wage-rent ratios, with wage and rent being the prices of labor and capital (input factors), respectively. Thus, in a two-commodity case, if one commodity is capital intensive, the other must be unambiguously labor intensive.

We have two commonly accepted definitions for the relative factor abundance of a country. According to the factor price definition, a country is capital abundant if its wage-rent ratio is greater than that of the other country. The second definition, expressed in terms of physical quantities of the endowed factors, states that a country is capital abundant if its ratio of capital endowment to labor endowment in physical units is greater than that of the other country. The assumptions of identical tastes and identical production functions together preclude the possibility that the country is capital abundant by one definition and labor abundant by the other. By adopting either one of the definitions, the H-O conclusion for the two-factor, two-commodity, and two-country case follows from the assumptions of the model. One must, however, take different approaches to reach the same conclusion.

Under the price definition of factor abundance, the law of comparative cost determines the direction of commodity flow. It is necessary only to ascertain which commodity can be produced comparatively cheaper in which country. For this purpose the inter-country cost ratio of the commodities should be compared. The ratio of a commodity's unit cost of production in one country to the same commodity's unit cost in another is called the commodity's intercountry cost ratio. For two countries, A and B, and for two commodities, X and Y, commodity X is said to be produced comparatively cheaper in A if the

A to B intercountry cost ratio is smaller for commodity X than for commodity Y. In other words,

$\frac{C_X^A}{C_X^B} < \frac{C_Y^A}{C_Y^B}$, where C_X^A is the unit cost of good X in country A, C_X^B is the unit cost of good X in country B, and C_Y^A and C_Y^B are unit costs of commodity Y in countries A and B, respectively.

Alternatively, one may adopt the physical definition of capital abundance and compare, at a post-trade equilibrium, a country's output and consumption of the commodities to find out which commodity the country would export or import. Denoting output by Q and consumption by D, there would be four pairs of output and consumption to be compared in a two-commodity, two-country world, that is, a pair of Q_i^j and D_i^j for $i = X, Y$ and for $j = A, B$. Under the assumptions of identical and homothetic tastes, this task is simplified to a comparison of two ratios—one ratio of the outputs of two commodities in each country: $Q_x^j \,/\, Q_y^j$ for $j = A, B$.[2] Therefore, if country A's output ratio of commodity X to commodity Y is greater than country B's, that is, if

$\frac{Q_X^A}{Q_Y^A} > \frac{Q_X^B}{Q_Y^B}$, then country A produces more (less) of commodity X(Y) than it consumes; country A must then be exporting commodity X to B while importing commodity Y from B.

The simple factor proportion theory introduced by Eli Heckscher in 1919, and developed by Bertil Ohlin, was the fundamental theorem of international trade for some time. In 1953, Wassily Leontief published an empirical study which showed that a lower capital-labor ratio was required to produce U.S. exports than was required to produce import-competing goods. Because of the widely held assumption that the United States was better endowed with capital relative to labor than was the rest of the world, his results contradicted the H-O factor endowment hypothesis. The Leontief results and those from similar investigations pertaining to other countries have shaken the confidence of economists in the simple version of H-O trade theory.[3]

The Leontief results were subsequently confirmed by Leontief himself (1956) using the 1951 trade pattern, by Hufbauer (1970) using the 1958 input-output (I-O) table and 1963 trade data, and by Baldwin (1971) using the 1958 I-O table and 1962 trade data. Hufbauer shows that the Leontief results also hold for manufactured goods separately. Baldwin's study strongly supports the view that a straightforward application of a two-factor (capital and labor) factor-proportion model along H-O lines is inadequate for understanding the pattern of U.S. trade. Not only is the sign of the capital-labor ratio different from what would be expected from the model, but also it is statistically significant in this unexpected direction. This negative sign seems to suggest, as was also noted by Vanek and others, that there is a strong complementarity between certain natural resources and physical capital. When various natural resource products are eliminated from the factor-content calculations, the overall ratio of capital per worker in import-competing goods to capital per worker in export goods drops from 1.27 to 1.04. Using the 1963 I-O table, 1963 capital and labor coefficients, and the 1969 commodity composition of trade (expressed in 1963 prices) yielded the same result. The ratio of capital per worker embodied directly and indirectly in competitive import replacements to capital per worker in exports is 1.06 for 1969 in contrast to 1.27 for 1962. When the so-called natural resource products are omitted, the ratio drops to 0.91 and becomes consistent with the expected result from the H-O theory.[4]

At a later stage, the so-called Leontief Paradox stimulated extensive theoretical and empirical research directed at providing alternative explanations of the commodity pattern of a country's trade. These alternative hypotheses rely on the following factors to explain the structure of a country's trade:

(1) The complementarity between natural resources and capital;
(2) the relative abundance of skilled compared to unskilled labor;
(3) economies of scale;
(4) technological advance and industries oriented toward research and development;
(5) the product cycle;
(6) the "new" theories of monopolistic competition.

(A) The Human Skills Theory of International Trade

The human skills theory is based on the proposition that the relative availability of skilled to unskilled labor is the fundamental determinant of international trade patterns. Although capital is a factor of production, it is relatively more mobile internationally than labor and hence is less likely to determine trade patterns. Since labor is immobile, if the skill intensity rankings of commodities across nations are similar, relative skill endowments will determine trade flows.

In 1956, Kravis discovered that U.S. exports comprised the outputs of predominantly high-wage industries and that U.S. imports competed with low-wage industries. To the extent that wage differentials are the product of skill differences, it is hypothesized that trade flows reflect the differential application of education and training to human labor. As a matter of fact, in his original article, Leontief proposed a "labor efficiency" resolution of the famous paradox. Somewhat later, Bhagwati suggested that human capital should be treated as a separate factor input, like physical capital, in evaluating trade patterns.

In the late 1960s the skill theme had found an intellectual, "base" at Columbia University. Two lines were pursued: human skills and human capital. Keesing related trade flows to skill differentials as reflected in interindustry employment of different kinds of labor. Kenen-Yudin and Waehrer followed Kravis's lead in relating trade flows to skill differentials as reflected in interindustry wage differentials. The Kenen-Yudin approach, also employed by Bharadwaj and Bhagwati in evaluating Indian trade, essentially consists of treating the difference between skilled labor wage and unskilled labor wage as an approximate measure of human capital, and then capitalizing this rent at an approximate interest rate to secure estimates of the human capital employed in average exports and imports.

Under the same assumption of the H-O model concerning the production function, Keesing used skill indexes to test the theory. His method required the computation of the amount of services from laborers of each class embodied in a given export and import flow. Indexes were constructed to measure the relative skill intensity of each country's exports to imports using U.S. labor coefficients. The following skill classes were used:

I. Professional, technical, and managerial

II. Craftsmen and foremen (skilled manual workers)

III. Clerical, sales, and service

IV. Operatives (semiskilled)

V. Laborers (unskilled)

From these classifications several ratios of skill indexes were formulated:

A = classes I and II/classes IV and V

B = class I/classes IV and V

C = class II/classes IV and V

The occupational index is a fundamental tool of the human skills approach which measures the skill intensity of an industry. Although several specific indexes have been employed, the common objective has been to devise a measure of the ratio of skilled to unskilled workers. The index was used to reveal the factor intensity of an aggregate trade flow.

The rankings of nine leading industrialized countries according to indexes A, B, and C computed from 1957 export and import flows of manufactured goods were very similar.[5] Keesing found that the export rankings were approximately the inverse of the import rankings. The ratio of .8170 (skill ratio represents direct requirements for classes I and II skills divided by direct requirements for classes IV and V) was the U.S. requirement for the production of manufactured exports for 1957, which ranked the highest. The lowest ranking was Japan (.3129). As far as the direct skill ratios for imports are concerned, Keesing found that for the United States the ratio was .4740 and for Japan .8372.

Excluding the most unskilled labor-intensive industries in the United States and the most skilled intensive ones in Japan, the skill ratio for exports became .8125 and .6634, respectively, and the skill ratio for imports was .6726 for the U.S. and .8973 for Japan. Interyear comparisons showed great stability in these patterns, although there was an upward trend over time (1954-1957) in the skill intensity of the goods traded by the United States, France, West Germany, and the United Kingdom. Thus, Keesing's study showed that labor skills influence the pattern of international trade in industrial goods.

Baldwin used estimates of education costs for various skill levels as a proxy for human capital. He applied the H-O model to the United States using 1962 trade data and 1958 capital, labor, and intermediate input data. In testing the relationship between relative factor supplies and the factor content of trade, Baldwin argues that given a particular equilibrium pattern of trade, it is necessary to include both the direct and indirect labor and capital involved in producing exports and imports in order to determine a country's net trade balance in factor services via trade in commodities.

The educational breakdown showed that the proportions of individuals with 9-12 years of education, and especially with 13 or more years, are higher in export than in import-competing production, whereas the share of those with only 0-8 years of education is higher on the import side. Baldwin's study also showed that there is a significant positive relationship between the percentage of engineers and scientists, craftsmen, and farmers in an industry and the net world export surplus of the industry.

The human capital approach begins from the proposition that labor essentially is homogeneous. From that beginning, empirical studies set out to measure the extent to which an industry's labor force embodies human capital over and above a specified base level. Generally, this is measured as the excess of the industry wage over a selected base wage. Kravis had found that hourly wages in 330 U.S. manufacturing industries in 1947 were higher the greater the ratio of exports to domestic production and, conversely, were lower the greater the ratio of imports to domestic production. The difference in average hourly wages was 15 percent in 46 leading export industries compared with 36 leading import-competing industries (weighted by the amount of trade in 1947 in each case). Subsequent research inspired by Kravis's paper and Leontief's findings suggests that both phenomena--high wages and relative labor intensity in U.S. export industries--have a single cause: the substantial use of skill in U.S. export industries or, as Kenen put it, the intensive use of human capital.

Helen Waehrer reproduced Kravis's work in 1960 and tested it for significance. She found that 22 major export industries paid a yearly wage of $5,649, while an equal number of import competitors paid only $4,932. Furthermore, there was a statistically significant relationship between an industry's trade balance, B, and its yearly wage, W. Taking all major trading industries together:

$$B = -18.48 + .003W \qquad r = .43.$$

Waehrer tried to find out why this is so and generated two more significant regressions that shed new light on Kravis's work. Constructing an occupational index, I, to measure the fraction of each industry's labor force employed in jobs that call for skill, she showed that:

$$B = 16.15 + .31I \qquad r = .50,$$

while

$$W = 1923.4 + 67.89I \qquad r = .86.$$

An industry's skill mix, I, gave a somewhat better statistical account of its trade balance than did its yearly wage, and its skill mix went a long way to explain its wage rate. In Waehrer's view, Kravis's findings represent the role of skills in structuring U.S. foreign trade, with wage rates (strongly linked to skills) serving as a proxy for skill intensity.

Kenen has also performed the interesting experiment on U.S data of capitalizing the excess of wages earned by various types of skilled labor above the wages of unskilled laborers in order to obtain an estimate of value of human capital involved in export-import competing production.

The wage-differential school has focused on single nation import-export trading patterns, while Keesing has examined the trade of several nations. Both have achieved plausible results. U.S. exports require more skills than U.S. imports, whether skill is measured by wage differentials or occupational categories. The same is true of West German trade.

Hufbauer compared the 1958 wage rankings for 13 industry groups in

23 countries. He also concluded that U.S. exports require more skilled labor than U.S. imports, whether skill is measured by wage differential or occupational categories. He finds that both approaches yield good results, and the Waehrer-Kenen-Yudin version gave particularly high coefficients. When professional labor force percentages are matched with skill ratios in trade, the Spearman correlation is .695, and the weighted correlation is .822. When the match is with wage rates, the correlations are .784 and .960, respectively. Therefore, most of these empirical studies support the human skills theory as an explanation of the pattern of international trade.

Hufbauer concludes that "since skill-intensive commodities overlap with capital-intensive commodities, while the acquisition of human skills and physical capital both involve acts of saving, there is no reason not to join forces by combining human skills and physical capital into a single measure of man-made resources." Indeed, Bhagwati and Kenen have advocated this approach on a theoretical plane, it is used in the empirical work of some other authors, and Lary has put it to use in examining the export prospects of developing countries.

The human capital explanation of the pattern of U.S. trade has been used to rescue the two-factor H-O hypothesis. Kenen presented an integrated treatment of both human and physical capital in a theoretical model of international trade. He concluded his article with a brief empirical application to factor proportions in U.S. foreign trade in relation to the Leontief Paradox. Following the Leontief supposition concerning U.S. foreign trade--that U.S. labor is more efficient than foreign labor--Kenen argues that skills reflect investment in people, and when we take this into account, perspectives change considerably.

Kenen assumes as a limiting case that skill differences are wholly due to the quantity of capital invested in the labor force and that the wage differences ascribed to skill represent the gross return on that capital. Following these two assumptions, Kenen computed the quantity of capital required to convert a man-year of crude labor into a man-year of skill. He then used the percentages furnished by Leontief to compute the capital embodied in a typical man-year of labor used in U.S. exports and U.S. import-competing production. Using a discount rate of 9 percent to compute the amount of human capital, Kenen found that U.S. net exports were capital intensive after all.[6]

Most studies mentioned above point to the importance of a third factor of production in explaining U.S. trade patterns. If the productivity of U.S. workers is due to a relatively large endowment of physical capital, then U.S. net exports should, by the factor proportion theory, be capital intensive. But if there is a third factor involved, namely, human capital, then a relatively high endowment of human capital relative to physical capital could explain the empirical results obtained by Leontief, Kravis, and others within a three-factor H-O model.

The clearest conclusion to be drawn from the studies by Kenen (1968), Hufbauer (1970), and Baldwin (1971) is that it is necessary to discard simple, double factor (or single-factor-ratio) (for example, capital per worker) trade theories in favor of multi factor trade models. In particular, the labor force must be separated into various skill categories and the notion of relative differences in human capital taken into account. yet, thus far few empirical studies have explicitly incorporated measures of physical capital (K), human capital (H), and labor (L) in an explanation of trade patterns.

Branson and Monoyios (1977) argue that it is inappropriate on several grounds to combine physical and human cpaital into one factor in trade models. First, it eliminates the possibility of detecting a positive correlation of net exports with human capital inputs and a negative correlation with physical capital inputs, if such exists in the data. Second, it seems unlikely that the two types of capital are close substitutes in production, which is the condition for such aggregation in production models. Finally, economists who investigate the role of human capital in production more frequently combine it with labor as an "effective labor" adjustment.[7]

In a cross-sectional study of manufactured goods Branson and Monoyios (1977) addressed two questions. What is the correlation between U.S. net exports (NX) and inputs of physical capital (K), human capital (H), and labor (L) in their production? Is skill or the discounted wage measure of human capital more significant in explaining variations in net exports?

Their conclusion was that human capital has a significantly positive effect on NX, reflecting the abundance of human capital in the United States; the labor effect is significantly negative, indicating the relative scarcity of unskilled labor; and physical capital is negative but only marginally significant in explaining net exports across commodities. These results would still hold even after "scaling" the data to industry size to reduce heteroscedasticity. They could not find any strong reason for preferring the discounted wage-differential approach to the skill-class method for measuring human capital.

(B) Scale Economies

It is often argued that (as suggested by Ohlin himself) the assumption of constant returns to scale in the H-O model is not realistic. The scale economy hypothesis is advanced to deal with this argument. It suggests that a large nation, because of an assured home market, will specialize in goods produced under increasing returns to plant size. Although it is presumed that large industries are usually the property of large nations, a small country occasionally might develop a scale economy industry, relying on export sales to justify production. But geographic, psychological, and tariff barriers restrict that possibility. With specialized production of scale economy goods come at least two advantages, easier productivity gains and greater market size.

A possible exception to the scale economy hypothesis is trade in homogeneous products. According to Jacques Dreze, industry size is not the key to scale economies in foreign trade. Small countries are handicapped when exporting commodities characterized by "brand" differences between markets. Yet, goods manufactured to international standards are susceptible to competition from small countries. With such items, small nations like Belgium can enjoy long enough production runs to reap the full benefit of scale economies and sell much of the output abroad.

Of the several possible versions of the scale economy hypothesis, we are concerned with scale economies internal to the plant. When scale economies are present, large plant size confers a comparative cost advantage to producers.

The scale economy theory has been tested by measuring "scale" as the proportion of an industry's employees working in establishments with 250 or more employees (Baldwin). This variable was insignificant in determining the commodity composition of U.S. trade when net export was used as the dependent variable in regressions estimated across industries. The coefficient of the scale variable was negative for U.S. trade with the world, and it was significantly negative for U.S. trade with Western Europe and Japan. The scale hypothesis was weakly confirmed by U.S. trade patterns with Canada and the less developed countries (LDCs); both coefficients were positive but insignificant. These conclusions indicate either that scale economy is not a determinant of U.S. trade patterns or that size alone is not a sufficient proxy for scale economies.

Another measure of internal economies of scale in an industry has been suggested by Hufbauer. It is calculated by relating the value added per employee to the number of employees across size classes of establishments within three-digit SITC categories. For each SITC category Hufbauer estimated the equation

$$V_i = kn_i^s ,$$

Where V_i represents the ratio between value added per employee in establishment i and the average value added per man in the SITC category; n_i is the number of employees in establishment i; k is constant, and s is the scale economy measure for production of that SITC commodity (scale elasticity parameter). An s value of .08, for example, indicates that a doubling of plant size increases output per man by roughly 8 percent.

Hufbauer tested the scale hypothesis in isolation using scale elasticity parameters by relating the scale embodied in a nation's manufactured exports to the size of national manufacturing output measuring national economic size.

On a simple correlation basis, the correspondence among 24 nations between manufacturing output and export scale economies was not significantly different from zero (only .427), whereas the simple correlation between GDP per capita and export scale economies was .809. Apparently, the benefits of scale economy are not distributed exclusively according to national economic size, but with some regard to economic sophistication. Small, rich countries, mainly those in Europe which have ready access to large markets, sometimes export scale economy products, whereas bigger, poor countries rarely specialize in these goods. This phenomenon could partly reflect the connection between scale economies and skilled labor. At any rate, the exports of Mexico and India show fewer scale economies than sheer size would warrant, while Denmark, the Netherlands, and Sweden specialize more in scale economy goods than may be expected on the basis of their manufacturing output alone.

Branson and Junz used the scale elasticity parameter in regressions estimated across three-digit SITC manufacturing industries. Human capital, physical capital, and a measure of technological intensity were also employed as independent variables. The coefficient of the scale elasticity parameter was positive and significant, thereby explaining 1964 and 1967 U.S. net exports. Branson, in a subsequent study, scaled the dependent variable, using $\frac{X}{X+M}$ across industries. The coefficient of the scale elasticity parameter was no longer significant, although it remained positive.

Weiser and Jay (1972) used the U.S. share of developed countries' exports as the dependent variable and estimated regressions across U.S. industries. The coefficient of the scale economy measure was positive and significant (at the one percent level). This indicated that scale economies were a determinant of the commodity composition of U.S. trade in 1960 and 1967.

Using the scale elasticity parameter in a different context, Homi Katrak has suggested that whenever

$$\left[\frac{N_i^a}{N_i^b}\right]^{s_i} > \left[\frac{N_j^a}{N_j^b}\right]^{s_j},$$

country a's exports of commodity i will be relatively greater than country b's. In this equation, N_i^a is the level of employment in the i^{th} industry for country a, and s_i is the scale elasticity parameter of the i^{th} industry. A multiple regression of U.S./U.K. exports on scale effects showed very significant positive results. This supports Katrak's contention that, whereas the combined influence of industry size and scale elasticities as captured in the scale effects provides a significant explanation of relative exports, neither industry size nor scale elasticities per se seem to have much influence, since the regressions done separately on them did not show significant results. Rank correlations between 1962 U.S./U.K. exports to the world and the relative scale effect produced a correlation coefficient of .59 for 17 manufacturing industries and .76 for 14 manufacturing industries. Both results are significant at the 5 percent level.

The most general conclusion based upon the empirical evidence is that size or relative size of industries is not a sufficient criterion by which to measure scale economies. It is essential to measure the scale intensity of industries. If the scale elasticity parameter is employed, it must be used in conjunction with a measurement of relative plant size. When tests are performed in the aggregate form (such as Hufbauer's), market size may serve as a proxy for plant size due to the empirical relationship between the two measures.

(C) Technological Advance and the R&D Oriented Industries

Some theorists maintain that a sequence of innovation and imitation underlies patterns of trade. Early producers enjoy easy access to foreign markets, while later producers must rely on some factor cost advantage to secure a share in foreign sales. The theory argues that the ability to become the early producer depends on the acquisition of superior technical and managerial skills, creating a technological gap. The key ingredient in creating the gap is expenditure on research and development.

Keesing (1968), Vernon, Gruber, and others have pointed to the significance of reserach activities in explaining trade patterns. In particular, they found a strong positive correlation between the relative importance of R&D activities in U.S. industries and U.S. exports as a proportion of total exports of all the major trading countries. These results confirmed the hypothesis that R&D expenditures are a proxy for temporary comparative-cost advantages provided by the development of new products and productive methods.

Using the U.S. data for 1962, Gruber, Mehta, and Vernon, in their empirical testing of the theory, showed that the five industries with the most research effort accounted for 72 percent of U.S. exports of manufactured goods. The same five industries were also responsible for 89.4 percent of the nation's total R&D expenditures, while fourteen industries with lower R&D efforts exhibited positive net imports. The Spearman coefficient also showed a strong relation between research efforts and exports in the same five industries. Similar results were obtained for the export profiles of the United Kingdom and Germany. This indicates that the latter countries are also ranked at the top of the advanced country list, with relatively high incomes and a relatively strong emphasis on industrial innovation and product development. Hence their export strength is derived from the same characteristics as those that influence U.S. export performance. Their export performance differs from that of the other OECD countries in the same way that U.S. export performance differs from that of the OECD countries (due to the differences in the structure of innovational habits).

The Gruber study indicates that intensity of the R&D effort is greatest in industries in which the degree of employment concentration is high and in industries in which large firms are particularly dominant.[8]

Using 1962 U.S. data, Baldwin concluded that R&D activities are much more important in export output than in import-competing goods. The ratio of R&D expenditures involved in producing a representative bundle of import-competing versus export commodities was .66.

The Keesing (1967) finding of the relationship of R&D expenditures as a percentage of value added, to net exports by industry, could supplement both the human capital and product cycle hypotheses: A firm with a high R&D ratio probably employs more than the average number of scientists and technicians, who in turn are paid wages above the average. Thus, research-intensive industries would be human-capital-intensive industries as well.

If these expenditures are only a proxy for human capital, then the R&D explanation would basically be the same as the skill ratio case. The inclusion of an R&D measure along with human capital in a regression equation explaining net exports should not significantly improve the explanation.

But research expenditures also fit into the product cycle hypothesis. Presumably, the production of new consumer and capital goods involves, on the average, a greater R&D ratio than does the production of mature, standardized goods. If the product cycle hypothesis is correct, then production of goods in which the United States has a trade surplus should involve higher research ratios than does production of goods with net trade deficits.

(D) Product Cycle

Vernon argues that successive states of standarization characterize the product cycle. Based on this theory, nations with highly sophisticated economies are expected to export nonstandardized goods, whereas less sophisticated countries specialize in more standardized goods.

According to Vernon, who postulated this hypothesis, manufacturing processes for new products are highly experimental at first. The early producer enjoys a certain amount of monopoly power, so cost is not as important a criterion as proximity to the market in deciding location. The U.S. market consists of consumers with the highest average incomes in the world and is further characterized by high unit labor costs. Thus, the opportunity to market a new product which conserves labor would be fir4st apparent to U.S. enterpreneurs. Production will be located close to the market. As a new product is introduced in the United States, some demand for it appears abroad. As this demand expands and the product becomes standardized, cost considerations cause the shift of production facilities to foreign locations.

The preceeding discussion implies that an advanced country's exports of high income products should grow faster than its exports of low income products. In an empirical test of the product cycle model, Wells used the income elasticity of ownership and the percentage of households owning durable goods ("saturation") as a measure of the income nature of goods. Wells estimated the income elasticity of ownership for twenty durable goods and the percentage of households owning the durable goods using the U.S. Starch[9] Consumer Survey for 1961. He also extended his survey to compare the U.S. data with U.K. and E.E.C. (6) data. Comparable figures of saturation (percentage of households owning durable products) for a number of products in the United Kingdom, United States, and the Common Market showed a striking similarity in ranking, with a coefficient of concordance of .91. In addition, the results of correlation tests confirmed the hypothesis. The correlation between the income nature of the product and U.S. export performance was strong. The equation $R = a + bE$, where

R = ratio of 1962-1963 average exports by value to 1952-1953 average exports, and

E = income elasticity of ownership,

was fitted across industries, and good results were obtained for the income elasticity of ownership as the predictor of export performance (80 percent of the variance in the data was explained). Wells then translated the number of plants producing a product into an index of dispersion, and the index was plotted against the same export ratios. The resulting scatter diagram indicated that export performance was better for products where the index of dispersion was low--where scale economies are exhausted only with large plant size.

Apparently, the product cycle and the technological gap hypotheses belong to the same family. Both emphasize the sequential development of production history. But while technological gap emphasizes time, product cycle stresses the transition from product differentiation to product standardization.

A test of the theory must relate the degree of standardization of a nation's exports to the level of its industrial sophistication. In view of the support for the product cycle theory provided by several industry studies[10] and by Hufbauer's (1970) multicountry test, it is surprising that large-scale studies of the overall U.S. comparative advantage have not found variables representative of this theory to have significant explanatory power.

Hufbauer estimated three-digit SITC product differentiation coefficients using 1965 export data to test the product cycle hypothesis. Product differentiation is measured as the coefficient of variation in unit values of 1965 U.S. exports destined to different countries, that is, product differentiation $= \frac{U_n}{V_n}$, where U_n is the standard deviation of U.S. export unit values for shipments of commodity n to different countries, and V_n is the unweighted mean of these unit values. This measure, which compares the homogeneity of a great many commodities at a given moment, assumes that standardized products imply standardized processes. If a product is standardized, presumably the unit values of different shipments will be similar. The rank correlation between first trade dates and product differentiation was not higher than .169.[11] When new but highly standardized goods were excluded, the rank correlation between product age and standardization improved to about .500. It should be noted that over the product cycle any given commodity may become more standardized, but, because of differences at birth, an exact correspondence between product age and product standardization may never exist. In that case, the success of this coefficient used by Hufbauer would effect the arguments made by Dreze. He claimed that small and less developed countries would concentrate on internationally standardized goods, since these nations cannot produce differentiated products in the long run. With these possible explanations in mind, Hufbauer tried to find the role that differentiation has as an explanatory characteristic. He assumed that Gross Domestic Product per capita (GDP/capita) is the national attribute that determines differentiation in exports. The rank correlation coefficient (Spearman correlation) was found to be .724 between this attribute and trade characteristics among 24 countries using 1965 data. His study implies that scale economy is a better determinant of foreign trade and is the standardization of products in the product cycle model.

(E) Imperfect Competition and the Pattern of Trade

In addition to the trade theories mentioned earlier, there is the phenomenon of intraindustry trade. A good deal of trade, especially among the industrialized countries, seems to take place within industries rather than between them. That is, it is quite normal to find countries both exporting and importing goods from the same classification, and very often this "intraindustry trade" accounts for a substantial fraction of the total. This was noted by Balassa (1966) and Grubel (1967) and has led to a huge literature attempting further to document and explain such trade.

It is generally agreed that explaining the existence of this intraindustry or two-way trade requires some modification to the conventional theoretical framework, but there is disagreement over the extent of modification necessary. Finger (1975), for example, suggests that measured intraindustry trade may be largely a result of factor proportions varying more within than across "industries" as defined by established data categories. Thus, while the actual trade pattern may be quite adequately explained in the traditional manner (via factor endowment differences), spurious intraindustry trade may emerge as a result of inappropriate statistical aggregation. Gray (1976) argues that the presence of two-way trade in such volume "is prima facie evidence of the inadequacy of the orthodox body of theory to provide a realistic framework for analysis of modern patterns of international trade."[12] He suggests that such a framework must involve economies of scale and/or product differentiation, particularly the latter. Unfortunately, the alternative structure Gray chooses to develop contains so many complexities (taste differences, marketing and transport costs, administered prices) from which the standard theory seeks to abstract that he is forced to take as given many features one would ideally like to explain, and comparison with the standard framework is made very difficult.

Grubel and Lloyd (1975) explain the possibility of intraindustry trade in homogeneous products through seasonal and peak-load demand and supply differences across countries, as well as entrepot trade. Trade in differentiated products, although largely determined by the standard considerations (comparative costs, and so forth), might easily be of the intraindustry variety if product and national characteristics are closely related. Each country would then tend to produce and export its own particular variety of each product and import others.

Those who seek to explain intraindustry trade tend to argue that it usually exists in a monopolistic competition type of market structure in which the manufacturing sector is characterized by product differentiated groups which cater to the diversity of consumer preferences. This intraindustry trade covers the exchange of goods within each product class but not the exchange of totally identical goods. Furthermore, it is also characterized by economies of scale, which are internal to the firm and which give rise to trade and to gains from trade even when there are no international differences in tastes, technology, or factor endowments. In fact, trade of this nature is more common among similar economies, and the volume may be much higher than that based on comparative advantage.

The interest in the effects of product differentiation, economies of scale, and monopolistic competition on international trade has existed for many years. Nevertheless, traditional theories have not been extended to incorporate these elements. With the recent growth of formal models of industrial organization, the need to integrate these with theories of international trade has been recognized. Very recently a handful of works have appeared dealing with economies of scale and imperfect competition and seeking to develop other theories to supplement, if not replace, the traditional models.

Two studies by Krugman (1979) and Lancaster (1980), who used a one-sector model, began the new literature on the effects of product differentiation, monopolistic competition, and economies of scale on international trade. Krugman has developed a simple, general equilibrium model of noncomparative advantage trade. He has adopted a Chamberlinian approach to the analysis of trade under conditions of increasing returns to scale.[13] It shows that trade need not be a result of international differences in technology or factor endowments, instead, product differentiation allows for intraindustry trade. Krugman also implies that there are gains from trade (from consuming more varieties of commodities) even between countries identical in factor endowments, technology, and consumer preferences.

Lancaster applies the analysis of perfect monopolistic competition to the problem of intraindustry trade. He argues that the kind of market structure generated within an industrialized economy will result in a great amount of intraindustry trade within product classes; such trade will even take place within economies absolutely identical in all respects and can persist under conditions of comparative advantage.

Lancaster argues that a market structure similar to traditional monopolistic competition is the most competitive structure possible when the number and design of goods are equilibrium variables and not specified as initial data. Thus, perfect monoplistic competition is the most relevant form of competition in the analysis of modern high technology economies. He goes on to say: "Traditional trade theory is irrelevant to such economies since perfect competition throughout the economy is an impossible market structure under conditions of diverse preferences and infinitely variable product specifications."[14]

Dixit and Norman present three models of imperfect competition. In the first they consider a Cournot model with entry, in which it is shown that trade leads to greater equilibrium number of firms (and hence more competition) and to an increase in welfare. In the second model they examine the effect of trade on product selection in a monopoly model. Their third model, which seems to be the richest of the three, incorporates product differentiation and intraindustry trade, as in Krugman's work. An economy is divided into a competitive and a monopolistically competitive sector, and then equilibrium in a trading world economy is characterized. Their two main conclusions are as follows. First, the factor-abundance hypothesis (the H-O theorem) explains the pattern of interindustry trade; second, regarding intraindustry trade, a smaller country has comparative advantage in the production of differentiated goods, which are produced in the monopolistically competitive sector.

Helpman (1981) provided an integration of the Heckscher-Ohlin approach to product differentiation, economies of scale, and monopolistic competition. He uses the H-O model to explain intersectoral trade and Chamberlin's monopolistic competition to explain intraindustry trade. Helpman suggests that under monopolistic competition, the pattern of intersectoral trade can be derived from factor endowments even when the production function is not homothetic and consumer spend fixed budget shares on each good (Cobb-Douglas utility functions). In addition, a redistribution of factor endowments which enlarges the difference in capital-labor ratios available in each country reduces the intensity of intra-industry trade such that the volume of trade is not related monotonically to differences in factor-use ratios, unless the country sizes are constant. He posits that in a cross-sectional comparison, the intensity of intraindustry trade is negatively correlated with the absolute difference in incomes per capita. This position has some common points with the preference similarity theory (Linder model), but in this case it is restricted to intraindustry trade and stems from supply considerations, whereas the preference similarity theory is related to demand. A recent study by Loestscher and Wolter tends to support this hypothesis. In the case of a time series comparison, Helpman proposes that the share of intraindustry trade in world trade is negatively correlated with the dispersion of the countries' income per capita, but this has not yet been tested empirically.

Finally, Ethier emphasizes trade in manufactured goods involving intermediate products when both external and internal economies are present. An economy is assumed to consist of two sectors: one producing intermediate and manufactured products subject to the above conditions, and the other producing a pure consumer goods (wheat) under perfectly competitive conditions and constant returns to scale. Ethier then examines a series of theoretical questions. One result of particular importance is that the factor abundance hypothesis does explain the pattern of trade between manufactured goods and a pure consumer good.

Summary

To summarize these contributions, one could conclude that they are all concerned with endogenous market structures, meaning that the number of firms in a sector is endogenous. This is why the term "monopolistic competition" has often been used.

These models are too new to have been tested empirically. In more general terms, however, there has been some empirical work on the interaction between imperfect competition and international trade, and this has been ably reviewed by Jacquemin (1982). He notes that there is empirical support for two propositions: that trade reduces monopolistic distortions, and that trade permits expansion of outputs and lowered costs through economies of scale. Jacquemin notes that both theory and empirical evidence give mixed results as to whether trade, through intraindustry trade, makes a greater variety of products available to consumers.

On the latter point, Caves (1981) has made the interesting observation that product differentiation does not necessarily lead to greater intraindustry trade. On the one hand, if product differentiation is inherent in an industry due to the complexity of the characteristics of its product, then this should stimulate intraindustry trade as firms in different countries can specialize in products with different combinations of characteristics. On the other hand, if product differentiation has a strong informational component, requiring substantial advertising by the firm in order to inform customers of its product's uniqueness, then language and cultural barriers to advertising in a foreign country may make product differentiation a hindrance to intraindustry trade. But it is only the first of these aspects of product differentiation that operates in the theoretical models of Lancaster, Krugman, and others.

CHAPTER THREE

FACTORS UNDERLYING U.S. COMPARATIVE ADVANTAGE: A MULTIPLE REGRESSION ANALYSIS

3.1 A Multifactor Proportions Model

Since the "Leontief Paradox" (1953), there have been many empirical studies based on what is often called the neofactor proportions theory of international trade. In addition to capital and labor, the two traditional factors in the Heckscher-Ohlin theorem, these studies introduce other factors such as human cpaital and sometimes technology. Almost all of them conclude that a straightforward application of a two-factor (capital and labor) model along Heckscher-Ohlin lines is inadequate for understanding the pattern of U.S. trade, and that it is necessary to discard the simpler theories in favor of multifactor trade models. This chapter examines the implications of a modified multifactor proportions model by measuring the simultaneous effect of a variety of factor intensities on the comparative advantage of all U.S. manufacturing, classified by the Standard International Trade Classifications (SITC) and disaggregated to the three-digit STIC level.

We begin with a variant of the Heckscher-Ohlin model involving three direct factor inputs. Our hypothesis states that the comparative cost between two countries is determined by the effects of differences in factor intensities among commodities.

(a) Standard Assumptions

Following tradition we shall assume (1) identical production functions among countries, linearly homogeneous in factors of production, (2) perfect competition in factor markets for both buyers and sellers, and (3) no factor intensity reversal. The last assumption needs to be extended to the multifactor case. Assuming no factor intensity reversal for a two-factor case means that the relative magnitude of factor input ratio, K/L, does not change between any pair of commodities for any wage-rent ratio. A natural extension of this assumption to a multifactor case would be that the relative magnitude of every factor input ratio does not change among any pair of commodities for all sets of factor prices. For a three-factor case with physical capital (K), labor (L), human capital (H), and their factor prices--rental rate of capital (r), wage (w), and return to human capital (i)--the assumption means that the relative magnitude of K/L, H/L, or K/H does not change between any two commodities for all factor price combinations.

(b) Direct vs. Total Factor Requirements

In addition to the standard assumptions, we assume that this model applies across all industries and that indirect inputs can be ignored. In empirical tests of the factor proportions hypothesis, sometimes direct and sometimes total (direct plus indirect via intermediate inputs) factor intensities are used. Investigators have disagreed about using only direct inputs or direct as well as indirect (total) input-output coefficients. At one level the issue seems to depend on the empirical question of whether inputs are tradable. Obviously, factors needed to produce a nontraded input should be accounted for in assessing the potential for trade in a commodity, since the costs of these factors will have to be passed through. For inputs available as imports this does not seem necessary.

Some authors contend that indirect capital and labor inputs also should be included namely those used in producing the intermediate inputs and material used in the manufacture of final goods. They argue that direct factor requirements include only first-stage materials inputs and those specific to the final stage of fabrication. Ignoring the inputs into inputs process implies that the total factor content of a product is not adequately measured, regardless of the location of the supplies of that input.

In their application of a factor proportions (two-country, n-good, n-factor) model, Hamilton and Svensson (1982) conclude that whether or not there is specialiazation in production, if all goods are traded, including the intermediate inputs, direct factor intensities are relevant for explaining the allocation of gross production among countries; total factor intensities are relevant for explaining net trade flows in commodities. Deardorff (1982) also states that total factor intensities are appropriate determinants of trade patterns on the grounds that they determine the autarky prices.

There are those who argue that since, in various manufacturing industries, the intermediate inputs needed are traded on the world market, the use of direct factor intensities is more appropriate. In all such items competition takes place in the world's commodity markets, and countries which do not produce the materials can import them. Lary (1968) maintains that direct factor intensities are relevant both for the location of production and for the explanation of trade flows under the assumption that all intermediate inputs in production are traded on the world market. "To include indirect factor inputs in these cases (when intermediate inputs needed are really transportable internationally) fits ill with the very purpose of explaining international specialization and trade."[1]

Others, including Baldwin, agree that Lary's approach is appropriate for such exercises as predicting the detailed nature of a country's trade pattern, given its factor endowment and a set of international commodity prices. The more appropriate procedure would therefore be to count only direct inputs into manufacturing.[2] This is employed in the present study.

(c) <u>The Model</u>

Our initial model is as follows:

$$NX_{it} = f(K_{it}, H_{it}, L_{it}) \quad , \tag{1}$$

where NX_{it} is net exports (the difference between exports and imports, $NX_{it} = X_{it} - M_{it}$) of the ith three-digit Standard International Trade Classifications (STIC) commodity group in categories 5-8 at time t, and K_{it}, H_{it}, and L_{it} are direct production inputs of physical capital, human capital, and labor, respectively. In a subsequent model, scale economy (S) is included as an additional explanatory variable. The choice of the dependent variable is important because it is this variable which the theory under consideration purports to explain. If the variable is a poor measure of comparative advantage, then the test of the theory is not valid. We have to choose a dependent variable which would reflect the export and import performances of industries along with their comparative cost position.

From a theoretical standpoint, net exports is the proper variable by which to measure comparative advantage for a factor proportions test. It appears that at any level of statistical disaggregation most commodities are subject to two-way trade. The notion of comparative advantage thus becomes the proposition that a country should be a net exporter of goods in which it has a comparative advantage--whether derived from resource endowment, technological advantage, or education embodied in human capital--and a net importer of goods in which it is at a disadvantage.[3] Thus it is appropriate to focus on net exports by commodity group in an analysis of U.S. comparative advantage and trade. The net exports variable subtracts out imports and focuses on the net flow of goods. Other things being equal, when comparative cost is the only determinant of commodity trade, the smaller an industry's comparative cost, the greater its exports and the smaller its imports. Therefore, it is appropriate to select net exports (NX_i) as our dependent variable. The independent variables will be defined in detail in the next section.

3.2 Estimating Equations

The two basic estimating equations are of the form[4]

$$NX_i = b_0+b_1K_i+b_2H_i+b_3L_i+U_i \ , \qquad (2)$$

$$NX_i = b_0+b_1K_i+b_2H_i+b_3L_i+b_4S_i+U_i \quad . \tag{3}$$

Equation (2) is employed for estimating the initial model with three direct factor inputs, and equation (3) is used when a measure of scale economies is included as an explanatory variable. The independent variables entered in the multiple regressions measure four main economic characteristics (to be defined below): physical capital intensity, human capital intensity, labor (unskilled) intensity, and scale economy intensity.

Although attempts have been made to determine the commodity composition of U.S. foreign trade in manufacturing, this study has the following distinctive features:

(1) inclusion of scale economy as an explanatory variable;

(2) disaggregation of total U.S. trade data into bilateral trade with six economically distinctive countries or regions, and

(3) examination of possible structural changes in U.S. trade with different regions of the world over eighteen years (1963-1980).

In addition to our initial three direct factors (physical capital, human capital, and labor), a measure of economies of scale in production within industries is tested for significance in explaining the pattern of U.S. trade. According to the scale economy thesis because of an assured home market a large nation will specialize in goods produced with increasing returns to industry size. Specifically, industries capable of achieving high increases in value added per worker as the size of the firm increases should give countries with a large domestic market, like the United States, a competitive export advantage over smaller countries in those industries. Therefore, U.S. industries with high values for scale should have large export shares.

In addition to determining the commodity composition of U.S. trade with all countries, this study examines the factors influencing U.S. comparative advantage in bilateral trade with individual countries or country groupings. This approach not only would indicate the position of the United States with respect to its trading partners but also would suggest how its position can be more effectively maintained or enhanced. To make the study as comprehensive as possible and to update Baldwin's 1971 research, I have disaggregated the data and tested the factor proportions model with respect to U.S. trade vis-a'-vis the developed countries of Western Europe (DCs), Japan, and Canada, and the less developed countries (LDCs). The latter are divided into two groups, the new industrial countries (NICs) and the rest of the LDCs.[5] This division seems reasonable because in 1975 more than 77 percent of manufacturing exports from developing to developed countries originated in eleven semi-industrial LDCs.[6] European countries also are divided into two groups. The first includes Switzerland, Sweden, Denmark, West Germany, Norway, and Belgium-Luxemburg, all of which have income per capita equal to or higher than that of the United States.[7] The second group includes Italy, the United Kingdom, Finland, Austria, France, and the Netherlands, whose per capita GNP is lower than that of the United States.[8] Among the first group, using 1978 data, Switzerland has the highest GNP per capita ($12,100) and Belgium the lowest ($9090). In the second group Italy has the lowest GNP per capita ($3,850) and the Netherlands the highest ($8,410).

Finally, as mentioned earlier, most previous studies have focused on the determinants of trade in a given year. Our goal is to obtain cross sections for several years (1963, 1967, 1977, and 1980) and to analyze the structural determinants of U.S. trade with different world regions at different times and for a long enough period to detect what changes, if any, might have occurred, especially since the introduction of generalized floating exchange rates.

The choice of years was determined by the availability of data. In essence, census years were selected. The study begins with 1963 three years prior to the appearance of excess demand and inflation in the United States. While the conclusions concerning the trends in U.S. trade advantage are not changed in any fundmental way by adjusting for the effects of aggregate demand associated with the Vietnam War, it seems useful to focus on a year that does not suffer from this qualification. More important, there is a full set of data on production characteristics by SITC three-digit categories for the mid-1960s, developed by Hufbauer. The last year for which trade data are available is 1980.

3.3 Definition of Variables and Data Sources

This section describes the data necessary for testing the hypothesis concerning the basis of comparative cost. Two sets are needed: (1) trade data for the dependent variable and (2) data on the production characteristics of industries for independent variables. A common basis of classification is necessary for relating the trade and production data sets. The Standard International Trade Classification (SITC) is used; it classifies manufactures into 102 product groups. The two tables in Appendix A list the industries and show the concordance between the SITC and the Standard Industrial Classification (SIC), which serves as a basis for the U.S. census containing production characteristics. The conversion from four-digit SIC to three-digit SITC groups has been accomplished by using the concordance developed by Hufbauer (Table A-I) for the years 1963 and 1967.[9] Table A-II provides the concordance between SIC and SITC groupings for 1977 and 1980 only; in 1972 SIC was revised.[10]

(a) Trade Data

Data for exports and imports for each of the four years (1963, 1967, 1977, and 1980) were obtained from OECD, Trade by Commodities, Series C, for 102 three-digit SITC commodity groups in categories 5-8.[11] Net exports are the difference between exports and imports: $NX_{it} = X_{it} - M_{it}$.

(b) Industrial Characteristics

The data on factor inputs for 1963 were originally published by Hufbauer. He compiled information on capital per workers and wages per man for each of the 102 three-digit SITC categories in 1963. Both of these are measured in 1963 dollars. He also provided the underlying data on total employment in 1963. Branson and Monoyios tried to improve and extend that data set. The data on factor inputs for 1963 and 1967 were available from Appendix A to Branson and Monoyios (1975).[12] The data on labor (L) refer to total employment in thousands. Wages (W) refer to total payroll in millions of dollars. The basic source for employment, wages, and capital expenditures is the U.S. Census of Manufactures and the Annual Survey of Manufactures. Those publications report figures by industry group rather than by commodity according to

SIC categories, requiring the use of the concordance tables (Appendix A).

Human Capital - If it is is possible to value capital accurately and if this value is reflected in earned income, then wage differentials should fully capture the effects of productivity differences in human capital per person. The presence of, say, a high proportion of scientists in an industry should make that a high wage industry, and the capitalized value of the excess of that wage rate over the wage for unskilled (uneducated) labor should measure the human capital input. That is, the wage differential should capture the contribution of human capital to production. Only if the scientists contribute something to production in excess of their wage would a "skill ratio" of scientists to total employees add to the ability of the human capital measure to explain variations in output.

Assuming that wage rates correctly reflect differences in human capital, the discounted value of the average wage above the wage of unskilled labor can be used as a measure of human capital in explaining net exports. Following Branson ahnd Monoyios, the stock of human capital is calculated as the discounted industry wage differentials:

$$H_{it} = \frac{(\overline{W}_{it} - \widetilde{W}_{t}) \cdot L_{it}}{0.10} , \qquad (4)$$

where H_{it} is the stock of human capital for group i at time t, $\overline{W}_{it}$ is the average annual wage for each industry at time t, and $\widetilde{W}_t$ is the median wage for males with eight years of education at time t.[13] This figure ($\widetilde{W}_t$) is used as a proxy for the return to unimproved labor, and anything in excess of that is assumed to be return to human capital.[14]

L_{it} is industry employment, and the discount rate used is 10 percent. The choice of the capitalization rate in this approach is not crucial, since changing it would affect only the size of the coefficient but not its sign or level of significance.[15]

Physical Capital - Two different sets of data on physical capital for 1963 exist and have been used here. The first, obtained from a rather complicated procedure by Hufbauer, involves five steps.

(1) Using Leontief's coefficients for capital per dollar of output in 1947 and multiplying them by output in the corresponding industry, Hufbauer obtained estimates of 1947 capital stock on a three-digit SIC basis. He assumed that this stock consisted of 37 percent structures and 63 percent equipment. He applied a depreciation rate of 2.5 percent and an inflation rate of 3.5 percent on a straight-line basis to structures; on the same basis he applied depreciation and inflation rates of 5 percent and 2.5 percent, respectively, to equipment to calculate the portion of 1947 capital stock in 1963.

(2) He added to that the yearly expenditures on structures without adjusting for depreciation and inflation.

(3) Hufbauer also added yearly expenditures on equipment adjusted by the factors mentioned above.

(4) Adding (1), (2), and (3) yields an estimate of 1963 physical capital on a three-digit SIC basis, which was then allocated to four-digit SIC industries by proportion of nonwage value added.

(5) he allocated the four-digit SIC figures on capital to the three-digit SITC group according to his concordance.

An alternative set of data on physical capital for 1963 and 1967 was developed by Branson and Monoyios based on gross book value, which is reported periodically in the Annual Survey of Manufactures. The gross book value series for 1963 is very highly correlated with Hufbauer's capital series ($r = .91$).[16]

In this study the measurement of physical capital is based on gross book value. To that is added rent payments during the year capitalized at the rate of 10 percent and inventories of supplies and materials. Finished goods inventories were excluded, and work in progress was initially included but finally excluded from capital stock without much difference in the final results. Gross book value, the largest component of this variable, however, has two offsetting deficiencies. On the one hand, it is based on historical cost and as such tends to understate the current value of the capital stock. On the other hand, it does not take into account accumulated depreciation, and this works in the opposite direction.

Economies of Scale - In addition to the three direct factors, a measure of scale economies in production within industries was incorporated into the regression explaining the pattern of U.S. trade. Since scale economy could not be readily observed, it had to be approximated. As previously reviewed, Hufbauer calculated a measure of scale economies for 1963. For each SITC category, we followed Hufbauer and estimated the following equation for each year:

$$V = \frac{q_i}{q} = aN_i^S , \qquad (5)$$

where

V = the ratio between value added per employee in a particular size plant and the average value-added per worker for all establishments in that industry, or equivalently, $V = \frac{q_i}{q}$;

q_i = value added per man in establishment i;

q = average value added per employee in the SITC category;

N_i = number of employees in establishment i;

S = scale economy measure for production of that SITC commodity; and

a = a constant.

The data for estimating the equation came from the 1963, 1967, and 1977 Census of Manufactures. It reports the relevant data by the employment size class of establishments. The value added and employment statistics are arranged in employment size classes for establishments ranging in size from one to four employees up to 2,500 (or more) employees. Four-digit industrial were reclassified according to the three-digit SITC prior to running the regression analysis. The regression equation which was estimated is:

$$\ln V_{ijt} = \ln a_{jt} + S \ln N_{ijt} + U_{ijt} , \qquad (6)$$

where U_{ijt} is the error term.

This equation was estimated across establishment class sizes, i, for each three-digit SITC commodity group, j, for the given time, t. These estimates include negative values for diseconomies of scale and positive values for economies of scale. Use of the scale elasticity parameters implies that increases in value added per worker due to increased plant size are passed on in the form of lower prices. However, it is possible that other factors not accounted for in (6) affect output per worker; therefore, the estimates of the scale elasticity parameter (S) may have a bias because of systematic relationships between plant size and one or more of the following factors.[17]

(1) Product Type - Different plants within a given four-digit industry may produce different products. If products requiring much skilled labor and physical capital are manufactured by large plants, then S is biased upward (this coefficient would exaggerate the extent of scale economies); in the opposite case, the S coefficients would understate the extent of scale economies.

(2) Quantity and Quality of Human and Physical Capital - Among factories making the same product, different qualities of labor and different amounts of machinery per man may be systematically associated with plant size. Therefore, part of the statistically estimated scale economies may reflect the use of highly skilled labor as plant size gets larger. Another part may reflect increasing capital intensity with size.

(3) Technology - If larger plants also happen to be newer plants, the scale elasticity parameter (S) would then reflect improved technology as well as larger size, and therefore overstate the measured scale effect.

(4) Monopoly Powers - Since market power usually accompanies size, the coefficient S could also reflect an element of monopoly profit.

However, when compared to estimations based on engineering data (an alternative method), the values of scale parameter S are somewhat low.[18] According to this more common approach, the measurement of scale economies is in terms of "plant factors" and "labor factors." These "factors" are exponential expressions of the relationship either between inputs and output or between inputs and capacity. The typical labor factor formulation is:

$$n - kQ^z, \quad 0 < z < 1 , \qquad (7)$$

where n is the number of workers, Q is the physical output or capacity, k is constant, and z is the labor factor.[19]

Despite its shortcomings, Hufbauer's scale measure is useful because of its broad coverage of industries, wide range of plant sizes, and clear indication of the relationship between size and productivity. It is used in this study.

3.4 The Effect of Industry Size on the Volume of Trade: Scaling to Size

It is assumed here that comparative cost is the only determinant of the commodity composition of trade and that, in turn, comparative cost is entirely determined by differences in factor intensities among commodities. Other things being equal, when comparative cost is the only determinant of commodity trade, the smaller an industry's comparative cost, the greater its exports and the smaller its imports. Hence the industry's net exports are the proper variable by which to measure comparative advantage, and is used as our dependent variable. Other things are not equal, however, even under our very restrictive assumptions. Perhaps the most important variable which differs across industries and needs to be taken into consideration is industry size.

Different industry sizes pose a problem. Two industries with the same comparative cost position would not have the same value of net export if their sizes were not the same. For example, if the imports of motor vehicles are ten times larger than the imports of textiles, that does not mean that the comparative cost disadvantage of the motor vehicle industry is in some sense ten times greater than that of textiles. It may simply reflect the much larger size of the automobile industry. Moreover, size tends to affect an industry's volume of trade regardless of its net export or import position. The effect of size on net exports is thus positive among export industries and negative among import-competing industries.

There is also the possibility that the variance of the disturbance term (U_i) in estimating equations (2) and (3) may increase with size of industry. The reason is that the variables in (2) and (3) are supply variables, but demand conditions also affect the volume of exports and imports. Therefore, in estimating equation (2) or (3), demand conditions are incorporated into the error term. If we anticipate an increase in the variance of trade with the size of industry, controlled by aggregate demand for its output, then the error terms in estimates of equations (2) and (3) are heteroscedastic, and the estimates of standard errors are biased, as are the significance tests. This is the problem with estimating equations such as (2). The standard treatment for solving the heteroscedasticity problem is to scale the data by the square root of the variable to which the variance of the error term is proportional.[20] Econometrically, this weighting corrects the

heteroscedastic covariance matrix of the disturbance vector. Intuitively, the greater the importance of an industry, the greater is its volume of trade. Thus, in the above example of the motor vehicle and textile industries, although their dependent variables may have the same values, the observation on the motor vehicle industry would have, say, a ten times greater influence than the observation on the textile industry in determining the outcome of the regression.

There are three steps in our adjustment for heteroscedasticity. First, it is necessary to confirm that the problem exists. To do that we divided the sample into three groups by size of shipments (Z_{it})[21]—small, medium and large—and estimated equation (2) for each subgroup. The ratio of the sum of squared residuals (SSR) of the subset with large Z to the SSR of the subset with small Z has an F distribution; if it is significantly large, heteroscedasticity exists. In every case, the ratio was greater than 10, which is much higher than the significant value at both the 95 and 99 percent level. (Hence, the presence of heteroscedasticity was confirmed.)

Second, having established the presence of heteroscedasticity, it is appropriate to scale the data by the square root of the variable to which the variance of the error term is proportional. To identify this variable, we regressed the absolute values of residuals from full-sample regression equation (2) on alternative size measures, such as Z_{it}, $Z_{it}^{1/2}$, and Z_{it}^{2}. The best fitting regression yielded the scale variable, which turned out to be the square root of shipments, $Z_{it}^{1/2}$.

Having identified the square variable as $Z_{it}^{1/2}$, we divided the data matrix, including the constant term unity, whose coefficient is b_0 in equation (2) and (3), by $Z^{1/2}$ and finally ran the regressions. The next section presents the results.

3.5 Cross-Section Results at the Three-Digit SITC Level for 1963, 1967, 1977, and 1980

For each of the four years, we performed two multiple regressions relating net exports by SITC commodity groups to: (1) three production characteristics: physical captal (K), human captial (H), and unskilled labor (L); and (2) four production characteristics: the same three noted above plus a measure of economies of scale in production (S):

$$NX_i = b_0+b_1K_i+b_2H_i+b_3L_iU_i \;, \tag{8}$$

$$NX_i = b_0+b_1K_i+b_2H_i+b_3L_i+b_4S_i+U_i \;. \tag{9}$$

With the procedures outlined earlier, these equations were scaled to neutralize the effect of industry size. The results of weighted regressions are summarized in Tables 3.1 through 3.9. It will be noted that these regressions include the variable $Z_{it}^{-1/2}$, which corresponds to the constant term of the unscaled regression. Branson and Monoyios have reported a new constant term in their scaled regressions (pp. 199) which has been criticized by Stern and Maskus,[22] who correctly argue that since the original data matrix, including the constant term, was scaled by $Z^{1/2}$, their scaled regression should have been estimated without an intercept. As a consequence, their results are not quite accurate but probably would not have changed substantially if the constant term were excluded.[23]

For this study both versions of scaled regressions were estimated. This chapter reports on regressions in which a new constant is included. The estimated regressions without a new constant term are presented in Appendix B. Comparison of the results reported in this chapter with those in Appendix B indicates that there is not much difference in sign or size of the estimated coefficients, but some coefficients reported in this chapter are more significant. This could very well be the reason Branson and Monoyios chose to report their results as they did, including a new constant in their regressions.

<u>U.S. - World Trade</u> - The regression equations pertaining to U.S. trade with the world are presented in Table 3.1. The first column identifies the dependent variable, net U.S. exports to the world for different years (NX). The next six columns show the estimated coefficients of K, H, L, S, $Z^{-1/2}$ (the scale factor), and the constant terms of the regressions, in that order. The eighth column indicates the number of three-digit SITC commodity groups (N), which varied slightly from year to year because of missing data. The level of significance is indicated as *(0.05) and **(.01), and t-values are reported in parentheses. In the last column we note the multiple correlation coefficient R^2 (not $\bar{R}^2$) for the regression. Equations A_1 through A_4 show the results for each of the four years before we introduce the scale economy factor. All the variables have the expected signs based on previous studies: a negative sign for K_{it}, illustrating the Leontief Paradox; a positive sign for H_{it}, reflecting the relative abundance of human capital in the United States; and a negative sign for L_{it}, indicating the relative scarcity of unskilled labor. For 1963 and 1967, the human capital variable is highly significant, physical capital is marginally significant, and the employment variable is significant.

TABLE 3.1
Weighted Regressions at the 3-digit Level U.S. Trade with the World#

	Independent Variables								
Dependent Variable	K	H	L	S	$Z^{-1/2}$	C	N	R^2	Eq. No.
NX (1963)	-.04 (1.75)	.03 (3.18)**	-.95 (2.67)**		-66.4 (3.1)**	3.7 (3.08)**	90	.20**	(A_1)
NX (1967)	-.04 (2.01)*	.04 (3.94)**	-1.06 (2.8)**		-84.38 (3.8)**	2.8 (2.13)*	92	.32**	(A_2)
NX (1977)	-.08 (2.1)*	.04 (1.97)	-2.55 (2.47)*		-401.7 (4.2)**	8.65 (2.52)*	92	.24**	(A_3)
NX (1980)	-.07 (.97)	.02 (.53)	-4.31 (1.8)		-788.07 (4.5)**	20.07 (3.22)**	89	.22**	(A_4)
NX (1963)	-.06 (2.46)*	.03 (3.35)**	-.96 (2.83)**	125.2 (3.09)**	-122.6 (4.53)**	5.4 (4.25)**	90	.33**	(B_1)
NX (1967)	-.04 (1.97)	.04 (3.93)**	-1.05 (2.75)**	13.62 (.27)	-81.79 (3.36)**	2.67 (1.94)	92	.32**	(B_2)
NX (1977)	-.08 (2.1)*	.04 (1.95)	-2.55 (2.41)*	-16.3 (.04)	-400.6 (4.0)**	8.64 (2.5)*	92	.24**	(B_3)
NX (1980)	-.07 (1.04)	.02 (.65)	-4.35 (1.83)	-1130.9 (1.65)	-708.12 (3.97)**	19.14 (3.09)**	89	.24**	(B_4)

(A) Without Economies of Scale

(B) With Economies of Scale

For 1977, with the exception of a lower level of significance for H, results are the same as in previous years. It thus appears that the three-direct factor input model of the structure of U.S. net exports of manufactures holds for the first three years, in particular for 1963 and 1967. Therefore, the multifactor proportions model receives support in explaining U.S. trade with the world as a whole. The results of the estimated equation for 1980 indicate that there is no significant relationship between the net exports of U.S. manufactures to the world and any of the economic characteristics under consideration. One could conclude that in 1963 and 1967 U.S. trade with the world was mainly interindustry because of large differences in comparative costs, which in turn are due to large differences in factor endowments. By 1980, however, U.S. factor endowments presumably were similar to the rest of the world's and hence trade became largely intraindustry. This hypothesis will be tested directly in the last section of this chapter.

When the scale economy variable is incorporated into the regression, the size and the sign of the coefficients of H, K, and L for 1963 are not affected, but their significance is increased; K becomes significant at the 5 percent level and the R^2 is raised from .20 to .33. The scale economy factor itself is positively significant in explaining the U.S. commodity composition of trade for 1963 but not for the later years. Only the 1963 result is consistent with the findings of Branson and Junz (for 1964), who concluded that scale economy is an important determinant of U.S. comparative advantage. Our findings for 1967 and beyond are consistent with the results obtained by Baldwin (1971) and Stern and Maskus (1981), suggesting that the scale economy variable is insignificant in determining the U.S. pattern of trade when net export is used as the dependent variable in regression estimating across industries.

Trade with Japan - Table 3.2 reports the results of the same regression analysis for U.S. bilateral trade with Japan. The Leontief Paradox does not exist in the case of U.S.-Japanese trade. The regression results (Table 3.2, Equation B_1) show that only in 1963 is there a significant positive relationship between the net export surplus of a U.S. industry to Japan and the human capital intensity and scale intensity in that industry. The United States was a net importer of labor-intensive commodities from Japan in 1963 and 1967. The results of the estimated equation for 1977 indicate that there is no significant relationship between the net export of U.S. manufactures to Japan and any of the economic characteristics under consideration.

This may be due to protectionist distortions. Alternatively, it can be hypothesized that, since the two countries have become more similar in per capita incomes over time and therefore presumably also in factor endowments, a good deal of trade has taken place within rather than between industries. This is tested in the next section to see whether the percentage of intraindustry trade between the United States and Japan has grown over time.

The results obtained for 1980 for U.S.-Japanese trade show a negatively significant coefficient for (H) and a positive and significant coefficient for (K). This indicates that while the United States was a net exporter to Japan of goods that were physical capital intensive, it was the net importer from Japan of commodities intensive in human capital.

Trade with Canada - As far as U.S.-Canadian bilateral trade is

TABLE 3.2

Cross-Section Regressions Explaining U.S. Bilateral Trade With Japan: Net U.S. Export of Manufactured Goods, 3-digit SITC

	Independent Variables								
Dependent Variable	K	H	L	S	$Z^{-1/2}$	C	N	R^2	Eq. No.
NX (1963)	-.004 (.913)	.005 (3.19)**	-.182 (3.11)**		-8.41 (2.43)*	.147 (.75)	90	$.15^{**}$	(A_1)
NX (1967)	-.003 (.73)	.003 (1.20)	-.223 (2.43)*		-11.50 (2.13)*	.345 (1.07)	90	.10	(A_2)
NX (1977)	.016 (.88)	-.019 (1.98)	.241 (.393)		-65.01 (1.46)	.631 (.397)	92	.06	(A_3)
NX (1980)	.05 (2.07)*	-.05 (3.84)**	1.28 (1.61)		-23.08 (.40)	-.159 (.08)	89	$.16^{**}$	(A_4)
NX (1963)	-.006 (1.56)	.005 (3.34)**	-.183 (3.26)**	19.35 (2.89)**	-17.1 (3.82)**	.41 (1.38)	90	$.23^{**}$	(B_1)
NX (1967)	-.004 (.95)	.003 (1.09)	-.239 (2.66)**	-25.18 (2.09)*	-16.39 (2.83)**	.56 (1.68)	90	$.14^{*}$	(B_2)
NX (1977)	.016 (.88)	-.019 (1.97)	.24 (.39)	14.6 (.08)	-66.0 (1.43)	.64 (.40)	92	.06	(B_3)
NX (1980)	.05 (2.05)*	-.05 (3.79)**	1.27 (1.6)	-62.69 (.27)	-18.65 (.31)	-.21 (.10)	89	.16	(B_4)

concerned, the coefficients of human capital, unskilled labor, and scale economy have the expected signs but are not significant (Table 3.3). Moreover, as already noted, the physical capital factor in an industry appears as a significant variable negatively correlated with the industry's export surplus. This indicates that the Leontief Paradox does exist with respect to trade between the United States and Canada, and this is not unexpected. Considering the strong complementary between capital and natural resources in the two countries and given Canada's abundant supply of the latter, it is not surprising that Canada is the net exporter of capital-intensive commodities to the United States. Wahl (1961) and Postner (1975) studied Canadian trade patterns and found that Canada, the most important single trading partner of the United States, exports goods with higher capital-labor ratios than its import substitutes. According to Postner's findings, human capital appears to be scarce. He also found that Canadian exports are most strongly intensive in natural resources, which accords well with expectations. Their results dovetail nicely with ours regarding U.S. bilateral trade with Canada.

Other factors, such as the nature of Canadian protectionism and production relationships, influence U.S.-Canadian trade. It is well recognized that after the 1965 U.S.-Canada auto agreement eliminated all tariffs on shipments of auto parts, the two economies basically have a common automobile industry. The role of multinational corporations and U.S. subsidiaries also cannot be ignored. The importance of direct investment in Canada is revealed in Table 3.4. Almost 60 percent of Canadian industry is foreign controlled, and more than 80 percent of that control is based in the United States. It appears that U.S.

TABLE 3.3

Cross-Section Regressions Explaining U.S. Bilateral Trade with Canada: Net U.S. Export of Manufactured Goods, 3-digit SITC

Dependent Variables	Independent Variables								
	K	H	L	S	$Z^{-1/2}$	C	N	R^2	Eq. No.
NX (1963)	-.032 (2.69)**	.005 (2.90)**	-.078 (1.16)		-24.27 (.51)	1.42 (2.77)**	90	.16**	(A_1)
NX (1967)	-.029 (2.56)*	.006 (.97)	-.049 (.23)		-32.61 (2.52)*	1.57 (2.02)*	90	.14**	(A_2)
NX (1977)	-.079 (7.53)**	.011 (1.89)	-.054 (1.51)		-121.97 (4.70)**	4.43 (4.76)**	92	.44**	(A_3)
NX (1980)	-.13 (6.58)**	.017 (1.56)	-.405 (.60)		-287.2 (5.84)**	8.87 (4.99)**	89	.44**	(A_4)
NX (1963)	-.03 (3.13)**	.005 (1.2)	-.08 (.52)	23.66 (1.31)	-34.89 (2.88)**	1.74 (3.07)**	90	.18**	(B_1)
NX (1967)	-.028 (2.48)*	.006 (.99)	-.04 (.17)	16.402 (.55)	-29.43 (2.07)*	1.43 (1.74)	90	.14*	(B_2)
NX (1977)	-.079 (7.55)**	.011 (1.94)	-.06 (.17)	-90.94 (.88)	-115.8 (4.3)**	4.36 (4.68)**	92	.45**	(B_3)
NX (1980)	-.13 (6.63)**	.018 (1.64)	-.41 (.61)	-220.7 (1.13)	-271.56 (5.32)**	8.65 (4.88)**	89	.45**	(B_4)

TABLE 3.4

Percentage of Total Canadian Sales Accounted

For By Foreign Controlled Firms, 1976*

All Nonfinancial Corporations			35%
Industry		58	
Food	36		
Chemicals	82		
Transportation Equipment	87		
Petroleum and Coal Processing	96		
Mining and Smelting	66		
Distribution		21	

Source: Statistics Canada, Corporations and Labour Unions Returns Act Report

* Presented in Ethier, Modern International Economics, New York: W.W. Norton and Company, 1983, p. 280.

subsidiaries account for a substantial amount of Canadian manufacturing exports. One could perhaps conclude that U.S. capital (through subsidiaries) is being employed in Canada, allowing that country to become relatively capital abundant and therefore produce and export capital-intensive goods.

Trade with Europe - It was noted earlier that Western Europe is divided into two groups for this study: DC_I, countries with GNP per capita higher than or roughly equal to that in the United States, and DC_{II}, countries with GNP per capita lower than that in the United States. The results pertaining to U.S. trade with each group are presented in Tables 3.5 and 3.6. None of the regression coefficients reported in Table 3.5 are significant, and the R^2 is also extremely low. The only exception is the scale economy variable, which has a significantly positive relationship with net exports of the United States to DC_I, but only in 1963. With net exports as our dependent variable, we can conclude that the U.S. pattern of trade with this group cannot be readily explained by the orthodox, factor proportions theory of international trade, even in its multiple-factor version. Since these countries share similar per capita income and factor endowments with the United States, perhaps factor proportions should not be expected to account for U.S.-DC_I trade. Indeed, much of this trade may be of the intraindustry variety. Test results presented in the next section testify to that fact.

The results of regression equations for U.S. trade with European countries having lower GNP per capita than the United States (DC_{II}) are shown in Table 3.6. The regression coefficients for the independent variables representing human capital and labor are statistically

TABLE 3.5

Cross-Section Regressions Explaining U.S. Trade with DC_I:
Net U.S. Export of Manufactured Goods, 3-digit SITC

Dependent Variable	Independent Variables								
	K	H	L	S	$Z^{-1/2}$	C	N	R^2	Eq. No.
NX (1963)	.0004 (.105)	−.00004 (.026)	.003 (.05)		−1.13 (.348)	−.055 (.299)	90	.003	(A_1)
NX (1967)	−.001 (.298)	.0018 (.65)	.038 (.39)		−.33 (.06)	−.377 (1.08)	90	.03	(A_2)
NX (1977)	−.0001 (.016)	−.004 (1.12)	.299 (1.33)		−18.38 (1.12)	.05 (.08)	92	.05	(A_3)
NX (1980)	.03 (1.31)	−.007 (.58)	.83 (1.04)		163.2 (2.8)**	−4.30 (2.06)*	89	.10	(A_4)
NX (1963)	−.002 (.52)	−.00001 (.01)	.002 (.03)	17.99 (2.86)**	−9.21 (2.19)*	.19 (.95)	90	.09	(B_1)
NX (1967)	−.002 (.31)	.0017 (.63)	.037 (.37)	−2.13 (.16)	−.743 (.12)	.36 (.97)	90	.03	(B_2)
NX (1977)	.00004 (.006)	−.004 (1.16)	.303 (1.34)	50.55 (.78)	−21.8 (1.28)	.08 (.14)	92	.05	(B_3)
NX (1980)	.03 (1.35)	−.008 (.65)	.84 (1.05)	257.99 (1.12)	144.94 (2.4)*	−4.09 (1.95)	89	.11	(B_4)

TABLE 3.6

Cross-Section Regressions Explaining U.S. Trade with DC_{II}:
Net U.S. Export of Manufactured Goods, 3-digit SITC

Dependent Variable	K	H	L	S	$Z^{-1/2}$	C	N	R^2	Eq. No.
	Independent Variable								
NX (1963)	.0013	.005	-.197		-5.10	.19	90	.19**	(A_1)
	(.34)	(3.61)**	(3.75)**		(1.64)	(1.07)			
NX (1967)	-.003	.006	-.263		-21.53	.76	90	.29**	(A_2)
	(.80)	(2.51)*	(3.05)**		(4.22)**	(2.47)*			
NX (1977)	-.004	.007	-.315		-23.58	.19	92	.11*	(A_3)
	(.64)	(2.05)*	(1.45)		(1.5)	(.34)			
NX (1980)	.0007	.01	-.22		62.06	-1.3	89	.04	(A_4)
	(.04)	(1.27)	(.40)		(1.53)	(.89)			
NX (1963)	-.001	.005	-.198	16.81	-12.65	.42	90	.23**	(B_1)
	(.27)	(3.77)**	(3.91)**	(2.79)**	(3.13)**	(2.2)*			
NX (1967)	-.003	.006	-.254	14.15	-18.79	.63	90	.30**	(B_2)
	(.67)	(2.58)*	(2.94)**	(1.22)	(3.38)**	(1.99)*			
NX (1977)	-.004	.007	-.315	-1.75	-23.5	.19	92	.11*	(B_3)
	(.64)	(2.04)*	(1.44)	(.03)	(1.43)	(.34)			
NX (1980)	.0008	.01	-.22	46.59	58.76	-1.27	89	.04	(B_4)
	(.05)	(1.24)	(.39)	(.29)	(1.4)	(.86)			

significant and have the theoretically correct sign (until 1977). When the scale variable is included in the regression analysis (Table 3.6, Equations B_1-B_4), it fails to show a significantly positive relationship with the U.S. industries' trade balances for 1967, 1977, and 1980. This holds not only for U.S. trade with DC_{II} but also the world, DC_I, Canada, NICs, and LDCs. As these tables indicate, regardless of its trade partner, the United States derived an advantage from economies of scale only in 1963.

The regression results for the first three years shown in Tables 3.5 and 3.6 may suggest that U.S. trade with DC_I is mainly intraindustry and with DC_{II} interindustry. In 1980, however, U.S. manufacturing trade with both groups was of the intraindustry variety.

Trade with the NICs - Table 3.7 shows how the net exports of U.S. industries to eleven semi-industrial countries (NICs) are related to our four economic characteristics. In this case the coefficient of human capital is positive and highly significant, and the coefficient of unskilled labor is negatively significant for every year. It is obvious that the U.S. disadvantage is centered in unskilled labor. The U.S. derives an advantage from human capital but surprisingly not from physical capital, as might be expected given its relatively high capital endowment. The three- and four-factor approach used here revealed the United States to be relatively more human capital abundant than physical capital abundant. This implies that the U.S. strength from human capital does, in fact, "swamp" the U.S. physical capital advantage.

Trade with LDCs - The results of regression equations for U.S. trade with the less developed countries (LDCs) are presented in Table 3.8. It is evident that all the variables, with the exception of scale

TABLE 3.7

Cross-Section Regressions Explaining U.S. Trade With NICs:
Net U.S. Export of Manufactured Goods, 3-digit SITC

	Independent Variables								
Dependent Variables	K	H	L	S	$Z^{-1/2}$	C	N	R^2	Eq. No.
NX (1963)	-.0005 (.08)	.006 (2.46)*	-.203 (2.34)*		-12.32 (2.29)*	.50 (1.63)	90	.15**	(A_1)
NX (1967)	-.004 (.45)	.009 (2.16)*	-.341 (2.21)*		-12.93 (1.42)	.75 (1.37)	90	.10	(A_2)
NX (1977)	.004 (.36)	.026 (4.55)**	-2.37 (6.56)**		-60.39 (2.31)*	.89 (.95)	92	.39**	(A_3)
NX (1980)	.01 (.48)	.034 (2.35)*	-4.46 (5.08)**		-269.15 (4.23)	6.4 (2.79)**	89	.35**	(A_4)
NX (1963)	-.005 (.75)	.006 (2.6)*	-.20 (2.36)*	31.56 (3.05)**	-26.49 (3.82)**	.93 (2.86)**	90	.23**	(B_1)
NX (1967)	-.004 (.47)	.009 (2.14)*	-.34 (2.2)*	-4.12 (.20)	-13.73 (1.37)	.78 (1.36)	90	.10	(B_2)
NX (1977)	.004 (.37)	.026 (4.5)**	-2.37 (6.52)**	28.4 (.27)	-62.3 (2.28)*	.91 (.96)	92	.39**	(B_3)
NX (1980)	.009 (.39)	.037 (2.67)**	-4.49 (5.36)**	-743.9 (3.08)**	-216.56 (3.44)**	5.79 (2.64)**	89	.41**	(B_4)

TABLE 3.8

Cross-Section Regressions Explaining U.S. Trade with LDCs: Net U.S. Export of Manufactured Goods, 3-digit SITC

	Independent Variables								
Dependent Variable	K	H	L	S	$Z^{-1/2}$	C	N	R^2	Eq. No.
NX (1963)	-.011 (.72)	.008 (1.35)	-.25 (1.15)		-14.35 (1.10)	1.42 (1.91)	90	.04	(A_1)
NX (1967)	-.001 (.22)	.006 (2.15)*	-.08 (.73)		-9.49 (1.47)	.398 (1.03)	90	.18**	(A_2)
NX (1977)	-.015 (1.3)	.016 (2.53)*	-.25 (.63)		-89.99 (3.1)**	2.04 (1.96)	92	.29**	(A_3)
NX (1980)	-.017 (.54)	.009 (.54)	-1.32 (1.2)		-403.6 (5.24)**	9.8 (3.5)**	89	.31**	(A_4)
NX (1963)	-.013 (.79)	.008 (1.35)	-.25 (1.15)	10.8 (.41)	-19.2 (1.1)	1.56 (1.89)	90	.04	(B_1)
NX (1967)	-.001 (.17)	.007 (2.17)*	-.075 (.68)	6.92 (.47)	-8.14 (1.15)	.34 (.83)	90	.18**	(B_2)
NX (1977)	-.015 (1.29)	.016 (2.52)*	-.25 (.63)	-22.5 (.194)	-88.46 (2.93)**	2.02 (1.93)	92	.29**	(B_3)
NX (1980)	-.018 (.58)	.01 (.59)	-1.33 (1.25)	-250.5 (.82)	-385.89 (4.82)**	9.57 (3.44)**	89	.32**	(B_4)

economy for 1977 and 1980, have the expected signs. However, only the regression coefficient for human capital is statistically significant. Evidently, the U.S. comparative advantage is not derived from physical capital but from human capital. Furthermore, and contrary to expectations, there is no significant negative correlation between U.S. net exports and unskilled labor intensity.

Equations presented in Table 3.9 show the results when gross export is used as the dependent variable. These regressions were run to check for a positive (negative) significant correlation between gross exports of U.S. industries and physical capital intensity (labor intensity). These equations indicate that industries with high gross exports to the LDCs are human capital intensitve in production, other things being equal. Physical capital input is not significant.

3.6 Inter- versus Intraindustry Trade

This section tests directly the hypothesis advanced above that U.S. trade (both in the aggregate and in bilateral flows) has become increasingly intra- rather than interindustry in nature. The question is to what extent the United States both exports and imports within each three-digit SITC in its trade with Japan, the NICs, and the two groups of Western European countries (DC_I and DC_{II}).

A rough measure (index) of intraindustry trade, used by Balassa and Kreinin,[24] is expressed as the unweighted average of ratios of the absolute difference between exports and imports to the sum of exports and imports of each commodity category (three-digit SITC). The formula used in calculations is as follows:

TABLE 3.9

Cross-Section Regressions Explaining U.S. Trade with LDCs: U.S. Export of Manufactured Goods, 3-digit SITC

	Independent Variables							
Dependent Variable	K	H	L	S	$Z^{-1/2}$	C	R^2	Eq. No.
X (1963)	-.003 (.24)	.007 (1.7)	-.21 (.99)		-.16 (.52)	.94 (1.99)*	.02	(A_1)
X (1967)	-.001 (.21)	.005 (2.34)*	-.10 (1.17)		-7.41 (1.49)	.63 (2.13)*	.17	(A_2)
X (1977)	-.007 (.73)	.01 (2.77)**	.01 (.04)		-10.49 (.43)	.68 (.79)	.20	(A_3)
X (1980)	-.01 (.94)	.02 (1.98)*	-.38 (.76)		-50.0 (1.39)	2.96 (2.29)*	.12	(A_4)
X (1963)	-.04 (.27)	.007 (1.7)	-.21 (1.01)	-8.80 (.49)	-.10 (.02)	.93 (1.97)	.03	(B_1)
X (1967)	-.001 (.25)	.005 (2.3)*	-.10 (1.19)	-4.5 (.40)	-8.3 (1.52)	.67 (2.14)*	.17	(B_2)
X (1977)	-.007 (.72)	.01 (2.75)**	.01 (.04)	-7.94 (.01)	-10.44 (.42)	.68 (.79)	.20	(B_3)
X (1980)	-.01 (.91)	.02 (1.96)*	-.37 (.74)	73.94 (.51)	-55.3 (1.5)	3.02 (2.31)*	.12	(B_4)

$$\frac{1}{N}\sum\frac{|X_{ijt}-M_{ijt}|}{X_{ijt}+M_{ijt}} ,$$

where X_{ijt} and M_{ijt} refer to U.S. export and import of commodity group i to and from country (or country groups) j at time t, and N_t is the number of commodity categories considered at time t. Should interindustry trade dominate, the index is expected to approach unity since the United States would either export or import a commodity. By contrast, in the case of intraindustry trade, the ratios would approach zero because exports and imports would tend toward equality within each category.

Table 3.10 presents the results of calculations for all the regions and over time. Relatively low figures for U.S. trade with DC_I (for all four years) confirm our earlier speculation and suggest that trade is indeed mainly intraindustry. Because these countries share similar per capita income and factor endowments with the United States, the factor proportions theory cannot be expected to explain U.S.-DC_I trade. Table 3.10 also shows that the measure (index) for Japan dropped markedly between 1963 and 1980. In 1977 and 1980 compared to 1963 and 1967, more U.S. trade with Japan took place within rather than between industries. The U.S.-DC_{II} index also declined over time.

These results support our previous hypothesis that the factor endowment model could explain the U.S. pattern of trade with Japan and DC_{II} in 1963 and 1967 (largely interindustry trade) but not in later years (mainly intraindustry trade). A similar observation can be made with respect to U.S.-Canadian trade. Finally, although interindustry trade with the two LDC groups also declined over time, it remained high even in 1980.

TABLE 3.10

Indices of Intraindustry Trade*

Region \ Year	1963	1967	1977	1980
World	.50	.47	.46	.41
Canada	.72	.61	.56	.50
Japan	.75	.71	.62	.58
DC_I	.49	.43	.42	.43
DC_{II}	.51	.49	.44	.43
NICs	.74	.69	.63	.61
LDCs	.80	.84	.74	.69
	N=90	N=92	N=92	N=89

* Calulated as unweighted averages of the ratio of the absolute difference of exports and imports to the sum of exports and imports for N (as indicated in the table) industries by the use of the formula

$$\frac{1}{N} \sum \frac{|X_i - M_i|}{X_i + M_i} .$$

3.7 Summary

To summarize our findings, regression results in most cases and especially in earlier years (1963 and 1967) are consistent with the Leontief Paradox and supportive of his explanations of the Paradox. The scale economy factor turned out to be important in influencing the United States net exports to most regions of the world in 1963, but not in later years.

The multi-factor proportions theory performed well in explaining U.S. trade patterns with the NICs in all four years, with Japan, and DC_{II} in 1963 and 1969. But it did not receive much support in explaining U.S. trade with DC_{I} (for all four years), and with Japan and DC_{II} for 1977 and 1980. We found that in the latter cases intraindustry trade tends to predominate.

The next chapter investigates structural changes in the U.S. manufacturing trade between 1963 and 1980.

CHAPTER FOUR

STRUCTURAL CHANGES IN THE DETERMINANTS OF U.S. TRADE PATTERNS

Introduction

This chapter examines whether there have been any structural changes in U.S. manufacturing trade with different countries and regions of the world. In the regression analysis of the last chapter, the question was asked whether sets of coefficients in those linear regressions were equal over time. Among the various statistical techniques which may be used for this purpose, two may be mentioned. If one wants to find whether the intercepts differ, given that the slopes are equal, the appropriate technique is the analysis of variance. If one wants to know whether the slopes differ, the appropriate method is the analysis of covariance.[1] For this study, however, a dummy variable specification of the scaled regression with 1963=0 and 1980=1 is estimated. This follows the procedure outlined in an article by Gujarati.[2] (The dummy variables 1 and 0 can be used as an alternative to the Chow test to find whether sets of coefficients in two linear regressions are equal. Both techniques give identical conclusions, but the dummy variable method is considered superior. If two regressions are different, the Chow test will show this without specifying the sources of the difference, whereas the dummy variable technique clearly points out the sources of the difference, that is, whether due to intercept, slope, or both. To test whether the assumption of two different regression models is correct, we usually start with the null hypothesis that the regressions are identical and see whether that hypothesis can be rejected.

The Generalized Dummy Variable Approach

In the previous chapter it was postulated that NX_i (net exports) is linearly related to K_i, H_i, L_i, and S_i as follows:

$$NX_i = b_0+b_1K_i+b_2H_i+b_3L_i+b_4S_i+U_i, \qquad i = 1, 2, \ldots. 94, \tag{9}$$

where U is the stochastic error term.

Since the data are for four different years, we would like to find out whether equation (9) differs from year to year. To do so, equation (9) could be written as follows:

$$NX_{it} = b_{ot}+b_{1t}K_{it}+b_{2t}H_{it}+b_{3t}L_{it}+b_{4t}S_{it}+U_{it} , \tag{10}$$

$t = 1963, 1967, 1977, 1980.$

Equation (10), stated more explicitly, consists of the following sets of equations:

$$NX_{i63} = b_{063}+b_{163}K_i+b_{263}H_i+b_{363}L_i+b_{463}S_i+U_{i63}\ , \qquad i = 1,\ 2,\ \ldots\ 90; \tag{11}$$

$$NX_{i67} = b_{067}+b_{167}K_i+b_{267}H_i+b_{367}L_i+b_{467}S_i+U_{i67}\ , \qquad i = 1,\ 2,\ \ldots\ 92; \tag{12}$$

$$NX_{i77} = b_{077}+b_{177}K_i+b_{277}H_i+b_{377}L_i+b_{477}S_i+U_{i77}\ , \qquad i = 1,\ 2,\ \ldots.\ 92; \tag{13}$$

$$NX_{i80} = b_{080}+b_{180}K_i+b_{280}H_i+b_{380}L_i+b_{480}S_i+U_{i80}\ , \qquad i = 1,\ 2,\ \ldots\ 89. \tag{14}$$

It should be pointed out that the numbers of observations in each year need not be equal.

The task now is to find whether regressions (11) through (14) differ from one another, as they might in a variety of ways. For example,

$$b_{063}=b_{067}=b_{077}=b_{080},\ b_{163}=b_{167}=b_{177}=b_{180},\ \text{but}\ b_{263}\neq b_{267}\neq b_{277}\neq b_{280}.$$

Of course, many other combinations are possible.

To test for structural change, consider the following equation:

$$NX_i = b_0+b_1D_1+b_2D_2+b_3D_3+b_4K_i+b_5(D_1K_i)+b_6)(D_2K_i)+b_7(D_3K_i)+$$

$$b_8H_i+b_9(D_1H_i)+b_{10}(D_2H_i)+b_{11}(D_3H_i)+b_{12}L_i+b_{13}(D_1L_i)+b_{14}(D_2L_i)+$$

$$b_{15}(D_3L_i)+b_{16}S_i+b_{17}(D_1S_i)+b_{18}(D_2S_i)+b_{19}(D_3S_i)+U_i \text{ ,} \tag{15}$$

where

D_1=1, if the observation belongs to 1967, 0 otherwise;

D_2=1, if the observation belongs to 1977, 0 otherwise;

D_3=1, if the observation belongs to 1980, 0 otherwise.

The various b's entering into (7) are interpreted as follows:

b_0=intercept for year 1963;

b_1=differential intercept for year 1977;

b_3=differential intercept for year 1980;

b_4=slope coefficient of NX with respect to K for 1963;

b_5,b_6, and b_7=differential slope coefficients of NX with respect to K for 1967, 1977, and 1980, respectively;

b_8=slope coefficient of NX with respect to H for 1963;

b_9,b_{10}, and b_{11}=differential slope coefficients of NX with respect to H for 1967, 1977, and 1980, respectively;

b_{12}=slope coefficient of NX with respect to L for 1963;

b_{13},b_{14}, and b_{15}= differential slope coefficients of NX with respect to L for 1967, 1977, and 1980, respectively;

b_{16}=slope coefficient of NX with respect to S for 1963; and

b_{17}, b_{18}, and b_{19}= differential slope coefficients of NX with respect to S for 1967, 1977, and 1980, respectively.

From these differential intercepts and differential slope coefficients, one can easily derive the actual values of the intercept and slope coefficients for various years as follows:

$$\text{(1963)} \quad NX = b_0+b_4K+b_8H+b_{12}L+b_{16}S; \tag{16}$$

$$(1967) \quad NX = (b_0+b_1)+(b_4+b_5)K+(b_8+b_9)H+(b_{12}+b_{13})L+(b_{16}+b_{17})S; \quad (17)$$

$$(1977) \quad NX = (b_0+b_2)+(b_4+b_6)K+(b_8+b_{10})H+(b_{12}+b_{14})L+(b_{16}+b_{18})S; \quad (18)$$

$$(1980) \quad NX = (b_0+b_3)+(b_4+b_7)K+(b_8+b_{11})H+(b_{12}+b_{15})L+(b_{16}+b_{19})S. \quad (19)$$

To derive equations (16) through (19) all that is needed is equation (15), which can be estimated by the ordinary least square (OLS) tehnique, provided the normal assumptions hold regarding the error term Ui.

Depending upon the statistical significance of the estimated differential intercept and slope coefficients, it is now possible to find out whether sets of linear regressions are different. The results of the scaled regressions for U.S. global trade are reported in Table 4.1. Equation (I) shows the results before the scale economy variable is incorporated into the model, and equation (II) shows the results when that variable is included.

Before interpreting these results we derive the regressions for each individual year as shown in equations (16)-(19) for equation (II) in Table 4.1.

$$(1963) \quad NX = 5.4 - .06K + .03H - .96L + 125.2S - 122.6Z^{-1/2}; \quad (16')$$
$$(4.25)^{**}(2.46)^{*}(3.35)^{**}(2.83)^{**}(3.09)^{**}(4.53)^{**}$$

$$(1967) \quad NX = (5.4-2.74)+(-.06+.02)K+(.03+.01)H+(-.96-.09)L+ (125.2-110.6)S+(-122.7+40.9)Z^{-1/2}$$

$$= 2.67-.04K+.04H-1.05L+13.62S-81.79Z^{-1/2}; \quad (17')$$
$$(1.94)(1.97)(3.94)^{**}(2.75)^{**}(.27)(3.36)^{**}$$

TABLE 4.1

Results of Scaled Regressions for the U.S. Global Trade

$$NX = \underset{(1.1)}{3.7} - \underset{(.18)}{.92D_1} + \underset{(1.0)}{4.94D_2} + \underset{(3.3)^{**}}{16.3D_3} + \underset{(.62)}{.045K} + \underset{(.05)}{.004D_1K} - \underset{(.44)}{.036D_2K}$$

$$- \underset{(.31)}{.02D_3K} + \underset{(1.13)}{.03H} + \underset{(.23)}{.009D_1H} + \underset{(.28)}{.01D_2H} - \underset{(.28)}{.01D_3H} - \underset{(.96)}{.95L} - \underset{(.07)}{.1D_1L}$$

$$- \underset{(.93)}{1.59D_2L} - \underset{(1.93)}{3.34D_3L} - \underset{(1.13)}{66.4Z^{-1/2}} \; \underset{(.21)}{18.07D_1Z^{-1/2}} \; \underset{(2.86)^{**}}{335.3D_2Z^{-1/2}}$$

$$- \underset{(6.11)^{**}}{720.8\,D_4Z^{-1/2}} \tag{I}$$

$$NX = \underset{(1.46)}{5.4} - \underset{(.51)}{2.7D_1} + \underset{(.63)}{3.2D_2} + \underset{(2.6)^{*}}{13.8D_3} - \underset{(.85)}{.06K} + \underset{(.24)}{.02D_1K} - \underset{(.24)}{.02D_2K} - \underset{(.11)}{.01D_3K}$$

$$+ \underset{(1.15)}{.03H} + \underset{(.23)}{.009D_1H} + \underset{(.28)}{.01D_2H} - \underset{(.20)}{.01D_3H} - \underset{(.97)}{.96L} - \underset{(.05)}{.08D_1L} - \underset{(.93)}{1.6D_2L}$$

$$\underset{(1.98)}{-3.4D_3L} + \underset{(1.06)}{125.2S} - \underset{(.58)}{110.5D_1S} - \underset{(.34)}{141.6D_2S} - \underset{(2.99)^{**}}{1274.9D_3S} - \underset{(1.55)}{122.7Z^{-1/2}}$$

$$+ \underset{(.39)}{40.9D_1Z^{-1/2}} - \underset{(2.12)^{*}}{277D_2Z^{-1/2}} - \underset{(4.45)^{**}}{584.9D_3Z^{-1/2}} \tag{II}$$

* Statistically significant at .05 level.

** Statistically significant at .01 level.

Note: t-statistics (t-values) in parentheses.

$$(1977)\quad NX = (5.4+3.24)+(-.06-.02)K+(.03+.01)H+(-.96-1.59)L+ (125.2-141.58)S+(-122.7-277.9)Z^{-1/2}$$

$$= \underset{(2.5)^{*}}{8.64} \underset{(2.1)^{*}}{-.08K} \underset{(1.95)}{+.04H} \underset{(2.41)^{*}}{-2.55L} \underset{(.04)}{-16.3S} \underset{(4.0)^{**}}{-400.6Z^{-1/2}}; \qquad (18')$$

$$(1980)\quad NX = (5.4+13.79) + (-.06-.01)K + (.03-.01)H + (-.96-3.41)L+ (125.2-1275.0)S+(-122.7-584.94)Z^{-1/2}$$

$$= \underset{(3.09)^{**}}{19.14} - \underset{(1.04)}{.07K} + \underset{(.65)}{.02H} - \underset{(1.83)}{4.35L} - \underset{(1.65)}{1130.9S} - \underset{(3.97)^{**}}{708.12} . \qquad (19')$$

Equation (I) indicates that for all industries the null hypothesis that there was no change in the coefficients is accepted for K, L, and H but is rejected for C, the intercept, and for $Z^{-1/2}$, the normalizing factor (measured by size of shipments). The same conclusions hold for Equation (II) but in addition the null hypothesis is rejected for S, the scale economy factor. This indicates that scale economy, which was an important determinant of U.S. comparative advantage in 1963 (with a positive and significant coefficient), was not an influence on U.S. trade patterns in 1980 (with a negative but insignificant coefficient). These results suggest that U.S. global net exports of manufactures neither made more nor less direct use of human capital, physical capital, or labor in 1980 compared to 1963.

Test results for structural changes in U.S. trade with Japan are presented in Table 4.2. The null hypothesis that all the regression coefficients are identical is accepted except for H and L. The coefficient on H is significantly more negative in 1980 as compared to 1963, while the coefficient on L is more positive. This suggests that U.S. net exports of manufactures have been making less direct use of (H) human capital (as measured by the discounted industry wage

TABLE 4.2

Results of Scaled Regressions for U.S. Trade With Japan

$$
\begin{aligned}
NX = {} & \underset{(.12)}{.15} + \underset{(.11)}{.20D_1} + \underset{(.27)}{.48D_2} - \underset{(.15)}{.28D_3} - \underset{(.15)}{.004K} + \underset{(.01)}{.0004D_1K} + \underset{(.65)}{.02D_2K} + \underset{(1.75)}{.05D_3K} \\
& + \underset{(.52)}{.005H} - \underset{(.15)}{.002D_1H} - \underset{(1.9)}{.02D_2H} - \underset{(4.2)^{**}}{.05D_3H} - \underset{(.50)}{.18L} - \underset{(.76)}{.04D_1L} + \underset{(.69)}{.42D_2L} \\
& + \underset{(2.3)^{*}}{1.4D_3L} - \underset{(.39)}{8.4Z^{-1/2}} - \underset{(.97)}{3.09D_1Z^{-1/2}} - \underset{(1.33)}{56.6D_2Z^{-1/2}} - \underset{(.35)}{15.04D_3Z^{-1/2}}
\end{aligned}
\qquad (I)
$$

$$
\begin{aligned}
NX = {} & \underset{(.30)}{.41} + \underset{(.07)}{.15D_1} + \underset{(.12)}{.23D_2} - \underset{(.31)}{.59D_3} - \underset{(.24)}{.006K} + \underset{(.61)}{.002D_1K} + \underset{(.72)}{.02D_2K} + \underset{(1.8)}{.05D_3K} \\
& + \underset{(.52)}{.005H} - \underset{(.17)}{.002D_1H} - \underset{(1.89)}{.02D_2H} - \underset{(4.16)^{**}}{.05D_3H} - \underset{(.50)}{.18L} - \underset{(.10)}{.05D_1L} + \underset{(.68)}{.42D_2L} \\
& \underset{(2.3)^{*}}{1.44D_3L} + \underset{(.45)}{19.3S} - \underset{(.64)}{44.5D_1S} - \underset{(.03)}{4.7D_2S} - \underset{(.59)}{92D_3S} - \underset{(.59)}{17.1Z^{-1/2}} + \underset{(.02)}{.71D_1Z^{-1/2}} \\
& - \underset{(1.01)}{48.9D_2Z^{-1/2}} - \underset{(.03)}{1.26D_3Z^{-1/2}}
\end{aligned}
\qquad (II)
$$

TABLE 4.3

Results of Scaled Regressions for the U.S. Bilateral Trade With Canada

---

$$NX = 1.42 + .14D_1 + 3.0D_2 + 7.4D_3 - .03K + .03D_1K - .05D_2K - .1D_3K$$

(1.4) (.093) (2.02)* (4.9)**(1.47) (.11) (1.89) (4.03)**

$$+ .005H + .001D_1H + .006D_2H + .013D_3H - .08L + .03D_1L + .02D_2L$$

(.59) (.74 (.55) (1.2) (.26) (.65) (.46)

$$- .31D_3L - 24.3Z^{-1/2} - 8.3D_1Z^{-1/2} - 97.7D_2Z^{-1/2} - 262.2D_3Z^{-1/2} \quad (I)$$

(.62) (1.41) (.21) (2.13)* (5.87)**

$$NX = 1.74 - .32D_1 + 2.62D_2 + 6.89D_3 - .03K_1 + .007D_1K - .04D_2K - .1D_3K$$

(1.55) (.19) (1.67) (4.36)**(1.58) (.24) (1.7) (3.8)**

$$.005H + .001D_1H + .006D_2H + .013D_3H - .08L + .04D_1L + .02D_2L$$

(.59) (.08) (.57) (1.23) (.26) (.1) (.37)

$$- .32D_3L + 23.6S - 7.25D_1S - 114.6D_2S - 234.7D_3S - 34.8 \quad Z^{-1/2}$$

(.62) (.66) (.13) (.91) (1.81) (1.45)

$$+ 5.47D_1Z^{-1/2} - 80.88\ D_2Z^{-1/2} - 236.9\ D_3Z^{-1/2} \qquad (II)$$

(.17) (2.04)* (5.9)**

---

differentials) and more direct use of labor (as measured by industry employment) over the period. There have been structural changes in U.S.-Japanese trade over the eighteen years, and Japan "emerged" as a major trader between 1963 and 1980.

To test for any significant changes in the regression coefficients between 1963 and 1980 for U.S.-Canadian trade, the same technique is used. The results in Table 4.3 indicate some differences in the regression coefficients between 1963 and 1980, indicating structural changes in U.S.-Canadian trade between 1963 and 1980. Both equations in Table 4.3 point out that the differential intercept for 1980 (b_3) is significantly negative, the coefficients on K and $Z^{-1/2}$ for net exports are significantly more negative in 1980 compared to 1963. This suggests that there has been even less direct use of physical capital in the U.S. net exports of manufactures to Canada in 1980 compared to 1963.

The results of scaled regressions for U.S. trade with both groups of European countries are reported in Tables 4.4 and 4.5. Table 4.4 shows the results of scaled regressions for U.S. trade with DC_I. The null hypothesis that there was no change in the coefficients is accepted for K, L, H, and S but is rejected for C, the intercept, and for $Z^{-1/2}$, the normalizing factor. The equations in Table 4.5 for DC_{II} show that none of the differential intercepts and differential slopes are statistically significant. Following the earlier discussion, therefore, those regressions do not differ from one year to another. Hence, the 1963 regression is common to all the years, indicating no structural changes in U.S. trade in manufactured commodities with DC_{II} countries.

With respect to U.S. net exports of manufactures to the NICs, Table 4.6 indicates significant changes in the regression coefficients between

TABLE 4.4

Results of Scaled Regressions for the U.S. Trade with DC_I

$$
\begin{aligned}
NX = {} & \underset{(.05)}{-.05} - \underset{(.21)}{.32D_1} + \underset{(.07)}{.10D_2} - \underset{(2.8)^{**}}{4.21D_3} + \underset{(.02)}{.0004K} - \underset{(.07)}{.002D_1K} - \underset{(.02)}{.0005D_2K} \\
& + \underset{(1.26)}{.03D_3K} - \underset{(.005)}{.00004H} + \underset{(.14)}{.002D_1H} - \underset{(.37)}{.004D_2H} - \underset{(.72)}{.008D_3H} + \underset{(.009)}{.003L} + \\
& \underset{(.08)}{.036D_1L} + \underset{(.57)}{.30D_2L} + \underset{(1.57)}{.82D_3L} - \underset{(.06)}{1.13Z^{-1/2}} + \underset{(.03)}{0.80D_1Z^{-1/2}} - \underset{(.49)}{17.24D_2Z^{-1/2}} \\
& + \underset{(4.60)^{**}}{163.8D_3Z^{-1/2}} \qquad \text{(I)}
\end{aligned}
$$

$$
\begin{aligned}
NX = {} & \underset{(.17)}{.19} - \underset{(.33)}{.55D_1} - \underset{(.07)}{.10D_2} - \underset{(2.7)^{**}}{4.27D_3} - \underset{(.09)}{.002K} + \underset{(.01)}{.0004D_1K} + \underset{(.08)}{.002D_2K} \\
& + \underset{(1.35)}{.034D_3K} - \underset{(.002)}{.00001H} + \underset{(.14)}{.0017D_1H} - \underset{(.39)}{.004D_2H} - \underset{(.79)}{.009D_3H} + \underset{(.005)}{.002L} \\
& + \underset{(.08)}{.035D_1L} + \underset{(.58)}{.30D_2L} + \underset{(1.61)}{.84D_3L} + \underset{(.50)}{17.99S} - \underset{(.35)}{20.12D_1S} + \underset{(.26)}{32.56D_2S} \\
& + \underset{(1.82)}{235.96D_3S} - \underset{(.38)}{9.2Z^{-1/2}} + \underset{(.26)}{8.47D_1Z^{-1/2}} - \underset{(.32)}{12.61D_2Z^{-1/2}} \\
& + \underset{(3.86)^{**}}{154.26D_3Z^{-1/2}} \qquad \text{(II)}
\end{aligned}
$$

TABLE 4.5

Results of Scaled Regressions for the U.S. Trade with DC_{II}

$$NX = \underset{(.25)}{.19} + \underset{(.50)}{.57D_1} + \underset{(.002)}{.003D_2} - \underset{(1.35)}{1.5D_3} + \underset{(.82)}{.001K} - \underset{(.24)}{.005D_1K} - \underset{(.30)}{.005D_2K}$$

$$- \underset{(.02)}{.0003D_3K} + \underset{(.87)}{.005H} + \underset{(.75)}{.0007D_1H} + \underset{(.23)}{.002D_2H} + \underset{(.78)}{.006D_3H} - \underset{(.90)}{.19L}$$

$$- \underset{(.20)}{.067D_1L} - \underset{(.31)}{.12D_2L} - \underset{(.73)}{.028D_3L} - \underset{(.39)}{5.1Z^{-1/2}} - \underset{(.85)}{16.4D_1Z^{-1/2}} - \underset{(.72)}{18.48D_2Z^{-1/2}}$$

$$+ \underset{(1.84)}{57.03D_3Z^{-1/2}} \qquad \text{(I)}$$

$$NX = \underset{(.51)}{.42} + \underset{(.18)}{.22D_1} - \underset{(.19)}{.23D_2} - \underset{(1.45)}{1.68D_3} - \underset{(.06)}{.001K} - \underset{(.1)}{.002D_1K} - \underset{(.17)}{.003D_2K}$$

$$+ \underset{(.11)}{.002D_3K} + \underset{(.87)}{.005H} + \underset{(.88)}{.0008D_1H} + \underset{(.23)}{.0\text{-}02D_2H} + \underset{(.76)}{.006D_3H} - \underset{(.90)}{.19L}$$

$$- \underset{(.17)}{.056D_1L} - \underset{(.31)}{.117D_2L} - \underset{(.06)}{.02D_3L} + \underset{(.64)}{16.8S} - \underset{(.06)}{2.66D_1S} - \underset{(.20)}{18.5D_2S}$$

$$+ \underset{(.29)}{28.2D_3S} - \underset{(.72)}{12.65Z^{-1/2}} - \underset{(.26)}{6.13D_1Z^{-1/2}} - \underset{(.37)}{10.8D_2Z^{-1/2}} + \underset{(1.84)}{60.4D_3Z^{-1/2}}$$

$$\text{(II)}$$

TABLE 4.6

Results of Scaled Regressions for the U.S. Trade with NICs

$$
\begin{aligned}
NX = {} & \underset{(.43)}{.50} + \underset{(.14)}{.25D_1} + \underset{(.22)}{.38D_2} + \underset{(3.36)^{**}}{5.83D_3} - \underset{(.02)}{.0005K} - \underset{(.09)}{.003D_1K} + \underset{(.15)}{.004D_2K} \\
& + \underset{(.39)}{.011D_3K} + \underset{(.64)}{.006H} + \underset{(.20)}{.003D_1H} + \underset{(1.61)}{.02D_2H} + \underset{(2.22)^{*}}{.028D_3H} - \underset{(.58)}{.20L} - \underset{(.26)}{.138D_1L} \\
& - \underset{(3.62)^{**}}{2.17D_2L} - \underset{(7.25)^{**}}{4.24D_3L} - \underset{(.59)}{12.32Z^{-1/2}} - \underset{(.02)}{.61\,D_1Z^{-1/2}} - \underset{(1.17)}{48.07\,D_2Z^{-1/2}} \\
& - \underset{(6.22)^{**}}{256.06D_3Z^{-1/2}} \qquad \text{(I)}
\end{aligned}
$$

$$
\begin{aligned}
NX = {} & \underset{(.74)}{.93} - \underset{(.08)}{.14D_1} - \underset{(.013)}{.02D_2} + \underset{(2.77)^{**}}{4.87D_3} - \underset{(.19)}{.005K_1} + \underset{(.034)}{.001D_1K} + \underset{(.31)}{.009D_2K} \\
& + \underset{(.53)}{.015D_3K} + \underset{(.67)}{.006H} + \underset{(.20)}{.003D_1H} + \underset{(1.66)}{.02D_2H} + \underset{(2.47)^{*}}{.03D_3H} - \underset{(.61)}{.20L_1} - \underset{(.28)}{.14D_1L} \\
& - \underset{(3.75)^{**}}{2.16D_2L} - \underset{(7.39)^{**}}{4.3D_3L} + \underset{(.79)}{31.56S} - \underset{(.56)}{35.7D_1S} - \underset{(.022)}{3.16D_2S} - \underset{(5.42)^{**}}{782.2D_3S} \\
& - \underset{(.99)}{26.5Z^{-1/2}} + \underset{(.36)}{12.76D_1Z^{-1/2}} - \underset{(.81)}{35.8D_2Z^{-1/2}} - \underset{(4.26)^{**}}{189.9D_3Z^{-1/2}} \qquad \text{(II)}
\end{aligned}
$$

1963 and 1980. For all industries the null hypothesis of no changes in the coefficients was accepted only for K and rejected for all the other factors at the .01 level. This suggests that U.S. net exports of manufactures to the NICs have been making increasingly less direct use of the (L) labor and (S) scale factors and more direct use of (H) human capital throughout the period. The NICs had "emerged" as major traders by 1980.

As for the results pertaining to U.S. trade with other developing countries (LDCs), Table 4.7 indicates that all the regression coefficients are identical except for C and $Z^{1/2}$. This suggests that even though there have been some structural changes, net U.S. exports in manufactured products to the LDCs have made neither more nor less direct use of human capital or any of the other production factors in 1980 compared to 1963. This is perhaps because LDCs exported manufactured products basically in the same commodity groups during this period, although their exports have grown over time.[3]

In conclusion, the analysis in this chapter indicates that some structural changes have occurred in U.S. trade of manufactured goods with the world, as well as at the disaggregated level, between 1963 and 1980. This analysis, however, does not attempt to identify what may have caused the observed changes. The only group of countries for which the test indicated no structural change is DC_{II}. This study also found that Japan and the NICs "emerged" as the major U.S. trading partners between 1963 and 1980.

TABLE 4.7

Results of Scaled Regressions for the U.S. Trade with LDCs

$$NX = 1.42 - 1.02D_1 + .62D_2 + 8.33D_3 - .01K + .01D_1K - .004D_2K - .006D_3K$$
(.99) (.47) (.30) (3.95)** (.37) (.26) (.11) (.18)

$$+ .008H - .002D_1H + .008D_2H + .001D_3H - .25L + .17D_1L + .001D_2L$$
(.71) (.10) (.52) (.09) (.60) (.28) (.001)

$$- 1.06D_3L - 14.35Z^{-1/2} + 4.88D_1Z^{-1/2} - 75.63D_2Z^{-1/2}$$
(1.46) (.57) (.13) (1.52)

$$- 388.8D_3Z^{-1/2} \qquad \text{(I)}$$
(7.80)**

$$NX = 1.56 - 1.22D_1 + .46D_2 + 8.01D_3 - .013K + .012D_1K - .002D_2K$$
(.99) (.52) (.21) (3.60)** (.41) (.30) (.067)

$$- .005D_3K + .008H - .002D_1H + .008D_2H + .002D_3H - .25L + .18D_1L$$
(.14) (.71) (.10) (.52) (.13) (.60) (.28)

$$- .0003D_2L - 1.08D_3L + 10.80S - 3.87D_1S - 33.3D_2S - 261.12D_3S$$
(.00004) (1.47) (.21) (.048) (.19) (1.43)

$$- 19.2Z^{-1/2} + 11.06D_1Z^{-1/2} - 69.25D_2Z^{-1/2} - 366.7D_3Z^{-1/2}$$
(.57) (.24) (1.24) (6.52)**

(II)

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

The objective of this dissertation was to investigate the determinants of U.S. foreign trade in manufactured goods to the world as a whole and also of its bilateral trade with different countries and regions of the world. In Chapter Three, a multifactor proportions model was used to test for the simultaneous effect of several factor intensities on the comparative advantage of U.S. manufacturing, classified by the SITC. Specifically, the chapter began with a three-factor input version of the Heckscher-Ohlin model, with K, H, and L being the direct inputs of physical capital, human capital, and labor, respectively. It assumed the same linearly homogeneous production function for each commodity. The assumption of no factor intensity reversal was extended to a three-factor case. The hypothesis of the determination of comparative cost was applied to an empirical study of U.S. bilateral trade with six economically distinct countries and regions of the world. Using the Ordinary Least Squares (OLS) estimation technique, the correlation between net exports of U.S. industries and different economic characteristics was examined for several years (1963, 1967, 1977, and 1980). In addition to the three direct factors, a measure of economies of scale in production within industries was tested for significance in explaining the pattern of U.S. trade.

Regression analysis was applied to determine whether physical or human capital intensity cause an increase or decrease in U.S. net exports in its bilateral trade with another country or group of countries. The results suggest that there is no uniform pattern of U.S. bilateral trade with any country or group of countries. In all four years the United States implicitly exported human capital to the NICs and imported labor. The same was true of U.S. trade with the DC_{II} group of Western European countries until 1977. We also found, surprisingly, that in trade with all regions the United States does not derive an advantage from physical capital, as might be expected given the relatively high U.S. ranking in capital endowment. In fact, the estimated coefficient of physical capital was in all regressions (presented in Chapter 3 and Appendix B). In particular, it was highly significant in the case of U.S. trade with Canada. In fact, this trade relationship is primarily the source of the Leontief paradox.

It was found that scale economy influenced U.S. net exports to most regions of the world in 1963 but not in later years. As reviewed in Chapter 2, studies by Baldwin (1971) and Stern and Maskus (1981) indicated that "scale" generally was not a significant determinant of U.S. trade patterns. Using Baldwin's data and a different measure of scale (the one used here), Weiser and Jay arrived at the opposite conclusion. The findings here also are conflicting. The regression results for 1963 demonstrated clearly the importance of scale economy influences on U.S. trade in manufactures, but in later years this variable lost its significance.

Usually, when a variable fails to perform significantly in a regression, it is concluded that the theory which that variable represents is not valid. However, due to the level of aggregation involved in this analysis, another conclusion is warranted. It appears that as far as U.S. trade with the NICs (all years), DC_{II} countries, and Japan (1963 and 1967) is concerned, the three-direct factor input model provides a reasonable explanation of U.S. trade in manufactures. The negative sign for the coefficient of physical capital could be due to the inclusion of natural resources industries [commodity groups 681-689 (nonferrous metals)] in the data sample. Hence, the results confirm both the Leontief Paradox and his explanation for it, that is, the importance of human capital as a source of U.S. comparative advantage. Yet, results obtained for U.S. trade with DC_I (all years), Japan (1977), and DC_{II} (1977 and 1980) showed that none of the regression coefficients were significant. Hence, it could be concluded that with net export as the dependent variable, the factor proportions model does not explain U.S. comparative advantage in manufactuing trade with these regions.

It was hypothesized that in the latter cases intraindustry trade tends to predominate. The hypothesis was tested directly with our data set using a rough measure (index) of intraindustry trade. The results confirmed that trade between the United States and Europe is mainly intraindustry. It was also found that intraindustry trade between the United States and Japan has increased substantially between 1963 and 1980.

The dissertation also explored the structural changes that may have occurred in U.S. trade in manufactured goods with Japan, Canada, and the NICs over the past two decades. It appears that there were no structural changes in U.S. trade with the industrial countries of Western Europe between 1963 and 1980. As far as U.S.-Japanese trade is concerned, the human capital coefficient became more significantly negative in 1980 as compared to 1963. This suggests that U.S. net exports of manufactures to Japan has been making less direct use of human capital over the period. It was also discovered that there were structural changes in U.S.-Canadian trade over these years, the difference being less use of physical capital in 1980 compared to 1963. U.S. net exports to the NICs made less direct used of unskilled labor and scale economy and more direct use of human capital from 1963 to 1980. It was found that Japan and the NICs have grown in importance as trade partners of the United States between 1963 and 1980.

A good deal of effort over the years has gone into empirical verification of trade theories. Although empirical studies have often been inconclusive, most of them have been suggestive, and they have been successful in stimulating the further development of theory more in accord with empirical reality. It is difficult to single out one theory which successfully explains the pattern of trade in general. Nevertheless, the consensus has favored the generalized factor proportions model - allowing for human capital, as well as physical capital and labor as separate factors, and perhaps also including certain natural resources. Obviously, not all trade data or patterns can be accommodated by the factor proportions theory, and there are cases of trade in particular industries for which a technology explanation is clearly the most appropriate. But as a general approach to understanding trade, the factor proportions theory has stood up fairly well to empirical scrutiny. This does not mean that the orthodox factor proportions theory, even in its multiple-factor version, is necessarily sufficient for describing the world economy. There is need for something more, or different, to explain the substantial amount of intraindustry trade taking place among industrial countries with similar factor endowments. With the recent growth of formal models of industrial organization, the need to integrate those with the theories of international trade has been recognized. In recent years there have been several attempts to develop new international trade theories [Krugman (1979, 1980, 1981), Lancaster (1980), Dixit and Norman (1980) and Helpman (1981)] to explain the pattern of trade among industrialized countries. Development of new trade theories suggests a new orthodoxy which integrates the Heckscher approach to international trade with a Chamberlin-type approach to product differentiation, economies of scale, and monopolistic competition.

APPENDICES

APPENDIX A

TABLE A-I

Concordance Between the three-digit Standard International Trade Classification (SITC) (top number in bold face) and United States four-digit Standard Industrial Classification (SIC)

512	**571**	**642**	2395	3313	3497
2818	2892	2641	2396	3321	
		2642	2397	3322	**685**
513	**581**	2643	2399		3332
2812	2821	2644		**672**	3356
2813		2645	**657**	3312	3399
2895	**599**	2646	2271	3323	
	2861	2647	2272		**686**
514	2891	2649	2279	**673**	3333
2819	2899	2651	3982	3312	3356
		2652			3399
515	**611**	2653	**661**	**674**	
nil	3111	2654	3241	3312	**687**
		2655	3274	3316	3339
521	**612**	2661	3281		3356
2814	3121			**675**	3399
2815	3131	**651**	**662**	3312	
		2281	3251	3316	**688**
531	**613**	2282	3253		3339
2818	3992	2283	3255	**676**	
		2284	3259	3312	**689**
532	**621**				3339
nil	nil	**652**	**663**	**677**	
		2211	3271	3312	**691**
533	**629**	2261	3272	3315	3441
2816	3011		3291		3442
2851	3069	**653**	3292	**678**	3444
2893		2221	3293	3317	3446
	631	2231	3295		3449
541	2431	2262	3296	**679**	2542
2831	2432	2269	3297	3391	
2833	2433	2296	3299		**692**
2834				**681**	3443
	632	**654**	**664**	3339	3491
551	2441	2241	3211		
2087	2442	2292		**682**	**693**
	2443		665	3331	3357
553	2445	**655**	3221	3341	3481
2844	2499	2291	3229	3351	
	2541	2295		3399	**694**
554		2298	**666**		3452
2841	**633**	3987	3262	**683**	
2842	nil		3263	3339	**695**
2843		**656**		3399	3423
	641	2299	**667**		3425
561	2621	2391	nil	**684**	3429
2871	2631	2392		3334	
2872		2393	671	3352	**696**
2879		2394	3312	3399	3421

TABLE AI (cont'd.)

697	3554	**726**	3494	2387	2789
nil	3555	3693	3495	2389	
	3559			3151	**893**
698	2794	**729**	**821**		3079
3411		3622	2511	**842**	
3392	**719**	3623	2512	2371	**894**
3361	3553	3624	2514		3941
3362	3561	3629	2515	**851**	3942
3369	3562	3611	2519	3021	3943
3492	3564	3641	2521	3141	3949
3493	3466	3642	2522	3142	
3496	3567	3691	2531		**895**
3499	3569	3692	2599	**861**	3951
2591	3581	3693		3811	3952
3993	3582	3694	**831**	3821	3953
3964	3585	3699	3161	3822	3955
	3586		3171	3831	
711	3589	**731**	3172	3841	**896**
3511	3599	3741		3842	nil
3519		3742	**841**	3843	
	722		2251	3851	**897**
712	3612	**732**	2252		3911
3522	3613	3713	2253	**862**	3912
	3621	3715	2254	2793	3913
714		3717	2256	3861	3914
3571	**723**		2259		3961
3572	3643	**733**	2311	**863**	
3576	3644	3751	2321	nil	**899**
3579		3791	2322		3199
	724	3799	2323		3962
715	3651		2327	**864**	3963
3541	3652	**734**	2328	3871	3981
3542	3661	3721	2329	3872	3983
3544	3662	3722	2331		3984
3545	3671	3723	2335	**891**	3995
3548	3672	3729	2337	3931	
	3673		2339		
717	3674	**735**	2341	**892**	
3552	3679	3731	2342	2711	
		3732	2351	2721	
718	**725**		2352	2731	
3531	3631	**812**	2361	2732	
3532	3632	3231	2363	2751	
3533	3633	3261	2369	2752	
3534	3634	3264	2381	2753	
3535	3635	3269	2384	2761	
3536	3636	3431	2385	2771	
3537	3639	3433	2386	2782	
3551					

TABLE AII

Concordance Between the three-digit Standard International Trade Classification (SITC) (top number in bold face) and United States four-digit Standard Industrial Classification (SIC) (1977 & 1980)

512	**571**	**642**	2394	3312	**684**	3495
2869	2892	2641	2395	3313	3334	3496
		2642	2396	3321	3353	
513	**581**	2643	2397	3322	3354	**694**
2812	2821	2645	2399		3355	3452
2813		2646		**672**	3398	
2895	**599**	2547	**657**	3312	3399	**695**
	2861	2648	2271	3324	3497	3423
514	2891	2649	2272	3325		3425
2819	2899	2651	2279		**685**	3429
		2652	3996	**673**	3332	
515	**611**	2653		3312	3356	**696**
nil	3111	2654	**661**		3398	3421
		2655	3241	**674**	3399	
521	**612**	2661	3274	3312		**697**
2865	3131		3281	3316	**686**	nil
	3199	**651**			3333	
531		2281	**662**	**675**	3356	**698**
2869	**613**	2282	3251	3312	3398	3411
	3999	2283	3253	3316	3399	3463
532		2284	3255			3361
nil	**621**		3259	**676**	**687**	3362
	nil	**652**		3312	3339	3369
533		2211	**663**		3356	3499
2816	**629**	2261	3271	**677**	3398	3493
2851	3011		3272	3312	3399	3993
2893	3041	**653**	3291	3315		3964
	3069	2221	3292		**688**	2591
541		2231	3295	**678**	3339	
2831	**631**	2262	3296	3317		**711**
2833	2431	2269	3297		**689**	3511
2893	2434	2296	3299	**679**	3339	3519
	2435			3462		
551	2436	**654**	**664**		**691**	**712**
2087	2439	2241	3211	**681**	3441	3523
		2292		3339	3442	3524
553	**632**		**665**		3444	
2844	2441	**655**	3221	**682**	3446	**714**
	2449	2291	3229	3331	3448	3573
554	2492	2295		3341	3449	3576
2841	2499	2298	**666**	3351	2542	3579
2842	2541	3999	3262	3398		
2843			3263	3399	**692**	**715**
	633	**656**			3443	3541
561	nil	2299	**667**	**683**	3412	3542
2874		2391	nil	3339		3544
2875	**641**	2392		3398	**693**	3545
2879	2621	2393	**671**	3399	3357	3546
	2631					

TABLE AII (cont'd.)

3547	724	733	2251	3823	3951
3549	3621	3751	2252	3824	3952
	3652	3792	2253	3829	3953
717	3661	3799	2254	3832	3955
3552	3662	2451	2257	3841	
	3671		2258	3842	896
718	3674	734	2259	3843	nil
3531	3675	3721	2311	3851	
3532	3676	3724	2321		897
3533	3677	3728	2322	862	3911
3534	3678	3764	2323	2793	3914
3535	3679	3769	2327	3861	3915
3536			2328		3961
3537	725	735	2329	863	
3551	3631	3731	2331	nil	899
3554	3632	3732	2335		3199
3555	3633		2337	864	3962
3559	3634	812	2339	3873	3963
2794	3635	3231	2341		3991
	3636	3261	2342	891	3999
719	3639	3264	2351	3931	
3553		3269	2352		
3561	726	3431	2361	892	
3562	3693	3432	2363	2711	
3563		3433	2369	2721	
3564	729	3494	2381	2731	
3566	3622	3498	2384	2732	
3567	3623		2385	2751	
3568	3624	821	2386	2752	
3569	3629	2511	2387	2753	
3581	3641	2512	2389	2754	
3582	3642	2514	3151	2761	
3585	3691	2515		2771	
3586	3692	2517	842	2782	
3589	3693	2519	2371	2789	
3592	3694	2521		2795	
3599	3699	2522	851		
		2531	3021	893	
722	731	2599	3142	3079	
3612	3743		3143		
3613		831	3144	894	
3621	732	3161	3149	3942	
	3713	3171		3944	
723	3715	3172	861	3949	
3643	3711		3811		
3644	3714	841	3822	895	

Note: There is no one-to-one correspondence between the two schemes. The same four-digit SIC industry frequently contributes to more than one three-digit SITC commodity, while some three-digit SITC groups find no counterpart four-digit industry. This concordance was used in estimating physical capital, human capital, labor and scale economies for three-digit SITC groups.

Hufbauer included the total figures for certain four-digit SIC industries in more than one three-digit SITC commodity group. For example: SIC 3399 (Primary Metal Products, N.E.C.) was included in SITC groups 682, 683, 684, 685, 686, 687. This resulted in serious overstatement of factor inputs primarily within the two-digit SITC group 68 (Nonferrous Metals).

To avoid this distortion I allocated the figures of those SIC industries that were included in more than one SITC group according to the percentage of exports that each SITC group contributed to the total. In the example mentioned above, SITC group 682 accounted for 22.7 percent of the exports of groups 682-687 in 1977 so I allocated to it 22.7 percent of the capital, labor, wages and shipments of industry 3399. The choice of exports rather than output for computing the allocation factors was dictated by the fact that exports and imports were the only data available on an SITC basis. Having an imperfect allocation seems more acceptable than multiple counting. However, there are a few cases in which an SITC group has exports so low that only a very small percentage of the corresponding SIC industry figures was allocated to it. In some instances this resulted in an SITC group with exports larger than the volume of shipments. These groups were excluded from the analysis.* Furthermore, Hufbauer did not provide any data on

the inputs for eight SITC groups so these were also excluded from our analysis leaving us with 90 three-digit SITC groups in 1963 and 92 groups in 1967 and 1977 for which both trade and factor input data were available.**

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* The groups excluded were 681, 688, 689 and 726 in 1963, and 688 and 726 in 1967 and 1977.

** Groups 515, 532, 621, 633, 667, 697, 863, 896.

APPENDIX B

TABLE B1

Weighted Regressions at the 3-digit Level U.S. Trade with the World#

	Independent Variables						
Dependent Variable	$Z^{-1/2}$	K	L	H	S	N	Eq. No.
NX (1963)	-13.23 (1.04)	.02 (1.28)	-.63 (1.76)	.02 (2.4)*		90	(A_1)
NX (1967)	-44.16 (3.73)**	-.018 (1.09)	-.72 (2.06)*	.042 (4.02)**		92	(A_2)
NX (1977)	-195.21 (3.8)**	-.042 (1.15)	-1.3 (1.03)	.05 (2.3)*		92	(A_3)
NX (1980)	-310.37 (3.3)**	.02 (.30)	-1.4 (.59)	.04 (.99)		89	(A_4)
NX (1963)	-32.76 (2.15)*	.027 (1.7)	-.54 (1.5)	.022 (2.2)*	149.9 (2.2)*	90	(B_1)
NX (1967)	-40.99 (3.32)**	-.019 (1.17)	-.73 (2.10)*	.042 (4.04)**	44.8 (.91)	92	(B_2)
NX (1977)	-190.62 (3.44)**	-.042 (1.16)	-1.32 (1.03)	.050 (2.3)*	-88.9 (.22)	92	(B_3)
NX (1980)	-242.7 (2.43)*	.01 (.16)	-1.6 (.69)	.04 (1.10)	-132.1 (1.85)	89	(B_4)

\# (A) Without Economies of Scale

(B) With Economies of Scale

TABLE B2

Cross Section Regressions Explaining U.S. Bilateral Trade With Japan:
Net U.S. Export of Manufactured Goods, 3-digit SITC

	Independent Variables						
Dependent Variable	$Z^{-1/2}$	K	L	H	S	N	Eq. No.
NX (1963)	-6.29 (3.17)**	-.001 (.53)	-.169 (3.03)**	.005 (3.11)**		90	(A_1)
NX (1967)	-6.61 (2.3)*	-.0006 (.16)	-.186 (2.19)*	.003 (1.27)		90	(A_2)
NX (1977)	-49.9 (2.18)*	.018 (1.1)	.33 (.59)	-.02 (1.95)		92	(A_3)
NX (1980)	-26.87 (.91)	.047 (2.23)*	1.25 (1.72)	-.05 (3.9)**		89	(A_4)
NX (1963)	-9.78 (3.93)**	.0001 (.045)	-.15 (2.8)**	.005 (2.94)**	13.72 (2.24)*	90	(B_1)
NX (1967)	-7.98 (2.69)**	-.0003 *(.007)	-.181 (2.15)*	.003 (1.23)	-18.91 (1.63)	90	(B_2)
NX (1977)	-50.43 (2.03)*	.019 (1.14)	.33 (.58)	-.019 (1.94)	9.25 (.05)	92	(B_3)
NX (1980)	-23.76 (.75)	.047 (2.19)*	1.24 (1.70)	-.05 (3.88)**	-60.60 (.27)	89	(B_4)

TABLE B3

Cross Section Regressions Explaining U.S. Bilateral Trade with Canada:

Net U.S. Export of Manufactured Goods, 3-digit SITC

Dependent Variable	Independent Variables						
	$Z^{-1/2}$	K	L	H	S	N	Eq. No.
NX (1963)	-3.83 (.71)	-.007 (1.06)	.046 (.31)	.002 (.49)		90	(A_1)
NX (1967)	-10.42 (1.49)	-.016 (1.7)	.118 (.57)	.007 (1.10)		90	(A_2)
NX (1977)	-16.31 (1.09)	-.058 (5.49)**	.58 (1.57)	.015 (2.38)*		92	(A_3)
NX (1980)	-76.84 (2.67)**	-.092 (4.43)**	.88 (1.24)	.026 (2.08)*		89	(A_4)
NX (1963)	-3.75 (.54)	-.007 (1.03)	.046 (.302)	.002 (.48)	-.32 (.018)	90	(B_1)
NX (1967)	-8.06 (1.1)	-.017 (1.8)	.11 (.53)	.007 (1.1)	32.33 (1.13)	90	(B_2)
NX (1977)	-9.72 (.60)	-.059 (5.55)**	.56 (1.5)	.15 (2.43)*	-127.5 (1.11)	92	(B_3)
NX (1980)	-61.14 (1.99)*	-.094 (4.56)**	.84 (1.18)	.027 (2.16)*	-306.6 (1.40)	89	(B_4)

TABLE B4

Cross-Section Regressions Explaining U.S. Trade with DC_I:

Net U.S. Export of Manufactured Goods, 3-digit SITC

	Independent Variables						
Dependent Variable	$Z^{-1/2}$	K	L	H	S	N	Eq. No.
NX (1963)	-1.93 (1.04)	-.0005 (.24)	-.002 (.04)	.00007 (.047)		90	(A_1)
NX (1967)	-5.66 (1.83)	-.005 (1.09)	-.002 (.02)	.001 (.57)		90	(A_2)
NX (1977)	-17.19 (2.03)*	.0001 (.02)	.306 (1.48)	-.004 (1.24)		92	(A_3)
NX (1980)	60.71 (1.98)*	.014 (.54)	.20 (.27)	-.012 (.89)		89	(A_4)
NX (1963)	-5.84 (2.5)*	.001 (.45)	.015 (.30)	-.0003 (.22)	15.4 (2.7)**	90	(B_1)
NX (1967)	-6.11 (1.88)	-.004 (1.04)	-.0002 (.002)	.001 (.55)	-6.13 (.48)	90	(B_2)
NX (1977)	-19.77 (2.17)*	.0004 (.069)	.31 (1.5)	-.004 (1.16)	49.84 (.77)	92	(B_3)
NX (1980)	45.42 (1.39)	-.014 (.64)	.25 (.33)	-.013 (.96)	298.6 (1.28)	89	(B_4)

TABLE B5

Cross-Section Regressions Explaining U.S. Trade with DC_{II}:

Net U.S. Export of Manufactured Goods, 3-digit SITC

Dependent Variable	Independent Variables						
	$Z^{-1/2}$	K	L	H	S	N	Eq. No.
NX (1963)	-2.38 (1.33)	.004 (2.1)*	-.18 (3.59)**	.005 (3.45)**		90	(A_1)
NX (1967)	-10.83 (3.88)**	.003 (.69)	-.183 (2.22)*	.006 (2.63)**		90	(A_2)
NX (1977)	-18.98 (2.4)*	-.003 (.55)	-.29 (1.43)	.007 (2.14)*		92	(A_3)
NX (1980)	30.98 (1.48)	-.005 (.34)	-.41 (.80)	.01 (1.14)		89	(A_4)
NX (1963)	-5.19 (2.3)*	.006 (2.6)*	-.17 (3.37)**	.005 (3.3)**	11.07 (1.99)*	90	(B_1)
NX (1967)	-9.28 (3.24)**	.002 (.53)	-.19 (2.32)*	.006 (2.72)**	21.24 (1.89)	90	(B_2)
NX (1977)	-18.80 (2.14)*	-.003 (.55)	-.29 (1.4)	.007 (2.13)*	-3.35 (.05)	92	(B_3)
NX (1980)	27.95 (1.24)	-.005 (.31)	-.40 (.77)	.01 (1.12)	59.17 (.37)	89	(B_4)

TABLE B6

Cross-Section Regressions Explaining U.S. Trade with NICs:

Net U.S. Export of Manufactured Goods, 3-digit SITC

	Independent Variables						
Dependent Variable	$Z^{-1/2}$	K	L	H	S	N	Eq. No.
NX (1963)	-5.11 (1.64)	.008 (2.16)*	-.159 (1.82)	.005 (2.11)*		90	(A_1)
NX (1967)	-2.32 (.48)	.002 (.38)	-.261 (1.82)	.009 (2.26)*		90	(A_2)
NX (1977)	-39.22 (2.88)**	.008 (.82)	-2.24 (6.69)**	.027 (4.76)**		92	(A_3)
NX (1980)	-116.91 (3.42)**	.041 (1.66)	-3.53 (4.2)**	.040 (2.71)**		89	(A_4)
NX (1963)	-9.89 (2.51)*	.01 (2.61)*	-.138 (1.59)	.005 (1.94)	18.78 (1.93)	90	(B_1)
NX (1967)	-1.98 (.39)	.002 (.35)	-.262 (1.81)	.01 (2.25)*	4.64 (.23)	90	(B_2)
NX (1977)	-40.29 (2.74)**	.008 (.82)	-2.24 (6.6)**	.03 (4.72)**	20.79 (.199)	92	(B_3)
NX (1980)	-75.87 (2.17)*	.035 (1.48)	-3.65 (4.55)**	.042 (3.03)**	-801.3 (3.22)**	89	(B_4)

TABLE B7

Cross-Section Regressions Explaining U.S. Trade with LDCs:

Net U.S. Export of Manufactured Goods, 3-digit SITC

	Independent Variables						
Dependent Variable	$Z^{-1/2}$	K	L	H	S	N	Eq. No.
NX (1963)	6.01 (.79)	.013 (1.45)	-.129 (.60)	.005 (.91)		90	(A_1)
NX (1967)	-3.85 (1.12)	.002 (.43)	-.037 (.37)	.007 (2.24)*		90	(A_2)
NX (1977)	-41.31 (2.7)**	-.006 (.53)	.04 (1.1)	.018 (2.82)**		92	(A_3)
NX (1980)	-170.8 (4.03)**	.026 (.86)	.103 (.99)	.019 (1.03)		89	(A_4)
NX (1963)	8.73 (.89)	.012 (1.28)	-.14 (.65)	.006 (.94)	10.71 (.44)	90	(B_1)
NX (1967)	-3.07 (.85)	.002 (.35)	-.04 (.39)	.007 (2.25)*	10.706 (.76)	90	(B_2)
NX (1977)	-39.27 (2.37)*	-.006 (.55)	.035 (.09)	.018 (2.82)**	39.48 (.34)	92	(B_3)
NX (1980)	-153.1 (3.37)**	.024 (.77)	.049 (.47)	.02 (1.08)	-345.5 (1.06)	89	(B_4)

FOOTNOTES

FOOTNOTES

CHAPTER TWO

[1]Derivation of H-O theorem can be found in any textbook. See, for example, Kemp (1969, pp. 74-77).

[2]Identical and homothetic tastes imply that the consumption ratio of two commodities, D^X/D^Y is the same in two countries under the same set of commodity prices. Hence, at the world trading equilibrium where commodity prices are equalized, the total world outputs of two commodities must be produced by the same ratio as the consumption ratio in each country. That is, at a post-trade equilibrium.

$$\frac{D_X^A}{D_Y^A} = \frac{D_X^B}{D_Y^B} = \frac{D_X^A + D_X^B}{D_Y^A + D_Y^B} = \frac{Q_X^A + Q_X^B}{Q_Y^A + Q_Y^B} \quad \text{Thus if} \quad \frac{Q_X^A}{Q_Y^A} \gtreqless \frac{Q_X^B}{Q_Y^B} \quad \text{then} \quad \frac{Q_X^A}{Q_Y^A} \gtreqless \frac{D_X^A}{D_Y^A}.$$

[3]See Masahiro Tatemoto and Shinichi Ichimura, Donald F. Wahl, Ranganath Bharodwaj, and Karl W. Roskany.

[4]See Baldwin "Determinants of Trade and Foreign Investment: Further Evidence".

[5]United States, Sweden, West Germany, United Kingdom, Netherlands, Belgium, Italy, France, and Japan.

[6]See tables 4-6 in Kenen's paper "Nature, Capital and Trade," Journal of Political Economy, October 1965, pp. 456-458.

[7]See Griliches (1970) and comment by Conlisk (1970).

[8]The index of employment concentration, calculated for each SIC 2-digit industry, consists of a ratio whose numerator is employment in constituent SIC 4-digit industries in which the largest 8 firms accounted for 60 percent or more of 2-digit total employment, and whose denominator was total employment in the 2-digit industry.

[9]1961 Starch Consumer Survey, Daniel Starch and Company.

[10]For example, see Hufbauer (1966) and Wells.

[11]First trade dates are expressed in a decimal version of the Christian calendar. The dates were found by examining successive issues of United States Census Bureau Schedule B (the detailed schedule of exportable goods) for the first appearance of specific commodities. See Hufbauer.

[12]Gray, A Generalized Theory of International Trade, New York: Holmes and Meier, 1976, pp. 172.

[13]In Krugman's model, which is derived from the work by A. Dixit and J. Stiglitz, equilibrium takes the form of Chamberlinian monopolistic competition: each firm has some monopoly power, but entry drives monopoly profits to zero. When two imperfectly competitive economies of this kind are allowed to trade, increasing returns produce trade and gains from trade even if both economies have identical tastes, technology, and factor endowments.

[14]Lancaster, "Intraindustry Trade Under Perfect Monopolistic Competition," Journal of International Economics, May 1980, pp. 152.

FOOTNOTES

CHAPTER THREE

[1]See Lary, Imports of Labor-Intensive Manufactures from Less Developed Countries, New York: Columbia University Press, 1968.

[2]This is also the view expressed by Donald B. Keesing in "Labor Skills and International Trade: Evaluating Many Trade Flows with a Single Measuring Device," Review of Economics and Statistics, August 1965, pp. 287-294.

[3]Strictly speaking, in a list of goods ranked from those with largest net exports to those with largest net imports, a country has comparative advantage in producing the goods higher on the list relative to those lower on the list.

[4]The application of this form of equation is traditional in the literature. See for example, Baldwin, "Determinants of Commodity Structure of U.S. Trade," American Economic Review (March 1971), Branson and Junz, "Trends in U.S. Trade and Comparative Advantage," Brookings Papers on Economic Activity (1971) and Branson and Monoyios, "Factor Inputs in U.S. Trade," Journal of International Economics (May 1977).

[5]The New Industrial Countries or NICs, include: Hong Kong, Taiwan, South Korea, Yugoslavia, Singapore, Brazil, India, Mexico, Argentina, Malaysia, and Pakistan.

[6]D Keesing, "World Trade and Output of Manufactures: Structural Trends and Developing Countries' Export," World Bank Staff Working Paper No. 316, January 1979, Washington, p. 27.

[7]The income per capita comparison between the United States and the European countries is based on exchange rate calculation and not purchasing power.

[8]Source: World Development Report, 1980.

[9]See Table A-I, Hufbauer, "The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods," in The Technology Factor in World Trade. Edited by R. Vernon, New York: Columbia University Press, 1970.

[10]There was a substantial redefinition of SIC industries in 1972, details of which are available in the 1972 Census of Manufactures. Vol. 1. I attempted to maintain continuity in the industry definitions for

the entire period, but some changes in coverage could not be satisfactorily resolved so that our results before and after 1972 may not be strictly comparable.

[11]The O.E.C.D. Bulletins of Foreign Trade, Series C, provide detailed information on the pattern of trade flows of O.E.C.D. member countries on the basis of the Standard International Trade Classification by country or country groupings (areas) of partner countries. The first revision of this classification, which took effect in 1961, has been utilized in this publication up to 1977. from 1978 onwards, the SITC Revision 2 is applied. In order to maintain comparability in the definition of commodity groups (at 3-digit level) for 1980 some three-digit SITC (Revision 2) had to be aggregated. Just as an example, to obtain commodity group 712 [agricultural machinery and implements (according to the first revision)], commodity groups 721 [agricultural machinery (excluding tractors) and parts thereof, n.e.s.], and 722 (tractors) had to be lumped together. The above adjustments would make the 1980 trade data comparable to the three previous years.

[12]See Appendix A to Branson and Monoyios, "Factor Inputs in U.S. Trade," Journal of International Economics, May 1977.

[13] $\tilde{W}$ the median wage for males with eight years of education in 1963 was $2,397 per year (Current Population Reports, Series P-60, No. 42. June 12, 1964, p. 39), $2,990 per year in 1967 (Current Population Reports, Series P-60, No. 60, June 30, 1969, p. 27), and $5,402 per year in 1977 (Current Population Reports, Series P-60, No. 118, March 1979, p. 185).

[14]As Baldwin (1971) has noted, the differential wage includes not only the return to human capital but many other factors. However, a precise estimation of human capital itself would require a separate study, if it is possible at all. The above estimation method is used in the trade literature.

[15]When Kenen aggregated the human and physical capital, the choice of capitalization rate was crucial, because the Leontief paradox was reversed when a 9% discount rate was used but not with a 12.7% rate. in our case the 10% rate of discount is a constant divisor for one of the variables (H) in a multiple regression and therefore affects only the size of the coefficient and not its sign or level of significance.

[16]Branson and Monoyios, op. cit., Appendix A.

[17]Presented in Hufbauer, op. cit, p. 179-181.

[18]Ibid., p. 179-181.

[19]There is also the "survival" approach used by G.J. Stigler.

[20]For treatment of heteroscedasticity, see Johnson, Econometric Methods, New York: McGraw-Hill Book Co., 1972, pp. 214-221.

[21]Z_{it} is the volume of shipments for commodity group i at timed t, which is used as a proxy for the industry size. U.S. Census of Manufactures is the source of data.

[22]See Branson and Monoyios, op. cit., p. 198.

[23]Stern and Maskus, "Determinants of the Structure of U.S. Foreign Trade, 1958-76," Journal of International Economics, 1981, pp. 207-224.

[24]See Bela Balassa, "Tariff Reduction and Trade in Manufactures," American Economic Review, June 1966; and Mordechai E. Kreinin, "Static Effect of E.C. Enlargement on Trade Flows in Manufactured Products," Kyklos, 1981.

CHAPTER FOUR

FOOTNOTES

[1]Chow test which basically is analysis of covariance is another test for the same purpose.

[2]See Gujarati, "Use of Dummy Variables in Testing for Equality Between Sets of Coefficients in Linear Regressions: A Generalization," The American Statistician, December 1970, p. 18-22.

[3]In 1963 LDCs had export surplus in 15 manufacturing commodity groups (3-digit SITC). In 1980 this group of countries had export surplus in the same 15, as well as 6 additional commodity groups (total of 21 commodity groups).

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