

Factor Proportions and the pattern of Foreign Trade: The Case of Puerto Rico

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Note:

This work is based on Chapter 6 on my doctoral dissertation written for the University of Wales, Great Britain. Only one input-output matrix was used in the dissertation.

In the present work I am using three matrices: 1963, 1967, and 1972. The same is true for labor coefficients and indirect capital requirements. Comments are welcome.

Introduction

The subject matter of this work falls within the field of what the specialists in this branch of economics call the "pure" theory, as distinct from the "monetary" theory, of international trade. The pure theory of international trade deals with two different kinds of problems: (1) those related to positive economics and (2) those related to "normative" economics. In other words, it applies the theories of value and welfare economics to problems of international economics. For instance, a question such as Aldrich factors determine the patterns of trade between countries, is related to the positive "pure" theory of international trade. On the other hand, questions such as whether free trade is better than no trade or whether free trade maximizes world income fall within those aspects analyzed by the "normative" (or pure welfare) theory of international trade (Bhagwati, J. (3) p.1 ; (4) p.7)

The basic questions related to the bases of trade, the pattern of trade, the terms of trade or the gains from trade are mostly approached in terms of the comparative costs doctrine. According to one writer (Bhagwati, J. (4) p.9).

"the serious study of international economic might be considered to have emerged contemporaneously with Ricardo's celebrated theory of comparative advantage".

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The point of departure for studying Ricardo's theory of international trade is his theory of value. According to this theory the value of commodities depends upon its labour costs. In his own words (Ricardo, D. (29) p.9):

"it is the comparative quantity of commodities which labour will produce that determines their present or past relative value, and not the comparative quantities of commodities which are given to the labourer in exchange for his labour".

Ricardo's theory of international trade then was based on his theory of value, -one factor of production (labour) two countries, and two commodity prices. His theory also abstracted the consideration of transport costs. Reading Chapter 7 of his Principles one also observes that no clear distinction is made between the "normative" and positive aspects of the pure theory. According to one writer (Viner, J. (37) p. 437), "the classical theory of international trade was formulated primarily with a view to its providing guidance on questions of national policy...the problems were expressly treated with reference to their bearing on 'gain' or loss to England, or on the distribution of gain as between England and the rest of the world". Therefore, Ricardian theory can be formulated in two ways, one relating to welfare aspects of trade and the other more connected with the explanation of the variables involved in the determination of the pattern of trade (Bhagwati, J. (3) p.437). Ricardian theory was endorsed by John Stuart Mill and remained largely unchallenged for almost a century, at least in England and the United States.

In the year of 1919 Eli Heckscher published an article which offered a different approach to Ricardian theory. The approach was also endorsed by his pupil Bertil Ohlin in his now famous book first published in 1933 (Heckscher, E. (15) pp. 272-300 and Ohlin, B

(27). The "new" approach came to be known as the Heckscher-Ohlin theory of comparative advantage. According to Bhagwati this theory was fully formalized in the 1950s and in its modern version it 'Gould probably be repudiated by them as an emasculated version of their writings" (Bhagwati, J. (4) p. 9 and his (3) p.17).

In the first edition of his book (in 1933) Ohlin summarized the conditions for trade as follows (Ohlin, B. (27), p.29).

“The first condition of trade is that some goods can be produced more cheaply in one region than in another. In each of them the cheap goods are those containing relatively great quantities of the factors cheaper than in the other regions. These cheap goods make up exports, whereas goods which can be more cheaply produced in the other regions are imported.”

In other words, Ohlin builds his theory about the pattern of trade around the differences in factor endowments between countries. While Ricardo assumed only one factor of production, the Heckscher-Ohlin theory assumes the existence of two factors of production, which makes factor endowments crucial to determining the comparative advantage a country may enjoy in the production of any commodity. Also, in contrast with Ricardo's theory, the H-O theory assumes the same production functions among countries, and is directed more towards a contribution to the 'positive" aspect of the theory rather than dealing with "normative" or welfare propositions. Its central theorem is then that

"a country's exports use intensively the country's abundant factor".¹

1. Bhagwati, J. (3) p.18. For a formal discussion of the Heckscher-Ohlin theorem see Chacholiades, M. (11), Chapter 9.

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In its modern version the H-O theory owes much to the works of Samuelson and others (See for instance Samuelson, p.(32) and (33) and it has been used mostly to answer questions of "comparative-static" rather than in dynamic analysis. For instance, Samuelson and Stolper used the Era work of H-O theory to establish the conditions under which a tariff will raise the return to a country's scarce factor (Samuelson, P. and Stolper, ELF., (34), also reproduced in Bhagwati, J. (4), Reading 10).

In spite of the many theoretical contributions to this theory, its empirical implementation or testing had to wait until the 1950's.

II The Empirical Testing of Comparative Cost Theory

A pioneering attempt to test Ricardo's theory was made by Donald McDougall. McDougall tested the extent to which the relative exports of the United States and Britain to the rest of the world were linked to their comparative layout costs vis a vis the other (MacDougall, G.D.A., (22). McDougall found that since wages in the U.S.A. were roughly twice those in Great Britain, the United States was the dominant exporter to third markets in those products in which its labour productivity was more than twice Britain's and Britain was the dominant exporter to third markets in product in which its labour productivity was less than twice that of the United States.²

The Heckscher-Ohlin theory of comparative advantage, or international specialization, was first tested by W. Leontief in his pioneer article to the American Philosophical Society (Leontief, W. (18). Reproduced in Bhagwati, J. (4), Reading Number 5). As is explained elsewhere in this work, in his article he applied for the first time

2. For a short explanation of this see Findlay, R. (14), pp. 88-92.

the tools of input-output to international trade theory to test the factor-intensities of the average exports and competitive imports in the United States. According to Leontief the general view in the United States was (at-least at that time) that the country had 'a comparative advantage in commodities which required for their production large quantities of Capital, and;relatively less" lab'our. He started his article by introducing the concepts of direct and indirect labour and capital requirements.

He followed his analysis by supposing the situation in which the United States wanted to reduce their dependence on foreign trade by reducing both its imports and exports by one million dollars. The reduction in both imports (competitive) and exports was to be done in such a way as to leave their percentage unchanged. The next step was to find how much capital and labour were embodied in an average million dollars' worth of competitive imports and exports. His results are reproduced below.

Capital and labour requirements per million dollars of U.S. exports
and competitive import replacement

	Import Replacement	Exports
Capital (dollars, 1947 - 100)	3,091,339	2,550,780
Labour (man-years)	170.004	182.313

Source: Leontief, W. (18)

Leontief's interpretation of the results are worth reproducing in his own words:³

3. Leontief, W (18) pages 125-126 as reproduced in Bhagwati, J. (4), Reading No. 5.

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“these figures show that an average million dollars' worth of our exports embodies considerably less capital and somewhat more labor than would be required to replace from domestic production an equivalent amount of our competitive imports. America's participation in the international division of labour is based on its specialization on labour intensive, rather than capital intensive lines of production...this country resorts to foreign trade in order to economize its capital and dispose of its surplus labor, rather than vice-versa. The widely held opinion that--as compared with the rest of the world--the United States' economy is characterized by a relative surplus of capital and a relative shortage of labor proves to be wrong.”

These results, to his own and other people's surprise, tend to contradict the now widely accepted H-O theory of comparative advantage, since everybody believed that the United States was the most richly capital endowed country in the world.⁴ The results of the test, which apparently contradicted H-O theory, became known as the "Leontief's Paradox". There were numerous criticisms of these results following almost immediately after Leontief's publication of his article. These criticisms can be classified into those related to the theoretical aspects involved, and those concerning the statistical procedures adopted or the data used. According to one writer:

"It is typical of his (referring to Leontief) and other contributions that, while factor-intensities are carefully ascertained, the factor-abundance of the country in question

4. In Leontief's results labour should be interpreted in 'efficiency units', since he posed the idea that U.S. workers were about three times as efficient as workers in the rest of the world.; The efficiency was mainly due to the better quality of U.S. labour force and not necessarily related to better managerial skill or more capital per-worker. Therefore, the U.S. was well endowed with labour measured in efficiency units.

is usually left Uninvestigated, except tangentially and vaguely. The result has been a failure to face up to the question raised by multi-country, multi-commodity analysis (Bhagwati (3) pp.21)."

One writer goes as far as to point out that Leontief's interpretation of his own data is in error (Ellsworth, P.T., (13) p.179). According to this writer, Léontief's data actually supports H-O theory. Other people, including Leontief himself, tried to rescue the theory by introducing a third factor of production, namely, natural resources (Leontief, W. (19), and also Vanek, J. (37) and Naya, S. (26).

Some other writers have tried to test the theory in their own countries. for instance, Wahl found that Canada's exports to U.S. were more capital intensive than the imports. Bharadwaj found that Indian bilateral trade with U.S. showed a quite similar pattern of capital intensive exports (Wahl, D.F., (39) and Bharadwaj, R. (6). M. Tatemoto and S. Ichimura found for Japan that an average million yens' worth of Japanese exports embodies more capital and less labor than would be required for the domestic replacement of competitive imports of an equivalent amount (Tatemoto, M. and S Ichimura (35), pp. 442-446).

One very important theoretical contribution to the explanation of Leontief's Paradox has been made by P.N. Mathur (Mathur, P.N., 23). This contribution is very important because it combines elements of both aspects of the pure theory of international trade namely, the "positive" and "formative" aspects, and in addition, it does not confine itself with static problems but enters into the field of economic growth or dynamic economics. This latter point is important, since according to some experts in this field "the trade theory has

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been confined by and large, to comparative-static" (Bhagwati, J. (4) p.11) According to P.N. Mathur (Mathur, P.N. (23), p.609-610):

"In all these discussions the effect of international trade on growth as distinct from that on income has been completely overlooked. The available models of the effect of trade on growth trace it through its; effect on income, which in its turn determines capital accumulation and growth. Its role in changing the structural composition of the economy in such a way as to alter its rate of growth has hardly been analyzed."

Mathur found that the empirical results of Leontief are such as would be expected if gains (welfare aspect) in terms not only of national income, but also of growth are taken into account. In other words, he distinguishes between two types of gains to be enjoyed by countries which engage in international trade, i.e., static gains and dynamic gains.

In what follows we will try to test, will data from the Puerto Rican economy and our results (capital and labour coefficients) from a previous study (Ruiz, A.L. (31) Chapters 3 and 4) some of the propositions of the-comparative costs theory--mainly those aspects concerning the factor content of Puerto Rican exports and competitive imports.

The case of Puerto Rico will be an interesting one for the following reasons:

1. Puerto Rico's strategy of economic development has been an "outward" looking one. Our exports as a percentage of value added in 1978 were 44.5% while our imports were 56.0t in the same year.
2. Unlike many countries in Latin America, Puerto Rico enjoy free access to the U.S. market and the island's exports are mostly manufactured products (mostly manufactured in Puerto Rico by branches of U.S. companies).

3. Our imports include a great number of commodities which can be classified as raw materials and capital goods.
4. Firms in Puerto Rica have, in most cases, adopted the methods of production of their parent companies in the United States.
5. As measured by its disposable personal income-per capita, which amounted to 2,543 during fiscal year 1978 (1,095 dollars in 1954 prices), Puerto Rico cannot be called a typical underdeveloped country.

Under the above-mentioned conditions, it will be interesting to examine the pattern of trade and the factor proportions or factor content of imports and exports in the Puerto Rican economy.

III. Pattern of Trade: The Puerto Rican Case

A. The Model

To test our model, the following data will be used:

- (1) An aggregated version (32 x 32) of 1963, 1967, and 1972 InputOutput Tables.⁵
- (2) Vectors of direct and indirect capital and labour requirements per unit of final demand.⁶
- (3) Vector of exports and competitive imports

5. Lack of data on investment by industrial sectors on annual basis made it impossible to use a more disaggregated Input-Out Table for the abovementioned years.

6. Direct capital coefficients are assumed to remain constant in the three periods under analysis. However, direct and indirect requirements will vary according to the input-output tables used.

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The methodology will follow the one used by Leontief in his articles (Leontief, W. (18) and (19). See also Roskamp, K.W. and McMeekin, G.C. (30).

Direct and indirect capital requirements are given by the following equation:

$$K_j = \sum_{i=1}^n \beta_j \bar{a}_{ij} \quad (1)$$

or in Matrix Notation: $K = B (I-A)^{-1}$

where: K_j is the vector of total (direct and indirect capital requirements per unit of final demand, \bar{a}_{ij} are the elements of the $(I-A)^{-1}$ and B the vector of capital coefficients.

Similarly, the direct and indirect labour requirements are given by:

$$E_j = \sum_{i=1}^n L_j \bar{a}_{ij} \quad (2)$$

or in matrix notation: $E = L (I-A)^{-1}$

where E_j is the vector of total labour requirements per unit of final demand, L_j the labour coefficients.

The input-output system that underlies the model becomes:

$$(I-A) X + n(N) - m(M) + (R) \quad (3)$$

- where:
- I = identity matrix
 - A = input-output coefficient matrix
 - X = Vector of outputs
 - n = column vector of exports coefficient defined as each sector's exports per million dollars of total exports (in dollars)
 - N = total value of exports in million dollars

- m = column vector of competitive import coefficients defined as each sector's competitive imports per million dollars of total competitive imports (in dollars)
- M = total competitive imports in million dollars $R \sim$ column vector of residual final demand

The solution to equation (3) is as follows:

$$X = (I-A)^{-1} [n(N) - m(M) + (R)] \quad (4)$$

Comparative Capital-Labour intensities and direct and indirect capital and labour requirements of a million dollars of competitive imports and a million dollars of exports are given by the following equations:

$$K_{ex} = B (I-A)^{-1} (n) = K(n) \quad (5)$$

$$K_{imp} = B (I-A)^{-1} (m) = K(m) \quad (6)$$

$$E_{ex} = L (I-A)^{-1} (n) = E(n) \quad (7)$$

$$E_{imp} = L (I-A)^{-1} (m) = E(m) \quad (8)$$

$$Z = \frac{K_{imp} / E_{imp}}{K_{ex} / E_{ex}} \quad (9)$$

where:

- K_{ex} = total (direct and indirect)- capital requirements per million dollars of total exports
- K_{imp} = total capital requirements per million dollars of total imports
- E_{ex} = total (direct and indirect) labour requirements per million dollars of total exports

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E_{imp} = total labour requirements per million dollars of total imports
(competitive)

Z = comparative capital-labour intensity

K and E are defined as in equations (11) and (12)

B. Computation and Results

The computational procedures will follow the mathematical model presented in section A above. Results will be given for three different years for which data could be obtained from the input-output table and in an unpublished form from the Puerto Rico Planning Board. These are 1963, 1967 and 1972. First, we will present the results for the industrial sectors included in our study. Second, we shall examine only manufacturing sectors plus mining (mainly quarries). Third, we shall analyze the capital and labour content of our exports and imports to foreign countries, excluding the United States.

In table 1 we present the vector of exports and competitive imports for the years 1963, 1967 and 1972. In table 2 the exports and import coefficients (in dollars) are presented (as defined by m and n in our model) for the same number of years. By applying our model, we obtained capital and labour requirements per million dollars of Puerto Rican exports and competitive imports for the years, 1963, 1967 and 1972.

Table 1

Export and Competitive Imports Vectors Puerto Rico
Fiscal Years 1963, 1967 and 1972 (in 1963 prices)

	Exports (in million dollars)			Imports (in million dollars)		
	1963	1967	1972	1963	1967	1972
Agriculture	13.9	7.1	7.6	45.5	90.5	66.2
Sugar Mills	149.2	94.4	10.6	0.2	1.0	2.4
Beverages	62.4	25.8	33.2	9.0	18.7	31.9
Dairy Products	6.4	1.4	1.3	30.1	29.1	45.6
Bakery Products	2.7	0.6	1.2	3.6	5.7	9.6
Other Food Products	55.7	77.5	137.5	166.7	181.9	293.2
Tobacco Products	80.2	117.2	93.4	28.6	50.4	43.7
Textiles	53.3	86.5	46.7	86.8	142.0	175.9
Apparel	141.5	216.9	271.2	60.7	64.4	93.2
Leather Products	39.8	65.1	38.9	36.3	43.4	46.0
Wood Products exe. Furn.	0.7	0.9	0.6	25.3	6.4	8.2
Furniture	1.2	3.6	3.2	14.0	37.0	33.5
Paper ~ Allied Products	6.8	5.8	5.3	29.7	31.9	49.6
Printing ~ Publishing	2.1	2.7	2.5	14.4	17.5	16.7
Chemicals	47.3	102.0	316.9	72.9	122.9	129.4
Petroleum ~ Coal	48.7	116.0	142.9	24.1	55.6	168.5
Non-metallic minerals	6.9	12.1	11.9	20.3	28.9	37.3
Metals	18.6	12.5	18.6	94.9	164.4	215.4
Machinery	66.6	95.1	167.9	98.9	139.4	204.2
Transportation Equipit.	0.7	1.6	1.4	4.6	50.0	84.5
Instruments & Other						
Manufacturing Sectors	81.2	99.8	123.3	61.2	126.9	298.3
Mining	0.1	0.2	0.2	0.2	0.5	0.6
Construction	14.7*	-	-	-	-	-
Trade	27.5	53.9	74.2	1.1	1.7	2.4
Transportation	50.1	55.0	79.6	35.6	57.8	87.1
Communications	2.2	2.6	4.0	2.2	3.1	3.9
Finance	3.9	7.2	10.5	-	-	-
Insurance	16.2	28.3	40.0	30.9	40.8	61.8
Real Estate	0.4	0.9	1.0	0.3	0.4	0.7
Services **	40.3	67.0	67.6	2.4	2.8	4.7
Electricity ~ Gas	-	-	-	-	-	-
Water ~ Sanitary Services	-	-	-	-	-	-
Total	1041.5	1360.0	1713.2	1011.0	1515.3	2214.7

* Unknown transaction connected with the Federal Government in the input-output table of 1963.

** In this table only miscellaneous services are included in the export vectors. -It does not include tourism or travel expenses. In the import vectors most services fall in the category of non-competitive imports.

The results are presented in Tables 3, 4, and 5 for the same number of years, respectively.

Table 3
Capital and Labour Requirements per Million Dollars of Puerto Rican
Exports and Import Substitution, 1963 (1963=100)

Industrial Sector	Direct and Indirect Requirements per million dollar of final output			Requirements per million dollars of Exports and Imports Replacements of Average 1963 Composition			
	Domestic Capital (in million dollars)	Total Capital (in million dollars)	Labour (man years)	Capital Contents (in million dollars)		Labour Contents (man years)	
				Exports	Imports	Exports	Imports
Agriculture	1.64	1.89	488	25,175.75	85,078.35	6.50	21.97
Shying	2.67	2.98	194	286.08	707.45	0.02	0.05
Construction	1.19	1.61	200	22,723.54	-	2.82	-
bairy Products	1.56	1.89	370	11,631.63	56,270.03	2.28	11.02
Bakery Products	1.45	2.18	203	5,572.36	7,762.54	0.52	0.72
Sugar Mills	2.35	2.70	334	386,794.44	435.24	47.85	0.05
Beverages	1.10	1.37	79	82,141.91	12,199.85	4.74	0.90
Other Food Products	1.43	2.30	221	122,952.71	379,313.47	11.81	36.45
Tobacco Products	0.82	1.49	231	114,700.50	42,206.34	17.78	6.54
Textile Products & Appare	10.59	1.21	153	226,306.78	176,614.50	28.62	22.33
Food & furniture	1.04	1.80	142	3,225.60	70,012.98	0.25	5.52
Paper & Illied Products	1.57	2.87	100	18,665.62	84,453.48	0.65	2.94
Printing & Publishing	0.82	1.39	126	2,873.27	19,857.26	0.08	1.80
Chemicals & Allied Products	0.99	1.73	41	78,654.10	124,823.48	1.86	2.96
Petroleum & Coal	0.88	2.93	19	137,054.56	69,943.20	0.89	0.45
Leather Products	0.50	1.30	157	49,688.34	46,692.10	6.00	5.64
Non-Metallic Minerals	1.88	2.33	134	15,547.39	46,802.71	0.90	2.69
Metals	0.83	1.77	74	31,642.56	166,220.70	1.32	6.95
Machinelike	0.71	1.38	91	88,307.58	134,949.23	5.82	8.90
Transportation Equipment	0.92	1.51	168	952.81	21,846.68	0.11	2.43
Instruments & Misc. Industries	0.57	1.60	124	124,678.40	96,830.88	9.66	7.50
Transportation	3.92	4.26	176	205,095.14	150,199.93	0.85	6.21
Communications	3.92	4.04	141	8,688.42	8,851.24	0.30	0.31
Electricity ~ Gas	4.01	4.52	72	-	-	-	-
Water ~ Sanitary							
Services	7.08	7.54	151	-	-	-	-
Trade	1.87	2.00	204	52,806.00	2,273.00	0.54	0.23
Finance	0.62	0.84	125	3,177.72	-	0.47	-
Insurance	1.16	1.31	136	20,424.34	40,038.58	2.12	4.16
Real Estate	8.51	8.65	59	3,736.80	2,224.78	0.03	0.02
Other Services	1.94	2.22	254	85,896.68	5,285.38	9.83	0.60
TOTAL				1,929,401.03	1,851,393.38	164.63	159.15

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Table 4

Capital and Labour Requirements per Million Dollars of Puerto Rican
Exports and Imports Substitution, 1967 (1963=100)

Industrial Sector	Direct and Indirect Requirements		Requirements per million dollars of Exports and Imports Replacements of Average 1963 Composition			
	Capital (in million dollars)	Labour (man years)	Capital Contents (in million dollars)		Labour Contents (man years)	
			Exports	Imports	Exports	Imports
Agriculture	2.05	373.44	11,004.40	122,395.25	2.00	22.30
Mining	3.29	200.60	483.63	1,129.13	0.02	0.05
Construction	1.68	181.04	-	-	-	-
Dairy Products	2.10	309.37	2,160.90	40,350.87	0.32	5.94
Bakery Product	1.99	143.84	877.59	7,535.53	0.06	0.54
Sugar Mills	2.85	317.30	197,824.20	1,856.21	24.67	0.23
Beverages	1.49	80.02	28,266.79	18,415.21	1.52	0.99
Other Food Products	2.35	178.71	133,914.75	282,040.19	9.52	20.05
Tobacco Products	1.38	121.26	118,922.88	45,928.06	10.45	4.04
Textile Products & Apparel	1.21	149.63	269,936.48	164,871.58	35.38	20.39
Wood & Furniture	1.97	146.01	6,518.73	56,373.72	0.48	4.18
Paper & Allied Products	2.63	86.26	11,216.95	55,349.14	0.37	1.82
Printing & Publishing	1.53	123.37	3,037.05	17,723.28	0.24	1.43
Chemicals & Allied Products	1.79	38.30	134,250.00	145,129.08	2.87	3.11
Petroleum & Coal	3.03	43.00	258,440.82	111,261.90	3.67	1.58
Leather Products	1.60	176.44	76,588.80	45,825.92	8.45	5.05
Non-Metallic Minerals	2.57	118.28	22,865.29	49,103.45	1.05	2.26
Metals	1.78	80.11	16,360.98	193,091.20	0.74	8.69
Machinery	1.39	100.75	97,197.14	127,886.81	7.05	9.27
Transportation Equipment	1.50	135.73	1,764.00	49,546.65	0.16	4.48
Instruments & Misc. Industries	1.36	125.25	99,799.52	113,865.59	9.19	10.49
Transportation	4.23	156.82	71,065.43	161,330.51	6.11	5.77
Communication	4.24	129.36	8,106.88	8,615.26	0.23	0.25
Electricity & Gas	4.50	52.19	-	-	-	-
Water & Sanitary Services	7.71	237.23	-	-	-	-
Trade	1.93	187.68	76,489.76	2,130.91	6.86	0.19
Finance	1.29	122.69	6,829.26	-	0.58	-
Insurance	1.17	115.75	24,346.53	31,545.19	3.15	4.08
Real Estate	8.41	25.91	5,567.42	22,242.11	0.02	0.01
Services	1.80	242.60	88,677.00	3,329.64	10.19	0.38
TOTAL			1,872,513.18	1,858,872.39	143.35	137.57

Table 5
 Capital and Labour Requirements per Million Dollars of Puerto Rican
 Exports and Imports Substitution, 1972 (1963=100)

Industrial Sector	Direct and Indirect Requirements		Requirements per million dollars of Exports and Imports Replacements of Average 1972 Composition			
	Capital (in million dollars)	Labour (man years)	Capital Contents (in million dollars)		Labour Contents (man years)	
			Exports	Imports	Exports	Imports
Agriculture	2.61	270.01	11,577.96	78,070.32	1.20	8.08
Mining	3.52	145.02	411.84	992.64	0.02	0.04
Construction	1.89	132.19	-	-	-	-
Dairy Products	2.35	144.66	1,783.65	48,435.85	0.11	2.98
Bakery Products	2.22	87.42	1,554.00	9,657.00	0.06	0.38
Sugar Mills	3.68	212.22	22,768.16	4,025.92	1.31	0.23
Beverages	1.79	54.50	34,688.41	25,763.47	1.06	0.78
Other Food Products	2.66	12.01	13,488.94	352,186.66	9.71	16.02
Tobacco Products	1.60	127.08	87,228.80	31,604.80	6.93	2.51
Textile Product & Appare	11.15	119.25	13,392.85	139,756.05	22.13	14.49
Wood & Furniture	1.72	125.20	3,814.96	25,982.32	0.28	2.35
Paper & Allied Products	2.57	64.89	7,951.58	57,544.87	0.20	1.45
Printing & Publishing	1.89	93.71	2,757.51	14,224.14	0.14	0.71
Chemicals & Allied Products	2.16	39.70	399,546.00	126,200.16	7.34	2.32
Petroleum & Coal	3.30	39.57	275,256.30	251,153.00	3.30	3.01
Leather Products	1.49	139.29	33,831.94	30,930.91	3.16	2.89
Non-Metallic Minerals	2.73	133.33	18,962.58	46,030.53	0.93	2.25
Metals	1.82	70.42	19,759.74	177,025.94	0.76	6.85
Machinery	1.44	75.08	141,125.76	132,796.80	7.36	6.92
Transportation Equipment	1.81	79.35	1,478.77	69,044.26	0.06	3.03
Instruments &						
Misc. Industries	1.56	96.84	112,274.76	210,102.36	6.97	13.04
Transportation	4.20	114.84	195,144.60	165,106.20	5.34	4.51
Communications	4.40	95.61	10,274.00	7,862.80	0.22	0.17
Electricity & Gas	4.79	37.91	-	-	-	-
Water & Sanitary Services	7.68	172.60	-	-	-	-
Trade	2.24	126.62	97,016.64	2,394.56	5.42	0.14
Finance	1.23	69.15	7,538.67	-	0.42	-
Insurance	1.28	95.22	29,885.44	35,717.12	2.22	2.66
Real Estate	9.06	19.55	5,291.04	2,754.24	0.01	0.01
Services	2.19	232.63	86,413.02	4,623.09	9.18	4.91
TOTAL			2,053,217.92	2,049,986.01	95.84	102.73

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In table 6 the results are summarized for the whole thirty-two sector's average million dollars of exports and competitive imports

Table 6

Domestic Capital and Labour Requirements per Million Dollars
of Exports and Competitive Imports Replacement
(of Average 1963, 1967 and 1972 Composition in 1963 prices)

	Exports	Import Replacement
Capital (in dollars)		
1963	1,929,401.03	1,851,893.38
1967	1,872,513.18	1,858,872.39
1972	2,053,217.92	2,049,986.01
Labour (man years)		
1963	164.63	159.15
1967	143.35	137.57
1972	95.84	102.73

From table 6 we can compute the comparative, capital-labour intensity by using our equation (9). The results are shown in table 7.

Table 7

Index of Comparative Capital-Labour Intensity of Exports and
Competitive Imports 1963, 1967 and 1972

Year	Index
1963	.99
1967	1.034
1972	0.93

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A glance at table 6 shows the following interesting points:

1. For all the three periods, the capital content of an average million dollars of exports is hither about by a very small amount) than the capital content of a million dollars of competitive imports.
2. Por both exports and imports the capital content has increased from 1963 to 1972.
3. The labour embodied in a million dollars of exports and competitive imports differs by a very small amount, being greater for exports in 1963 and 1967 but smaller in 1972.
4. As in tile case of capital, the labour content of both imports and exports has declined frond 1963 to 1972.

However, when we loot at the comparative capital-labour intensity of exports and imports we can observe the following interesting point: except for the year 1967, the capital-labour ratio of imports is lower t an the capital labour ratio of exports. This fact is reflected by the ratio of comparative capital-labouf Intensity being smaller than 1 in 1963 and in 1972 (it decreased from 0.99 to 0.93 from 1963 to 1972).

To test the models excluding services, we applied it to manufacturing sector, agriculture, and mining (this latter being a very small amount) exports and competitive imports. In table 8 exports and imports per million dollars of total exports and competitive imports of these sectors are shorn. Table 9 shows the results (the capital and labour content) of these sectors and table 10 summarizes the results. These tables show the following points:

1. The pita embodied in an average million dollars of our exports is slightly smaller than that embodied in one million dollar of import replacement for all three years under examination.
2. There is an upward trend in the capital content of both exports and competitive imports.

3. For the years 1967 and 1972 the labour content of our import replacement was slightly higher than that of exports. However, in 1963 the labour content of import replacement is lower than that of exports by a relatively significant amount.
4. In contrast with capital, we can observe a downward trend in the labour embodied in an average million dollar of exports and competitive import replacement.

By looking at Table 11 we can observe that the index of comparative capital-labour intensity of exports and competitive imports decreased from 1.115 in 1963 to 0.923 in 1972. This means a decline in the capital-labour ratio of imports in relation to the capital-labour ratio of our exports from 1963 to 1972 (in 1972 the capital labour ratio of exports was equal to 22,060.98 dollars while the capital labour ratio of imports was 20,369.09 dollars).

Table 10

Domestic Capital and Labour Requirements per Million Dollars
of Agriculture, Manufactured Products and Mining Exports and
Imports Replacement, 1963-1967, 1972 (1963=100)

	Exports	Import Replacement Capital
Capital (dollars)		
1963	1,733,804.82	1,770,087.96
1967	1,771,417.20	1,759,483.65
1972	1,901,877.39	1,979,264.57
Labour (man years)		
1963	173.70	159.07
1967	135.67	137.75
1972	86.21	97.17

Table 11

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Index of Comparative Capital-Labour Intensity of Exports and Competitive DARTS of Agriculture, Manufacturing Goods and Mining, Years 1963, 1967, 1972

Year 1963 1967 1972

Index 1.115 0.978 0.923

To test our model, excluding United States, we used the only data available (1967) on exports and competitive imports divided into trade with United States and that with foreign countries (including Virgin Islands). Table 12 shows the export and import trade of Puerto Rico with the United States and with foreign countries and in Table 13 we summarize the results of our computation. Table 13 shows that in our trade with foreign countries:

1. The capital embodied in a million dollars of exports is significantly higher than that embodied in an average million dollars' worth of import replacement.

2. The labour content is higher for exports than imports.

3. The capital-labour ratio of our exports is equal to 15,661.14 dollars while the capital-labour ratio of import replacement is equal to 16,651.79. These two figures give an index of comparative capital-labour intensity equal to 1.063 showing a small tendency for our exports to be slightly less capital intensive than our import replacement, on an average million dollars of both, respectively.

Unfortunately, we did not have other years in which to examine trends in our patterns of trade with foreign countries.

C. Some Implications of the Results

We have been able to analyze the experience of Puerto Rico for three years in a period of 10 years. According to our findings dollars worth of Puerto Rican exports to the rest of the world (including the United States) embodies more capital than we have also observed an upward trend in the capital content of both exports and imports from 1963 to 1972. However, when we look at the capital-labour intensity of exports and imports we notice a reduction in the index from 0.99 in 1963 to 0.93 during 1972. This small downward-trend implies a slight tendency for our exports to be relatively more capital intensive than our imports. However, the pattern is not so clear for the labour content of an average billion dollars' worth of exports and imports. In this latter case, the labour content of both exports and imports is about the same for the years 1963 and 1967, but by 1972 the labour content of exports is smaller than that of a million dollar worth of import replacement. If we assume that Puerto Rico is a labour-surplus country, then this latter result seems to be in line with Leontief's results--but this time the labour-surplus is working

in favour of exports... This latter result is strengthened by the fact that the index of comparative capital-labour intensity declined from 1963 to 1972.

If we excluded the United States from our analysis, we found in our trade with foreign countries for the year 1967 that the capital embodied in a million dollars' worth of exports was not significantly higher than that embodied in an average million dollars' worth of import replacement. In addition, it was found that the index of comparative capital-labour intensity

Table 12

Competitive Imports from and Exports to United States and
other Countries Fiscal Year 1967 (in million dollars - 1963=100)

Industrial Sector	Total Exports	To United States	To Other Countries	Total Imports	From United States	From Other Countries
Agriculture	7.300	4,517	2.783	90,471	89.524	6.756
Sugar Mills	94.385	90.638	3.747	0.987	0.937	-
Beverages	25.785	22.009	3.776	18.728	14.935	3,793
Dairy Products	1.388	0.124	1.264	29.116	26.615	2.501
Bakery Products	0.633	-	0.633	5.738	5.531	0.207
Other Food Products	77.487	65.332	12.154	181.862	155.662	26.200
Tobacco Products	117.233	115.744	1.489	50.431	48.992	1.439
Textiles & Apparel	130.463	296.457	6.920	206.471	196.434	10.037
Leather Products	65.142	64.391	0.751	43.400	33.400	10.000
Wood & Furniture	4.497	903.3	594	43.362	41.595	1.766
Paper & Allied Prods.	5.793	1.929	3.864	31.890	28.727	3.16a
Printing & Publishing	2.715	1.755	0.960	17.553	13.042	4.511
Chemicals & Allied Products	101.965	89.717	12.248	122.857	115.530	7.327
Petroleum & Coal Products	116.028	95.241	20.787	55.642	15.284	40.388
Non-Metallic Min. Products	12.118	8,598	3.520	28.952	22.924	6.028
Metals	12.528	6,570	5,958	164.377	139.439	24.938
Machinery	95.056	82.734	12.322	139.415	122.992	16.422
Transportation Eqpt.	1.632	0.232	1.400	50.052	48.909	1.143
Instruments & Other Products	99.817	89.048	10.769	126.868	109.938	16.930
Mining	0.188	0.005	0.183	0.520	0.520	-
Construction	-	-	-	-	-	-
Trade	53.986	48.777	5.209	1.673	1.451	0.222
Transportation	54.959	49.656	5.303	57.793	50.143	7.650
Communications	2.623	2,370	0.253	3.079	2,671	0,408
Finance	7,161	6,470	0.691	-	-	-
Insurance	28.320	25.588	2.732	40.855	35.448	5.407
Real Estate	0.873	0.788	0.085	.404	0.350	0.054
Services	154.640	139.719	14.921	2.803	2.432	0.371
Electricity & Gas	-	-	-	-	-	-
Water and Sanitary	-	-	-	-	-	-
Services						
Total	1,447.630	1,309.312	138.318	1,515.3	1,323.445	197.66

Table 13

Foreign Exports Aid Competitive Imports per Million Dollars of Their Totals Plus Direct
and Indirect Capital and Labour Requirements per Million Dollars of
Exports and Import Replacement 1967 1963=100)

Industrial Sector	Exports per	Direct & Indirect Capital and		Competitive	Direct & Indir. Capital and	
	million dollar of Total	Labor Requirements per million dollars of Exports		Imports pertm. dollars Total Competitive	Labour Requirements per million dollars of Import Requirements	
	Exports	Capital	Labour	Imports	Capital	Labour
Agriculture	20,120	41,246.00	7.51	34,180	70,069.00	12 76
Mining	1,323	4,352.67	0.27	-	-	-
Construction	-	-	-	-	-	-
Dairy Products	9,138	19,189.80	2.87	12,653	26,571.30	3.91
bakery Products	4,576	9,106.24	0.66	1,047	2,083.53	0 16
Sugar Mills	27,090	77,206.50	8.60	-	-	-
Beverages	27,299	40,675.51	2.18	19,190	28,593.10	1.54
Other Food Products	87,870	206,494.50	15.70	132,551	311,494.85	23.69
Tobacco Products	10,765	14,855.70	1.31	7,280	10,046.40	0.88
Textile ~ Apparel	50,030	60,536.30	7.49	50,779	~61,442.59	7.60
Wood ~ Furniture	25,983	51,186.51	3.79	8,914	~17,560.58	1.30
Paper ~ Allied Products	27,935	73,469.05	2.41	16,002	~42,085.26	1.38
Printing ~ Publishing	6,940	10,618.20	0.86	22,822	~34,917.66	2.82
Chemicals ~ Allied Products	88,548	158,500.92	3.39	37,069	~66,353.51	1 42
Petroleum ~ Coal	150,284	455,360.52	6.46	204,331	619,122.93	8.79
Leather Products	5,430	8,680.00	0.96	50,092	80,147.20	8 84
Non-Metallic Minerals	25,448	65,401.36	3.00	30,497	~78,377.29	3 61
Metals	43,074	76,671.72	3.45	126,166	~224,575.48	10.11
Machinery	89,083	123,825.37	8.98	83,082	115,483.98	8.37
Transportation Equipment	10,122	15,183.00	1.37	5,783	8,674.50	0.78
Instruments ~ Miscellaneous	77,856	105,884.16	9.75	85,652	116,486.72	10.73
Transportation	38,339	162,173.97	6.01	38,703	16,713.69	6.07
Communications	1,829	7,754.96	0.24	2,064	8,751.36	0.27
Electricity ~ Gas	-	-	-	-	-	-
Water ~ Sanitary Services	-	-	-	-	-	-

Table 13 (Ctd.)

Competitive Direct ~ Indir. Capital
Exports per Imports and Labour Requirements
million Direct ~ Indirect Capital and per/m. dollars per million dollars
dollar of Labor Requirements per million Total of Import
Total dollars of Exports Competitive . Requirements
Industrial Sector Exports - Capital Labour Imports Capital Labour
Trade 37,659 72,681.87 7.07 1,123 2,167.39 0.21
Finance 4,996 6,444.84 0.61 - -
Insurance 19,751 23,108.67 2.29 27,355 32,005.35 3.17
Real Estate 615 5,172.15 0.02 273 2,295.93 0.00
Services 107,873 191,171.40 26.17 1,877. 3,378.60 0.46
Total ~1,000,000 ; 2,089,509.89 133.42 3 1,000,000 ~ 979,398.20 118.87

of exports and competitive imports was more than one. Since data was only available for the year 1967, we cannot draw strong conclusions from the latter results, but they are very interesting since they show that Puerto Rico is labour intensive goods when trading with other countries (excluding the United States).

As P.N. Mathur specifies, to analyze the comparative advantage of a country, the gains from trade (both static and dynamic) should be examined at the "margin" and not on the average. In his own words:

"If both the parameters of the gains from trade are positive at the margin we get the ideal case for the trade...similarly if both are negative it is an obvious case for avoiding this particular piece of trade. The problem of choice presents itself only when one is positive and the other is negative."^{29/}

Our results have been limited to examining the capital and labour embodied in an average million dollars' worth of exports and import replacements. These results do not lead to any firm conclusion: However, the H-O hypothesis does not seem to work especially in 1972 when the index of comparative capital-labour intensity was less than one implying that the capital-labour ratio of our exports was higher than the same for our imports.

If we judge by the upward trend in capital content of exports and the downward trend in its labor content, then we see the Leontief's paradox working if we assume that ours is a labour surplus economy.

^{29/} Mathur, P.N., (23) page 619.32

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Table 9

Capital and Labour Requirements per Million Dollars of Manufactured Products,
Agriculture and Mining Exports and Imports, 1963, 1967 and 1972

Labor Requirements Labor Requirement

Capital Requirements per million Capital Requirements per million per Million Dollars per Million Dollar

llars of Exports (in dollars) ~ Dollars of Exports (in dollars) of Impt. Repl. (man-yrs.) of Expts.(man yrs~

i 1967 9 Z 1963 1967 1r972 1963 1967 1972 1963 1967 1972

.84 13,069.08 13,896.95 91,657.91 131,6S7.99 84,171.61 23.67 23.98 8.71 7.64 2.38 1.44
).31 540.15 438.59 762.14 1,214.47 1>069.31 0.05 0.07 0.04 0.02 0.03 0.02
 !.61 234,917.72 27,056.28 468.99 1,996.85 4,340.82 0.06 0.22 0.25 56.24 26~15 1.56
).49 33,552.22 41,325.73 13,143.44 19t808.-95 279778.10 0.76 1.06 0.85 5.57 1.80 1.26
 1.88 2,545.52 2,146.23 60,621.92 43,404.52 52,222.99 11.87 6.39 3.21 2.68 0.38 0.13
 7.05 1,040.37 1J919.32 8,362.96 8J105.83 10,410.87 0.78 0.59 0.41 0.62 0.08 0.08
 3.93 159,024.74 254,518.72 408,646.84 i 303,384.77 379,717.50 39.27 23.07 17.27 13.89 12.09 11.58
).31 141,285.28 96,018.05 45,470.55 49,403.83 34,075.34 7.05 4.34 2.71 20.90 12.41 7.63
 3.42 i20,579.67 254,491.25 190,273.76 177,457.74 148,381.34 24.06 21.94 15.39 33.64 39.64 26.39
 t.19 91,022.56 37,391.80 50,303.11 49,293.95 33,349.51 6.08 5.44 3 12 7.05 10.04 3.50
].48 7,736.72 4,558.12 75,427.81 60,640.03 34,877.70 5.95 4.49 2.54 0.30 0.57 0.33
 3.94 13,305.38 9,554.98 90,985.08 59,537.99 62,042.68 3.17 1.95 1.57 0.76 0.44 0.24
 7.28 3,627.68 3,311.45 21,393.09 19,064.55 15,336.18 1.94 1.54 0.76 0.31 0.29 0.16
 3.91 159,394.06 476,541.92 134,477.29 156,112.22 136,064.02 3.19 3.34 2.50 2.19 3.41 8.76
 5.50 307,024.75 328,383.76 75,352.60 104,532.12 270,786.91 0.49 1.48 3.25 1.04 4.36 3.94
 1.66 27,197.69 22,686.55 50,422.50 52,819.67 49,629 95 2.90 2.43 2.42 1.05 1.25 1.11
 3.01 19,474.64 23,599.99 179,076.07 207,704.07 190,864.62 7.49 9.35 7.38 1.48 0.88 0.91
 7.69 115,388.43 168,358.48 145,386.15 137,565.09 143,177.76 9.59 9.97 7.47 6.84 8.36 8.78
).57 2,137.86 1,829.44 23,536.05 53,296.25 74,441.44 2.62 4.82 3.26 0.12 0.19 0.08
 3.43 118,552.68 133,849.78 104,319.70 122,482.76 226,525.92 8.08 11.28 14.06 11.36 10.92 8.31
 t.82 1,771,417.20 1,901,877.39 1,770,087.96 1,759,483.65 1,979,264.57 159.07 137.75 97.17 173.70 135.67 86.21