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by Elio Londero and Simón Teitel *

This paper shows that Latin American exports of manufactures that grow consistently over time arise from both traditional as well as policy induced sources of comparative advantage. Case studies for Argentina, Colombia and Venezuela show that manufactures originally developed for the domestic market were exported with consistent growth rates and came to represent an important proportion of total manufacturing exports. The study also shows that inter-country differences in the factor content of these exports reflect both differences in original resource endowments as well as the effects of industrialization policy.

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by Elio Londero and Simón Teitel*

I. INTRODUCTION

The industrialization process that took place in Latin America until the 1980s has been criticized because of the extent, level and duration of the protection granted to manufacturing industry. Some analysts have stressed the dis-incentive to export that resulted from this protection, which not only altered relative prices against products with a static comparative advantage, but also reduced incentives to attain high product quality, introduce technical innovations, and increase productivity. Other analysts have emphasized technological aspects of the industrialization process, denying that free access to technology exists and stressing the existence of technological learning processes that could only take place when producing. The use of production incentives would thus be justified because they allow such learning to occur.

If those evolutionary processes took place, and had the required dynamism, countries that developed their industrial sectors with the help of protection should, in time, acquire quality and productivity levels that, coupled with export incentives often necessary to counteract the anti-export bias of the trade regime, would allow them to compete in international markets. According to this view, the industrialization process leads not only to changes in factor endowments, increasing the stock of capital relative to labor and natural resources, but also to improvements in the level of technical knowledge, and the skills of the work force. Thus, it would be expected that exports of goods from industrializing countries would show the emergence and growth of exports of manufactures originally developed under protection, and reflecting such changes in factor endowments.

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* Inter-American Development Bank, and Independent Consultant, respectively. Opinions are those of the authors and are not intended to represent the views of the Inter-American Development Bank. This paper is a synthesis of preliminary results from a wider study on sources of competitive advantage in the export of manufactures in Argentina, Colombia and Venezuela, financed by the IDB, and in which Héctor Cervini, Rodrigo Parot and Jorge Remes also participated. A preliminary version was presented to the XI Latin American Meeting of the Econometric Society, 1992. Research assistance by Marco Bonturi and Iván Guerra, comments by R. Parot and M. Vaillant, and invaluable help from an anonymous referee, are gratefully acknowledged.

To study these aspects of the relationship between industrialization and the structure and composition of international trade, a research project was launched in Argentina, Colombia and Venezuela, countries whose industrialization took place using strong production incentives, in particular, high and persistent protection.[1] The project investigated the existence of exports of manufactures that had grown steadily over time. This would indicate that the phenomenon was not sporadic and would point to the likely presence of evolutionary processes that had contributed to bring local quality and productivity closer to international levels. In addition, the factor content of those exports was analyzed to verify whether it reflected the changes in relative factor endowments that were expected to have taken place as a result of industrialization.

II. HYPOTHESES

Among those exports of manufactures that had grown consistently over an extended period of time in the three countries, it was expected to find a sizable number of manufactures based on natural resources, as well as others originating in manufacturing activities that grew while sheltered by protection.

The first hypothesis was that among these exports there will be products originating in manufacturing industry branches that were developed to process natural resources relatively abundant in these countries. In second place, it was expected to find labor-intensive products originating in industrial sectors created to satisfy growing domestic markets in those countries (e.g. clothing, textiles and shoes). However, due in particular to the relatively greater natural resource endowments of the Latin American countries, it was likely that those products would not play a role as important as in Asian developing countries, at a comparable stage in their development [*Teitel, 1989*]. Similarly, due to differences in factor endowments among the countries studied, it was to be expected that labor-intensive products would have greater relative importance in Colombia than in Argentina and Venezuela.

The existence of a flow of manufactured exports not based on natural resources, originally

[1] See, Berlinski [*1977*], and Berlinski and Schydlowsky [*1982*], for the Argentine case, Hutcheson [*1973*], Hutcheson and Schydlowsky [*1982*], and Ocampo [*1989*], for the Colombian case, and Bitar and Troncoso [*1983*], and Rodriguez and Schenone [*1986*], for the Venezuelan case.

developed to substitute for imports and to supply the domestic market, was also postulated as a third hypothesis [*Hirschman, 1958; Teitel and Thoumi, 1986*]. Given the characteristics of the import substitution process in Latin America, it was to be expected that such exports would include a high proportion of metalworking and chemical products, goods that are relatively intensive in high and medium level labor skills --and in the case of the intermediate metallurgical and basic chemical products-- also relatively capital intensive.

In other words, it was expected that the cost composition of those goods whose exports increased steadily over time, would reflect not only the relative endowments of factors given by nature or resulting from accumulation of capital and growth of the labor force, but also the technical knowledge and skills accumulated during the process of protected industrialization.

Specific country hypotheses were that among the goods whose exports grew consistently in Argentina would be found not only manufactures relatively intensive in natural resources, derived from that country's rich agricultural land endowment, but also capital intensive and/or skilled or semi-skilled labor intensive products. In Colombia, on the other hand, where the relative availability of natural resources is lower and that of labor greater, it was expected to find a lower proportion of products intensive in natural resources and a greater proportion of products intensive in labor with low and medium skill levels. Finally, in Venezuela it was expected to find products intensive in mineral natural resources and in capital, and a low proportion of those intensive in unskilled labor.

The preceding paragraphs are not meant to suggest that industrial production incentives used during import substitution industrialization were applied in an exemplary manner in the countries studied, nor to argue that those conceiving such incentives necessarily had in mind the results posited by the above hypotheses. In a number of cases those incentives were granted without paying sufficient attention to the negative impact of the lack of competition, both domestic and international, on quality and productivity, and consequently, on the potential for export growth. Nevertheless, it was expected that the external effects of industrialization, including technological learning, would compensate for the low level of competition and lead to corroboration of the proposed hypotheses.

III. METHODOLOGY

Product Selection

Products selected for the study in the three countries had to meet the following prerequisites: i) to have been produced by establishments classified as manufacturing according to the International Standard Industrial Classification of All Economic Activities (ISIC); ii) during the period 1970-83, the real value of their exports had shown a statistically significant upward trend; iii) the value of exports of each product represented, on average, at least 1/1000 of the value of total manufactured exports of the country during the same period.[2]

For each product group, the trend growth rate of the value of exports at constant prices was estimated by an OLS regression against time. Then, all product groups with positive and statistically significant growth trends were preselected. The significance criterion utilized was that the probability of the growth trend being positive should be greater than 0.95.

The preselected product groups were at the five-digit level of aggregation of the Standard International Trade Classification (SITC).[3] Subsequent analysis of these groups at the eight-digit level of the national custom tariffs classification led to the elimination or subdivision of some of them, or to a reduction in the number of products included in others. These changes were due to one or more of the following reasons: a) apparently statistically significant results were due to special circumstances (e.g. spurious correlation due to null exports during the initial years of the period); b) it was not possible to identify the products included in the group (e.g. products `not specified elsewhere'); c) the group included goods that were by-products of production processes; and d) the significance of the trend disappeared when the group was further disaggregated (i.e., to customs positions), or only some of the products comprising the group were responsible for the trend.

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[2] The period of analysis was defined according to the availability of data at the time of initiating the study in each country. In Venezuela's case, data used corresponded to the period 1974-87, and excluded petroleum, petroleum products, and raw iron castings.

[3] In the Venezuelan case it was necessary to use data at the four digit level of the national customs classification (NABANDINA).

Factor Content

The computation of the *total* factor content, direct and indirect, of the selected products may be conceptualized as a two-stage procedure. At the first stage, the costs of each of the selected products were broken down into direct factor content (including foreign exchange) and domestically-produced current inputs classified by sector. At the second stage, the indirect factor content of these inputs was calculated using an input-output table. The direct and indirect factor contents were then added together.

Cost structures of the selected products were obtained and arranged in matrix form

$$\begin{bmatrix} \mathbf{A}_s \\ \mathbf{F}_s \end{bmatrix} \qquad [1]$$

where $\mathbf{A}_s = [a_{js}]$ contains the value of domestically-produced current input j used per unit value of selected product s, and $\mathbf{F}_s = [f_{hs}]$ contains the value of factor h used per unit value of selected product s.

If $\mathbf{A} = [a_{ij}]$ is the matrix of domestically-produced input coefficients (current inputs i and outputs j), and $\mathbf{F} = [f_{hj}]$ is the matrix of factor input coefficients (factors h), then the matrix of total factor requirements of outputs j, $\mathbf{F}^* = [f^*_{hj}]$, can be computed as follows:

$$\mathbf{F}^* = \mathbf{F}\,(\mathbf{I} - \mathbf{A})^{-1} \qquad [2]$$

where $[f^*_{hj}]$ is the total requirement of factor h per unit value of product j.

Finally, the factor content of the selected products was calculated as:

$$\mathbf{F}^*_s = \mathbf{F}_s + \mathbf{F}^*\,\mathbf{A}_s \qquad [3]$$

where $\mathbf{F}_s$ is the direct factor content and $\mathbf{F}^*\,\mathbf{A}_s$ the indirect one.

In Argentina we utilized the 1973 input-output table prepared by the Secretaría de Planificación [*1986*]. This table consists of 209 industries but does not provide a value added breakdown, which had to be computed as part of the study [*Londero, Remes, and Teitel, 1991*]. The cost structures of the selected products were obtained from the source used in constructing the input-output table, namely the Censo Nacional Económico for 1973.

In Colombia we used the input-output table prepared by Cervini [*1992*]. This table consist of 267 industries and was also specially modified for this study [*Cervini and Londero, 1991*]. The data required to prepare the columns of the table corresponding to manufacturing industry, as well as the cost structures of the selected products, came from the Annual Manufacturing Survey, for the year 1985, carried out by the Departamento Administrativo Nacional de Estadística (DANE.)

The table for Venezuela, which consists of 181 industries, was prepared by Parot [*1992*], and was also specially modified for this study [*Parot, 1994*]. The data came mostly from the Industrial Survey carried out by Oficina Central de Estadística e Informática (OCEI) in 1986, supplemented with data provided by the Central Bank of Venezuela and other sources.

Two measures of factor content were calculated, the first being a breakdown of the total content of domestic value added, the second a breakdown of the total content of value added in the manufacturing sector only. In calculating the first of these measures, the gross operating surplus of the primary sector (agriculture, livestock, fishing and mining) was used as an indicator of natural resource content, and the gross operating surplus of other sectors as an indicator of capital content.

In Venezuela, the data on some public enterprises combined mining with the first phase of industrial processing. To have treated this combination as manufacturing would have underestimated natural resource content, and overestimated capital content. The inputs concerned, together with potable water and electricity, were therefore treated as a distinct factor (f_{hj}) and added to the natural resource content.

To asses the relative factor intensity of each selected product, its factor content was compared with that of the whole manufacturing sector. If f^*_{rs} is the natural resource content (based on the gross operating surplus originating in primary sectors), f^*_{ks} capital content (based on the gross operating surplus in other sectors), and f^*_{ws} the labor content (based on wages), product s is classified as intensive in natural resources relative to labour if

$$rw_s = \frac{f^*_{rs} / f^*_{ws}}{f^*_{r,man} / f^*_{w,man}} > 1 \qquad [4]$$

where $f^*_{h,man}$ is factor h content in a unit value of average manufacturing production. Similarly,

product *s* is classified as intensive in capital relative to labor if

$$kw_s = \frac{f^*_{ks} / f^*_{ws}}{f^*_{k,man} / f^*_{w,man}} > 1 \qquad [5]$$

and as intensive in capital relative to natural resources when

$$kr_s = \frac{f^*_{ks} / f^*_{rs}}{f^*_{k,man} / f^*_{r,man}} > 1 \qquad [6]$$

A product was classified as intensive in *one* of the three factors if, by comparison with the average for the manufacturing sector, it was so with respect to both other factors. For example, a product was classified as intensive in natural resources if it had both an above-average ratio of natural resources to capital and an above-average ratio of natural resources to labor, or, algebraically, if

$$rw_s > 1$$

$$kr_s < 1$$

The second measure of factor content, confined to value added in manufacturing only, involved not only a breakdown between capital and labor, but also a decomposition of the labor input by the level of skill of the workers concerned. Average wages were used as the skill indicator [*Teitel, 1976*]. The average wage of a sector was considered to be high (low) if it was greater (lower) than the average plus (less) one half the standard deviation (of the frequency distribution of average wages by sector), and it was considered to be a medium level wage if it fell within these limits.

Once again, the factor content of the manufacturing value added in each good is compared with that of the manufacturing sector as a whole. Thus the *manufacturing process* of good *s* is classified as relatively capital-intensive if

$$\frac{f^*_{km,s} / f^*_{wm,s}}{f^*_{km,man} / f^*_{wm,man}} > 1 \qquad [7]$$

where f^*_{km} is the capital content (based on the gross operating surplus originating in the manufacturing

sector) in a unit value of average manufacturing production, and f^*_{wm} is the corresponding labor content (based on the wages paid in the manufacturing sector).

The total manufacturing wage content of each selected product, $f^*_{wm,s}$, is split into three parts (f^*_{wmh},f^*_{wmm},f^*_{wml}), according to whether it originated in sectors with high, medium or low wages (i.e., in sectors of high, medium or low direct skill content). A product *s* is classified as relatively intensive in highly-skilled (or medium-skilled or low-skilled) labor if the share of high-wage (or medium-wage or low-wage) sectors in its total wage content is greater than the corresponding share for the for the whole manufacturing sector, or, in algebra, if

$$\frac{f^*_{wmh,s} / f^*_{wm,s}}{f^*_{wmh,man} / f^*_{wm,man}} > 1 \qquad [8]$$

where the breakdown of the wage bill in the whole manufacturing sector into the three skill categories is based on the proportions of total gross output contributed by sectors with high, medium and low wages.

Two caveats should be noted. The first is that the margin of error of the `capital content' measure is probably larger than the margin of error present in measures of the other factors. The second is that the factor intensity of each product is based on data for only one year, on the assumption that it will be representative of the whole period of analysis.

IV. RESULTS

Table 1 shows that, in each of the countries studied, the products analized in this study accounted for an important proportion of total manufactured exports. It can also be seen that in Argentina, the relative abundance of agricultural natural resources is reflected in a concentration of products of the food, beverages and tobacco industries, and the relative abundance of mineral resources in Venezuela shows up in a concentration of basic chemical and metal industries, while the relative abundance of labor in Colombia is manifested in the relative importance of products originating in the textile, clothing and leather industries. Also significant in all three countries is the substantial share of exports of products originating in other industries, such as chemicals and metalworking, which were mostly developed as import substitutes for the domestic markets.

Table 1
Selected Products by Manufacturing Division of the ISIC
(Percentages)

ISIC Division	Argentina [a]					Colombia [b]					Venezuela [c]			
	Number of Products	Value of exports				Number of Products	Value of exports				Number of Products	Value of exports		
		1970	1975	1980	1985		1970	1975	1980	1985		1975	1980	1985
All Selected Products	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Food, Beverages and Tobacco	27.1	46.8	34.8	42.4	57.7	9.1	4.4	7.2	14.3	23.9	4.9	0.0	0.9	14.3
Textiles, Clothing and Leather	16.7	26.5	24.7	33.3	19.3	29.5	10.1	38.7	40.0	30.1	-	-	-	-
Wood & Wood Products	-	-	-	-	-	2.3	1.4	0.7	1.3	1.9	-	-	-	-
Paper, Printing & Publishing	-	-	-	-	-	4.5	10.4	12.9	10.8	14.5	7.3	13.3	0.8	2.2
Chemicals	14.6	15.5	14.1	9.9	7.0	11.4	40.0	22.2	16.1	20.2	24.4	16.9	6.6	5.9
Non-Metallic Mineral Products	6.3	0.5	0.1	1.4	0.1	4.5	14.2	4.4	4.0	2.5	12.2	2.3	0.1	1.2
Basic Metals	-	-	-	-	-	-	-	-	-	-	14.6	60.8	86.8	84.7
Metal Products, Machinery and Equipment	35.4	10.8	26.2	13.0	15.8	38.6	19.5	13.8	13.5	6.9	36.6	6.7	4.8	4.7
Percentage of Total Exports of Manufactures		13.6	21.1	28.1	37.5		7.3	16.1	27.3	20.3		15.9	76.3	75.0

Sources: Data bases prepared by Londero, Remes and Teitel [*1991*], Cervini and Londero [*1991*], and Parot [*1994*].

[a] Includes only selected products with a significant trend during the period 1970-83.

[b] Excludes selected products exported only under the Plan Vallejo. Includes selected products exported under both the Plan Vallejo and the General Regime.

[c] Excludes exports of petroleum derivatives and gross iron castings.

Factor Content of Selected Products

Our estimates of the factor content of the *total* domestic value added of each selected product are presented in `relative intensity triangles' [*Londero, 1994*]. In these diagrams, the relative intensity of a product with respect to each pair of factors is measured along the triangle's sides. Thus in Figure 1, capital intensity with respect to labor (*kw*) is measured along the base of the triangle, while the left side measures natural resource intensity with respect to labor (*rw*), and the right side capital intensity with respect to natural resources (*kr*). All products with the same relative factor intensity with respect to a particular pair of factors must lie on a line that goes from the relevant point on the triangle's side to the opposite vertex. In Figure 1, for instance, all the products with a given capital intensity relative to labor, e.g. kw_s, must lie along the line from the top vertex to point kw_s on the triangle's base.[4] Hence, the relative intensity of a product with respect to all *three* factors is represented by its position at the intersection of two lines of this sort. For example, the point circled in Figure 1 corresponds to a product with capital intensity relative to labor kw_s and natural resource intensity relative to labor rw_s, which between them imply its capital intensity relative to natural resources (since by definition $kr_s = kw_s/rw_s$).

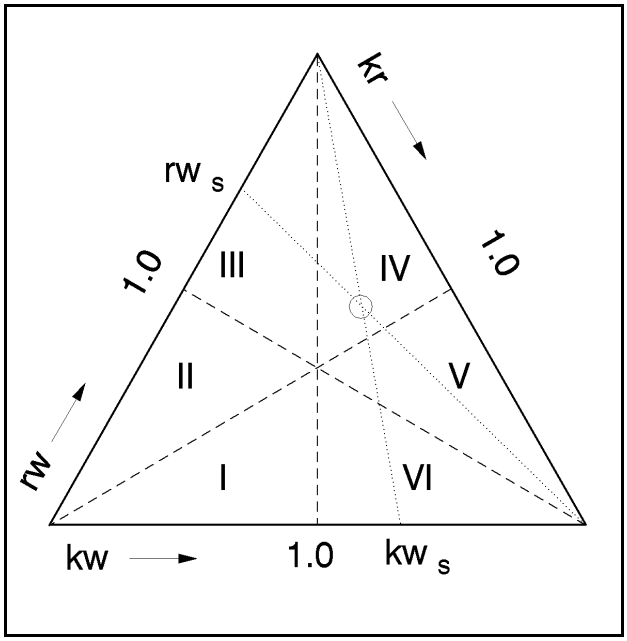

Figure 2. Relative Intensity Triangle.

In each case, our triangles have been constructed in such a way that the relative factor intensity of the aggregate manufacturing sector corresponds to the point at the center of an equilateral triangle (the intersection of its three median lines) where $kw = rw = kr = 1$. This provides a comparator for all other selected products, with reference to which the triangle can be divided in six regions, according to the relative intensity of the products concerned. These regions have been

[4] For a more detailed explanation see the Appendix, Leamer [*1987*], and Londero [*1994*].

numbered from one to six beginning from the left lower corner and continuing clockwise.

As already stated, a product will be said to be intensive in one of the three factors, without qualification, when it is so with respect to both the other two. A product will be said to be intensive in one factor *with respect to another* when it is so only with respect to that second factor. The six triangle regions consequently indicate the relative factor intensities shown in Table 2. Thus, for example, all products in regions I and II are unambiguously labor intensive, but those in region I are also capital intensive with respect to natural resources, and those in region II are natural resource intensive with respect to capital.

Table 2
Relative Factor Intensities and Regions of the Triangle.

Region	Unqualified			Qualified					
	L	*NR*	*K*	*K/NR*	*NR/K*	*L/K*	*K/L*	*NR/L*	*L/NR*
I	x			x					
II	x				x				
III		x				x			
IV		x					x		
V			x					x	
VI			x						x

Note: *L*, labor; *NR*, natural resources; *K*, capital.

The estimated factor contents of the products studied are shown in Figures 2, 3 and 4 for each country separately, and the results are collected together in Table 3. The figures show that in Argentina and Venezuela products which are relatively intensive in capital and in natural resources account for a higher proportion of the total *number* of products analyzed than in Colombia, where labor intensive products predominate. The figures also show that in Colombia the proportion of selected products which are capital intensive with respect to labor (i.e. $kw_s > 1$) is much smaller than in Argentina or Venezuela.

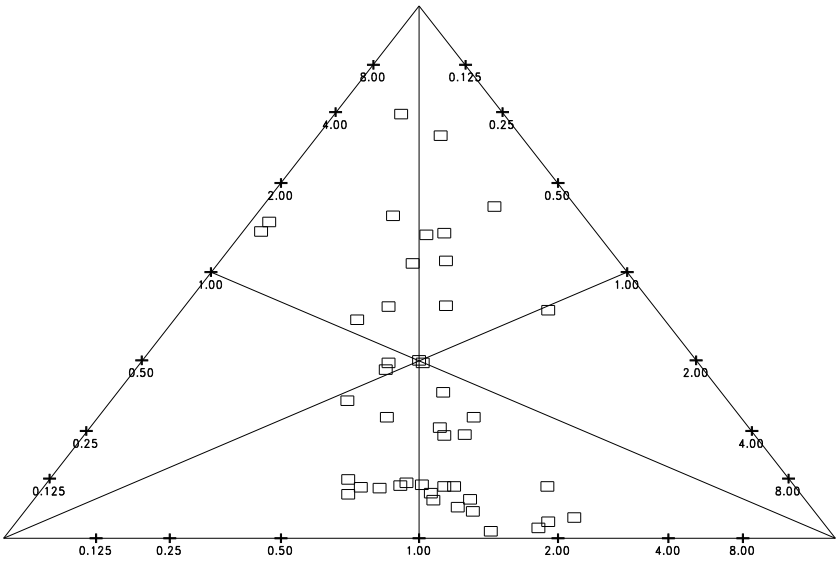

Figure 3 Argentina. Relative Intensity of Selected Products.

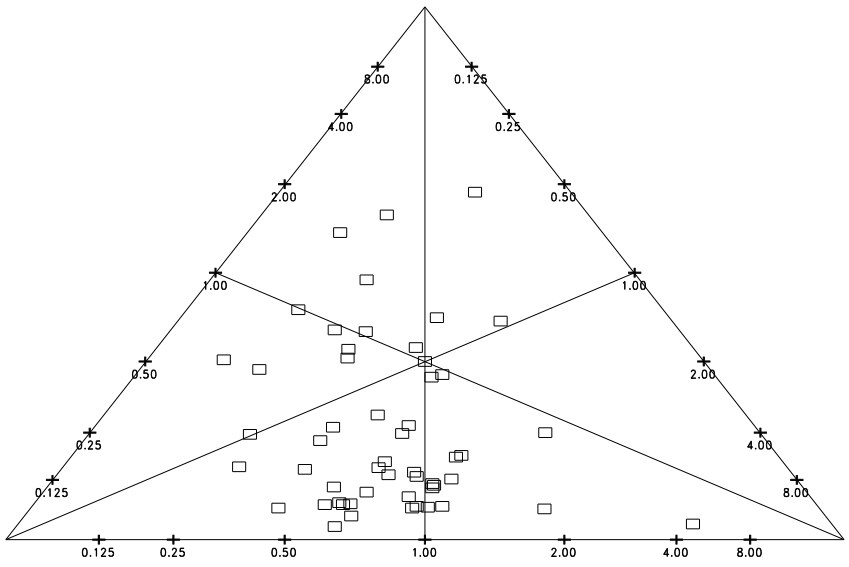

Figure 4 Colombia. Relative Intensity of Selected Products.

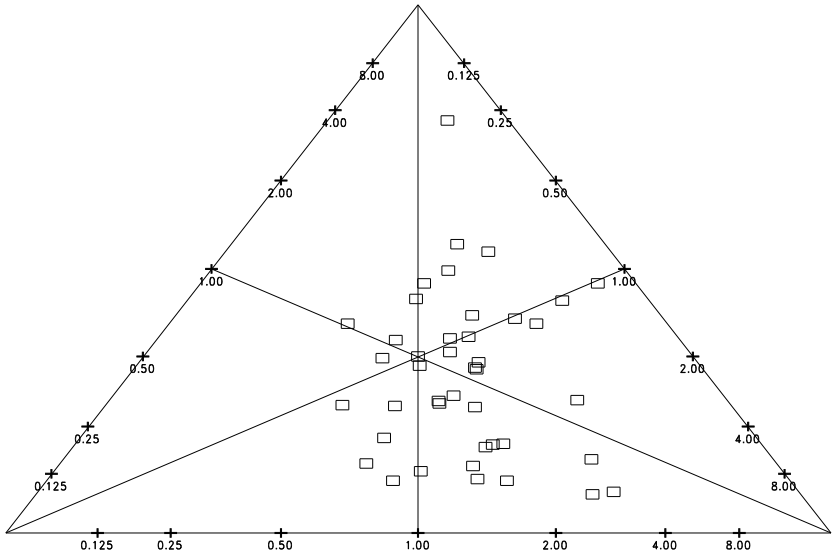

Figure 5 Venezuela. Relative Intensity of Selected Products.

Table 3: Selected Products by Relative Factor Intensity

	L-intensive	*K*-intensive	*NR*-intensive	Total
Argentina				
Number of products	10	15	19	44
Percentages	22.7	34.1	43.2	100
Colombia				
Number of products	31	8	13	52
Percentages	59.7	15.4	25.0	100.0
Venezuela				
Number of products	6	10	25	41
Percentages	14.6	24.4	61	100

Sources: Londero, Remes and Teitel [*1991*], Cervini and Londero [*1991*], and Parot [*1994*].
[a] Only selected products with a significant trend during 1970-83 are included. Excludes ships and boats.
[b] Excludes selected products exported only under the Plan Vallejo. Relative intensity under the General Regime was used for products exported under both regimes.
[c] Natural resources include the first round of manufacturing carried out by public enterprises.

Similar results obtain when the composition of the total *value* of exports of the selected products is analyzed (Table 4). However, two qualifications pertain in Colombia's case. First, products that are capital intensive (relative to aggregate manufacturing) account for a much larger share of the *value*, than of the *number*, of the selected exports. Second, the increase in the share of natural resource intensive products in that country towards the end of the period studied is attributable, almost entirely, to coffee extracts.

Table 4
Value of Exports of Selected Products Classified by their Relative Factor Intensities and that of their Manufacturing Processes
(Percentages)

	1970	1975	1980	1985
Argentina [a]	100.0	100.0	100.0	100.0
Labor	15.0	22.9	17.2	8.4
Natural resources	75.5	55.6	62.5	77.9
Capital	9.6	21.4	20.3	13.7
Colombia [b]	100.0	100.0	100.0	100.0
Labor	51.9	43.3	54.4	31.4
Natural resources	7.2	7.0	9.6	29.7
Capital	41.0	49.7	36.1	38.8
Venezuela [c]	n.a.	100.0	100.0	100.0
Labor	n.a.	1.9	0.1	0.6
Natural resources	n.a.	19.1	24.3	32.5
Capital	n.a.	79.0	75.6	66.9

[a] Includes only selected products with a significant trend during 1970-83. Excludes ships and boats, and selected products with different relative intensity whose export series cannot be separately identified.
[b] Excludes selected products exported only under the Plan Vallejo, and those whose relative intensities fall in different categories, but whose export series cannot be separately identified. Includes the value of exports of selected products exported under both the Plan Vallejo and the General Regime; in such cases relative intensity is that under the General Regime.
[c] Natural resources include the first round of manufacturing carried out by public enterprises.

Factor Intensity of Manufacturing Processes

When attention is focused on the factor content of total value added in manufacturing only (Table 5), it can be seen that in Colombia selected products originating in manufacturing processes which are labor intensive represent a larger proportion of the total *number* of products than in Argentina, and even more so than in Venezuela.

The breakdown of the labor content of manufacturing value added by skill level shows that a large majority of the products exported by Colombia originate in manufacturing processes that are relatively intensive in unskilled and semiskilled labor, while in Argentina and Venezuela the manufacturing value added of a much larger proportion of products show a relatively high skilled labor content. Moreover, of the minority of products in Argentina and Venezuela which originate in manufacturing processes intensive in unskilled labor, almost all are also products intensive in natural resources. And in these two countries, the large majority of products that are *not* intensive in natural resources and that originate in manufacturing processes that are labor intensive, have a high content of skilled and semiskilled labor.

A somewhat different picture emerges when we examine, in Table 6, the relative importance of different products in terms of their shares of the *value* (rather than the number) of exports. We observe relatively higher shares for products with unskilled manufacturing labor requirements in both Argentina and Venezuela, and a relatively higher share for products with more skilled intensive requirements in Colombia.

In Argentina's case this is due to the already-noted fact that most natural-resource-intensive products originate in unskilled-labor-intensive manufacturing processes. Moreover, many of the other products with unskilled-labor-intensive manufacturing processes originate in a second or third stage of the manufacturing of agricultural and livestock inputs, but do not show up as natural-resource-intensive because the aggregate manufacturing (with which they are being compared) is itself rather natural-resource-intensive.

Table 5 Number of Selected Products by Relative Factor Intensity of the Product and the Manufacturing Process

	Argentina [a]				Colombia [b]				Venezuela [c]			
	Manufacturing Wages				Manufacturing Wages				Manufacturing Wages			
	High	Medium	Low	Total	High	Medium	Low	Total	High	Medium	Low	Total
Products Intensive in Natural Resources	2	8	5	15	1	3	4	8	3	2	5	10
Manufacturing Processes												
Capital Intensive	2	4	5	11	1	2	0	3	1	2	5	8
Labor Intensive	-	4	-	4	-	1	4	5	2	-	-	2
Products Not Intensive in Natural Resources	10	17	6	33	6	14	24	44	13	14	4	31
Manufacturing Processes												
Capital Intensive	6	4	3	13	1	1	2	4	8	13	3	24
Labor Intensive	1	12	3	16	5	13	22	40	5	1	1	7
Not Determined [d]	3	1	-	4	-	-	-	-	-	-	-	-
All Products	12	25	11	48	7	17	28	52	16	16	9	41
Manufacturing Processes												
Capital Intensive	8	8	8	24	2	3	2	7	9	15	8	32
Labor Intensive	1	16	3	20	5	14	26	45	7	1	1	9
Not Determined [c]	3	1	-	4	-	-	-	-	-	-	-	-

Sources: Londero, Remes and Teitel [*1991*], Cervini and Londero [*1991*], and Parot [*1994*].

[a] Includes only selected products with a significant trend during 1970-83.

[b] Excludes selected products exported only under the Plan Vallejo. Includes selected products exported under both the Plan Vallejo and the General Regime; in such cases relative intensity is that under the General Regime.

[c] Natural resources include the first round of manufacturing carried out by public enterprises.

[d] Ships and boats.

Table 6
Value of Exports of Selected Products by the Relative Intensity of Manufacturing Wages
(Percentages)

	1970	1975	1980	1985
Argentina [a]	100.0	100.0	100.0	100.0
High Wages	15.0	22.5	13.9	18.0
Medium Wages	58.7	46.4	51.5	53.6
Low Wages	26.3	31.0	34.6	28.4
Colombia [b]	100.0	100.0	100.0	100.0
High Wages	41.8	28.0	18.5	38.4
Medium Wages	30.9	30.1	26.0	27.2
Low Wages	27.3	41.8	55.5	34.4
Venezuela [c]	100.0	100.0	100.0	100.0
High Wages	n.a.	71.1	74.2	58.6
Medium Wages	n.a.	21.2	5.6	9.9
Low Wages	n.a.	7.7	20.2	31.5

[a] Includes only selected products with a significant trend during 1970-83. Excludes selected products with different relative intensity whose export series cannot be separately identified.
[b] Excludes selected products exported only under the Plan Vallejo, and those whose relative intensities fall in different categories, but whose export series cannot be separately identified. Includes the value of exports of selected products exported under both the Plan Vallejo and the General Regime; in those cases relative intensity is that under the General Regime.
[c] Excludes value added by the first round of manufacturing carried out by public enterprises, which is included as value added by the primary sector.

In Venezuela's case, almost all the unskilled-labor-intensive manufacturing processes, are also capital intensive (see Table 5). In Colombia, the large share of skilled-labor manufacturing processes in the total value of exports of selected products is basically due to the rapid growth of two products, disinfectants and pesticides, and coffee extracts and essences. In 1985 these two products accounted for 75% of the value of exports of selected products originating in skilled-intensive manufacturing processes. Since both manufacturing processes are also capital intensive and one of the products, in addition, is relatively intensive in natural resources, this result reflects high ratios of skilled to total labor requirements, but small shares of manufacturing labor in total value added.

V. CONCLUSIONS

The first important conclusion is that all three of the countries studied not only exported products originating in a variety of industries developed during the import substitution period, but also that exports of many of these products grew consistently over time and came to represent an important proportion of total exports of manufactures.

The second important conclusion is that the relative factor intensity of those products whose exports grew consistently over time reflects the endowment of factors given by nature, plus capital accumulation, as well as those acquired as a result of economic policies, which gave rise to an important proportion of products intensive in semiskilled and skilled labor --especially in Argentina and Venezuela.

Bearing in mind that the capital intensity indicator is less reliable than the others, the results show a larger proportion of capital intensive products with sustained export growth in the countries with the greatest relative abundance of natural resources. This is more pronounced when we consider the relative factor intensity only of manufacturing processes. The large majority of the selected products that are natural resource intensive originate in manufacturing processes that are relatively intensive in unskilled labor. There is also evidence supporting the hypothesis of complementarity between capital and natural resources,[5] i.e. that the initial stages of natural resource processing tend to be capital intensive.

It is also interesting to note the consequences arising from the kind of natural resource that is relatively abundant. In Argentina, the abundance of agricultural land caused industrialization to follow the `traditional' road of the food, textiles and leather industries, which have low requirements of capital and skilled labor. That was followed by the development of chemical and metalworking industries, which tend to be more skill and capital intensive. A similar process took place in Colombia; the main difference being that the initially abundant resource was unskilled labor. In Venezuela, instead, industrialization based on abundant mineral natural resources led to increasing exports of products (refined petroleum, petrochemicals, steel and aluminum) that were both more capital and more skill intensive.

The results of this study highlight the relationship that exists between the resource endowment of countries, the changes generated by industrialization in their initial endowments, and the factor content of successful exports of manufactures. These results could be construed as implying that manufacturing production incentives are successful when they promote activities relatively intensive in the factors which the industrialization process tends to make more abundant.

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[5] See, *inter alia*, Vanek [*1963*], Naya [*1967*], and Baldwin [*1971*].

APPENDIX

Assuming only three factors, the factor content of a given manufactured product, expressed relative to the aggregate manufacturing sector, could be represented in the three-dimensional space by a vector that goes from the origin to the point ($k_s/\overline{k}$, $w_s/\overline{w}$, $r_s/\overline{r}$), where ($\overline{k}$, $\overline{w}$, $\overline{r}$) is the factor composition of the aggregate manufacturing sector, as represented in Figure 5. It could also be represented in a two dimensional plane by means of the point corresponding to the intersection of that vector (or the result of multiplying it by a scalar) and a plane, appropriately defined in the positive orthant (point circled in Figure 5(a). The points ($w_t/\overline{w}$, $k_t/\overline{k}$) corresponding to all the products with the same *kw* ratio as product *s*, will fall on the line that goes through the origin and the point ($w_s/\overline{w}$, $k_s/\overline{k}$). Similarly, the points associated with all the products with the same *kr* ratio will fall on the line that goes through the origin and the point ($r_s/\overline{r}$, $k_s/\overline{k}$).

Every point on the resulting triangle's base is associated with one, and only one, ratio *kw* (increasing from left to right), that is, a relation between the capital to labor ratios of the product and the overall manufacturing sector:

$$kw_s = \frac{k_s/\overline{k}}{w_s/\overline{w}} = \frac{f^*_{km,s}}{f^*_{wm,s}} \Big/ \frac{f^*_{km,man}}{f^*_{wm,man}}$$

On the left side of the triangle, the relation between natural resources and labor (rw_s) is similarly measured (increasing from bottom to top), and on the right side, likewise, the relation between capital natural resources (kr_s), increasing from top to bottom. The plane has been defined so that an equilateral triangle is obtained in which the overall manufacturing sector is shown at the center (where all ratios are equal to one). Straight lines can now be traced from each vertex to the mid point of the opposite side (geometric median lines) where the corresponding factor ratio is equal to one. For example, a line can be traced from the lower right vertex to the mid point of the opposite side, along which rw_s is measured, and another from the top vertex to the mid point of the triangle's base, where kw_s is measured. The points above the first line will have a rw_s ratio above the average, and the points to the right of the second line will have a kw_s ratio higher than the average. The point representing the relative factor intensity of a product is the intersection of two lines (the third one is redundant) originating in different vertices, and intercepting the opposite side of the triangle at the

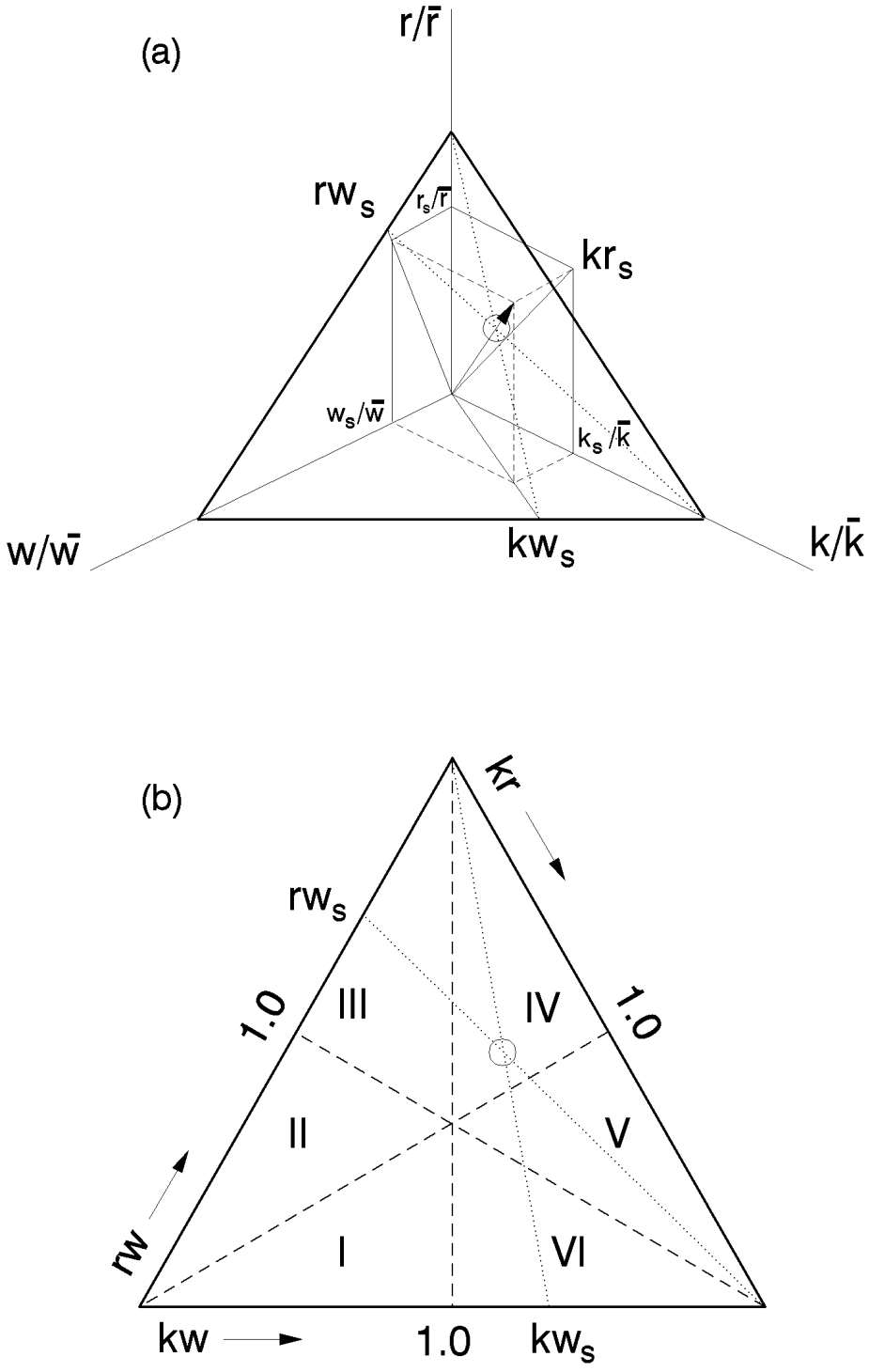

Figure 7 Relative intensity triangle

point associated with the value of the corresponding relative intensity. For example, the circled point in Figure 5(b) corresponds to a product with ratios *rw*, *rk* and *kw*, higher than those for the overall manufacturing sector, i.e. the product is intensive in natural resources with respect to both other factors, and capital intensive with respect to labor.

References

Baldwin, R., 1971, `Determinants of the Commodity Structure of U.S. Trade', *American Economic Review*, Vol. 61, No. 1, pp. 126-46.

Berlinski, J., 1977, *La protección arancelaria de actividades seleccionadas de la industria manufacturera argentina* (Tariff Protection of Selected Argentine Manufacturing Industries), Buenos Aires: Ministerio de Economía.

Berlinski, J. and D. Schydlowsky, 1982, `Argentina', in B. Balassa and Associates, *Development Strategies in Semi-industrial Economies*, Baltimore: Johns Hopkins.

Bitar, S. and E. Troncoso, 1983, *El desafío industrial de Venezuela* (Venezuela's Industrial Challenge), Buenos Aires: Pomaire.

Cervini, H., 1992, `Colombia', in E. Londero (ed.), *Precios de cuenta: principios, metodología y estudios de caso* (Accounting Prices: Principles, Methodology and Case Studies), Washington, D.C.: Inter-American Development Bank.

Cervini, H. and E. Londero, 1991, `Desarrollo industrial, crecimiento de las exportaciones de manufacturas y contenido de insumos primarios' (Industrial Development, Manufactured Exports Growth, and Primary Input Content), unpublished manuscript, Washington, D.C.: Inter-American Development Bank.

Hirschman, A., 1958, *The Strategy of Economic Development*, New Haven: Yale University Press.

Hutcheson, T., 1973, `Incentives for Industrialization in Colombia', Ph.D. dissertation, Ann Arbor: University of Michigan.

Hutcheson, T. and D. Schydlowsky, 1982, `Colombia', in B. Balassa and Associates, *Development Strategies in Semi-industrial Economies*, Baltimore: Johns Hopkins.

Leamer, E., 1987, `Paths of Development in the Three-Factor, n-Good General Equilibrium Model', *Journal of Political Economy*, Vol. 95, No. 5, pp. 961-99.

Londero, E., 1994, `Preparing Relative Intensity Triangles', Working Papers No. 198, Washington,

D.C.: Inter-American Development Bank.

Londero, E., J. Remes and S. Teitel, 1991, `Industrial Development and Manufacturing Exports in Argentina: Primary Input Composition', unpublished manuscript, Washington, D.C.: Inter-American Development Bank.

Naya, S., 1967, `Natural Resources, Factor Mix, and Factor Reversal in International Trade', *American Economic Review* (Proceedings), Vol. 57, No. 2, pp. 561-70.

Ocampo, J.A., 1989, `Efectos de la liberación y del control de importaciones sobre la industria manufacturera colombiana, 1976-1986' (Effects on Colombian Manufacturing Industry of Controlling and Liberalizing Imports), *Coyuntura Económica*, Vol. 19, No. 1, pp.121-51.

Parot, R., 1992, `Venezuela', in E. Londero (ed.), *Precios de cuenta: principios, metodología y estudios de caso* (Accounting Prices: Principles, Methodology and Case Studies), Washington, D.C.: Inter-American Development Bank.

Parot, R., 1994, `Venezuela: recursos naturales y empresas públicas' (Venezuela: Natural Resources and Public Enterprises), unpublished manuscript, Washington, D.C.: Inter-American Development Bank.

Rodríguez, C. and O. Schenone, 1986, `Commercial Policy in Venezuela' (mimeo), Washington, D.C.: World Bank.

Secretaría de Planificación, 1986, *Cuadro de Insumo-Producto de los Sectores Productores de Bienes*, 1973 (Input-Output Table for Good-Producing Sectors, 1973), Buenos Aires: Secretaría de Planificación.

Teitel, S., 1976, `Labor Homogeneity, Skill Intensity and Factor Reversals. An International Comparison', *Journal of Development Economics*, Vol. 3, No. 4, pp. 355-66.

Teitel, S., 1989, `Industrialization, Primary Commodities and Exports of Manufactures', in N. Islam (ed.), *The Balance Between Industry and Agriculture in Economic Development*, Vol. 5., London: Macmillan-International Economic Association.

Teitel, S. and F. Thoumi, 1986, `From Import Substitution to Exports: The Manufacturing Export Experience of Argentina and Brazil', *Economic Development and Cultural Change*, Vol. 34, No. 3, pp. 455-90.

Vanek, J., 1963, *The Natural Resource Content of United States Foreign Trade 1870-1955*, Cambridge (Mass.): MIT Press.

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