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NO CHEERS FOR PETROCHEMICALS

by

David Morawetz

To be presented at the Torremolinos Conference of the
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Import Substitution, Import and Foreign Exchange in Colombia:

No Cheers for Petrochemicals

David Morawetz*

Like several other Latin American countries, Colombia began to develop her own petrochemicals industry in the 1960s. This development was a continuation of the import substitution policies begun after the Great Depression. The first phase of import substitution, production of "light" consumer goods, was more or less completed by the 1950s. By the mid 1960s domestic production had been substituted for imports in many "middle range" products as well (paper and paper products, some chemicals and metal manufactures). This left only heavier more capital-intensive industries, including petrochemicals, as candidates for further import substitution. Over 100 million dollars were invested in petrochemicals in Colombia in the 1960s, and another 120 million dollars is scheduled to be invested during the 1970s.^{1/} Comparable sums were also slated to be invested in petrochemicals in the other countries of the Andean Group--Chile, Peru, Ecuador and Bolivia. In Colombia petrochemicals received more government finance and support than any other industrial sector in the 1960s. For example, in 1969 chemicals and petrochemicals participated 40 percent in the portfolio of the largest government industrial development agency (Instituto de Fomento Industrial) and received 25 percent of all credits and refinancings created by the government's Private Investment Fund (Fondo de Inversiones Privadas), in spite of the fact that it generated only 8 per cent of industrial production and employment. This paper analyzes the Colombian petrochemicals industry from an economic viewpoint, comparing past and projected future petrochemicals investments with potential alternative uses of the same funds in labor-intensive export-oriented industries--clothing, footwear, wooden furniture, textiles, glass products and some metal manufactures. It is assumed throughout the paper that capital is relatively scarce in Colombia--clearly, if capital were abundant the conclusions could well be different. The criteria used in making the comparison are direct and indirect employment created, foreign exchange saved and earned, degree of international competitiveness of costs and prices, and linkage effects on the rest of the economy.^{2/} It is found that on all counts investments in petrochemicals are inferior to labor-intensive export-oriented investment. Some conjectures are offered to attempt to explain why, despite their apparent economic unattractiveness, investments in petrochemicals have been and are so popular with governments and private entrepreneurs in Colombia and the other Andean countries.

Direct and indirect employment and linkages

Like all Latin American countries, Colombia suffers from a severe unemployment problem. In the late 1960s, there were more than twice as many people unemployed (700,000) as there were employed in the whole of manufacturing industry (300,000) (Table 1). Furthermore, at least as far as manufacturing employment was concerned, the situation was deteriorating as time went on. Employment in manufacturing industry grew at less than 0.3 percent per annum from 1962 to 1969, far behind population growth of over 3 percent per annum. Heavy investments in petrochemicals in the 1960s did nothing to ease the Colombian unemployment problem; on the contrary, they aggravated it. Despite investments of over 100 million dollars in "derivatives of petroleum and coal" (petrochemicals and oil refining) between 1957 and 1965, total employment in the sector actually decreased by 290 persons in the same period.^{3/} In at least one petrochemicals plant owned and operated by the government, each job created required half a million dollars of fixed investment. On average, it took thirty-nine thousand dollars of fixed investment to create a job in petrochemicals, twenty times more than in labor-intensive industry (Table 2). In other words, for each 100 million dollars invested in petrochemicals in Colombia, some 2,500 persons are employed, while investment of the same 100 million in labor-intensive industries would create 50,000 jobs. The direct unemployment created as a result of investing 100 million dollars in petrochemicals is therefore about 47,500 persons, or more than 15 percent of total Colombian industrial employment.^{4/}

But, it has been argued, surely petrochemicals creates more indirect employment than clothing, footwear, wooden furniture, etc. Not at all. An increase in clothing production stimulates the production of textiles and raw cotton, both relatively labor-intensive, and also of sewing machines, looms, etc. An increase in shoe production stimulates the leather and cattle industries, and also the production of shoe machinery. On the other hand, an increase in petrochemicals output stimulates oil refining and crude oil production, neither of which uses much labor. We can use the Colombian input-output table to quantify approximately the number of indirect jobs created by a given investment in a particular sector. Appropriate manipulation of the inverse of the Input-output Table indicates that an investment of 100 million dollars in "derivatives of petroleum and coal" creates fewer than 1,000 jobs indirectly throughout the economy, compared with 102,000, 50,000 and 49,000 indirect jobs created by an investment of the same magnitude in clothing, footwear and wooden furniture respectively.^{5/}

Furthermore, small-scale high-cost protected production of petrochemicals like that in Colombia penalizes the industries which use petrochemical products as inputs--plastics, synthetic fibres,

textiles, etc. To the extent that high protection is granted to user industries to enable them to absorb increased raw material costs, high cost production of petrochemicals contributes to raising the general cost structure of national manufacturing industry. But where the user industry is a potential exporter, actual indirect unemployment may be created as well. Take the case of the Colombian textile industry. Despite the fact that synthetic textiles are subject to much less stringent import quotas in the developed countries than cotton textiles, and that synthetic textiles are of greater value per square yard than cotton textiles, Colombia exported almost solely cotton textiles in the late 1960s and early 1970s--about 20 million dollars worth per year. The chief cause of this anomalous situation was that the domestically produced synthetic fibres which textile producers were forced to purchase were overpriced by up to 120 percent. This in turn was partly due to excessive protection granted to the (subsidiaries of foreign) firms producing synthetic fibres, and partly to the high cost of Colombian petrochemicals products used to manufacture these fibres. Assuming that Colombia could export, say, 100 million dollars worth of synthetic textiles per annum, employment in the Colombian textile industry could be increased by some fourteen thousand persons, or almost five percent of total Colombian industrial employment, if textile producers were permitted to buy their raw materials at world prices.7/

Foreign exchange earned and saved

The picture is no more favorable for petrochemicals if we look at foreign exchange earned and saved. In Colombia in the 1950s and '60s, foreign exchange earned and saved for a given fixed investment was on average five times as great in labor-intensive industries as in petrochemicals (Table 2). It is true that exports as a percentage of total sales were higher in petrochemicals than in labor-intensive industry. However, it is not legitimate to look only at foreign exchange earned without looking also at foreign exchange saved. The apparently successful export performance of petrochemicals mainly reflects the fact that once the tanks, pipes and cauldrons have been created the marginal cost of producing petrochemicals is very low, and hence exports can be profitably sold at very low prices. The poor export performance of Colombian labor-intensive industries mainly reflects the bias against exporting which is introduced by the tariff structure and the overvalued exchange rate.

International competitiveness and economic of scale

Clothing, footwear, wooden furniture, textiles and glass products are in general produced at close to world prices in Colombia, while domestically produced petrochemicals are on average 45 to 50 percent more expensive than imports (Table 2). Overpricing in Colombian petrochemicals could be even greater if local production did not receive the types of implicit subsidy. First, producers receive

to borrow large amounts of capital from government agencies at subsidized interest rates. Second, until the early 1970s, the special petroleum exchange rate system ("tasa petrolera") kept petroleum prices artificially low.^{8/} Preliminary estimates made in 1971 suggested that abolition of the special "tasa petrolera" would raise the price of petrochemicals products by from 5 to 30 percent. When account is also taken of the subsidy via artificially low interest rates, the "true" degree of overpricing in Colombian petrochemicals may be closer to 75 than to 50 percent.

While licensing and prohibition of imports explain how such overpricing can continue, the cause of the overpricing lies largely in the small size of Colombian petrochemicals plants by world standards. World petrochemical plants are on average five times larger than Colombian plants producing the same product (Table 3). Given the importance of economies of scale in the petrochemical industry, the fixed capital cost of producing one ton/year of output in Colombia are therefore on average six times greater than in a typical world plant (Table 3 and Fig 1).^{9/}

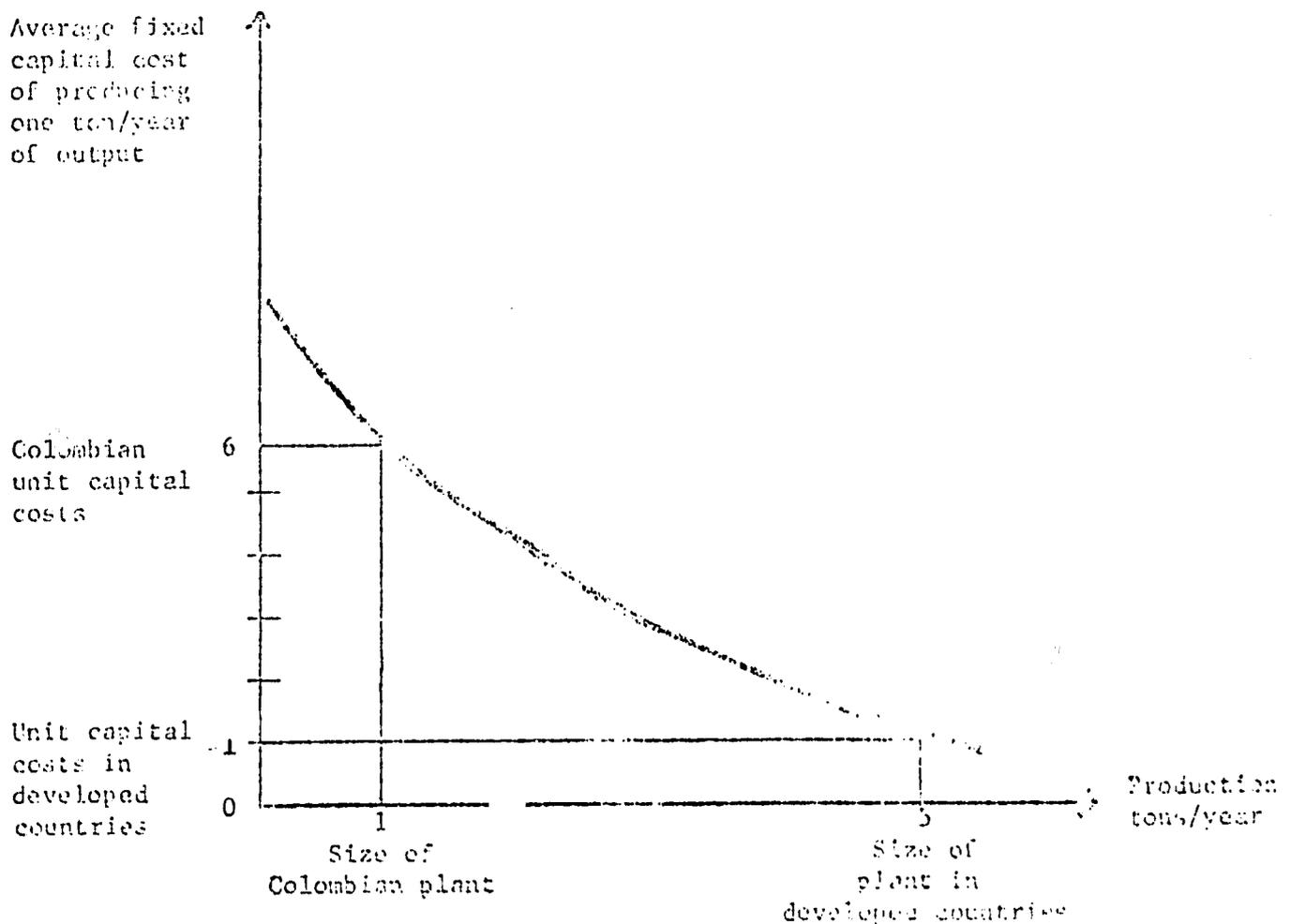


Fig. 1
Plant size and production costs in the petrochemical industry
in Colombia and in developed countries

This is not only the case for historical data; it is likely to remain true also at least in the near future. The Colombian projects which were in the planning stages in 1971 did not differ significantly in terms of size relative to typical world size from those built previously.

According to The Economist's (1970) authoritative survey of the petrochemicals industry, the worldwide trend towards construction of larger and more costly plants is likely to continue at least for some time. Even in the late 1960s, "a fair sized ethylene cracker. . . cost U.S. \$150 million perhaps. Add in an ammonia plant and something of an aromatics complex and one is quickly up to U.S. \$500 million."^{10/} This sum is almost three times as great as Colombian net fixed investment in all branches of industry in 1968, and represents about 40 percent of Colombian gross fixed investment of all kinds in the same year (the most recent one for which data are available).

A counter-argument

The best argument in favor of petrochemicals production in Colombia is that although it uses huge quantities of one scarce factor, capital and almost none of the abundant unskilled labor, ("the only unskilled laborers involved in a petrochemicals project are those keeping the place clean"^{11/}) it does save on the scarce factor management. Many petrochemicals plants in Colombia are built as simple turn-key operations, and the needs for supervision and coordination of the workers employed are minimal. By contrast a labor-intensive export-oriented operation using similar amounts of capital to a petrochemicals complex would require a great deal of expertise in labor force organization, product design and quality control, and in selling the finished product in export markets. In addition, exports may be confronted with quotas, tariffs or other barriers in the developed countries, problems which import-substituting petrochemicals producers do not have to face. These are very real problems. Nevertheless, they have been overcome by other less developed countries which have used exports of labor-intensive products as an engine of growth. There seems little reason to assume that Colombia and the other Andean countries could not do the same.^{12/}

Why so much emphasis on petrochemicals?

If the case against petrochemicals is so strong, one might ask why Colombia and the other Andean countries have placed such great emphasis on petrochemicals production. A first important reason seems to be that even within governments, capital is sometimes relatively "sector-specific". The Colombian government-owned oil company derives a large surplus from its refining and other operations. In the absence of some mechanism for siphoning off this surplus into general government revenues, the company invests it in lines with which its managers and engineers are familiar. Chemical engineers

know more about producing petrochemicals than about selling men's shoes in the United States, and are often keen to put their theoretical knowledge into practice.

Second, while there has been some recognition of the need to promote exports, the development policies pursued by the Colombian and other Andean governments have continued on balance to favor import substitution. For example, a Colombian petrochemicals producer whose price is 60 percent above the world price is receiving an implicit subsidy via the tariff and import licensing system of 60 percent. Colombian exporters, on the other hand, receive an export subsidy of only 15-20 percent.^{13/} Producing petrochemicals for the domestic market is therefore made more attractive to private entrepreneurs than exporting labor-intensive goods by the tariff-subsidy structure.

Finally, as noted above, the management and marketing problems are easier solved in petrochemicals than in labor-intensive exports, and labor-related problems are likely to be fewer. This third factor represents a "natural advantage" of petrochemicals; however, the first two factors are distortions which could be removed by changes in government policy.

Table 1
Industrial Employment in Colombia by Sector, 1956 and 1967

Sector	1956		1967		Ratio employment 1967/1956
	Persons	Percentage of total employment	Persons	Percentage of total employment	
Food	34.399	16	44.057	15	1.28
Beverages	11.926	6	15.362	5	1.28
Tobacco	5.450	2	3.469	1	0.64
Textiles and clothing	36.498	17	46.580	16	1.28
and footwear	29.116	14	29.037	9	1.00
Wood products	5.865	3	6.366	2	1.09
Furniture of wood	4.856	2	5.177	2	1.07
Paper products	2.968	1	6.183	2	2.08
Printing	8.711	4	11.884	4	1.36
Leather products	4.295	2	4.377	1	1.02
Rubber products	4.781	2	6.781	2	1.42
Chemicals Derivatives of petroleum and coal	11.148	5	23.832	8	2.14
Non-metallic minerals	2.027	1	2.061	1	1.02
Basic metals	18.968	9	24.739	8	1.30
Metal products	4.907	2	4.713	1	0.96
Machinery	6.216	4	20.224	7	2.45
Electrical machinery	2.215	1	5.937	2	2.68
Transport	3.062	1	9.507	3	3.10
Other industries	8.915	4	13.942	5	1.56
	3.645	2	9.567	3	2.63
Total	211,872	100	297,825	100	1.41
Manufacturing			72,100		

Source: D.S.P., Breve lección sobre el Problema del Desempleo en Colombia, (C.F.-50-116, June, 1970), Table 1.

Table 2
Capital-Intensive and Labor-Intensive Industry in Colombia

Industry	Fixed capital (US\$'000)	Total employment (persons)	Fixed capital per job created = 3/4 (US\$'000)	Exports (US\$'000)	Foreign exchange earned and saved (= total production) (US\$'000)	Exports/Production = 6/7	Production/Capital = 7/3	Percent of capital that is national	Domestic price/FOB export price
1	2	3	4	5	6	7	8	9	10
Petrochemicals	3680	146	29.0	263.0	3,426.0	7.5	0.61	55.2	1.47
Clothing	358.6	192	2.1	14.9	1,062.7	1.4	3.0	99.1	1.16
Footwear	128.1	175	1.5	1.1	785.7	0.1	6.1	99.1	0.83
Furniture of wood	320.0	140	2.3	-	241.0	-	1.4	100.0	1.06
Textiles	5,158.8	1,731	2.1	765.2	12,757.3	3.9	2.5	100.0	1.32(b)
Glass products	435.8	252	1.7	-	363.3	-	1.5	100.0	0.93
Metal manufactures	339.8	142	2.4	26.4	1,262.4	2.0	3.8	89.5	1.30
Majority of the six labor-intensive industries	1,125.1	439	2.0	164.6	2,736.7	1.6	3.1	97.9	1.10

Source: data at the individual firm level gathered by the Colombian National Planning Department and the Ministry of Development, 1969-70.

(a) Does not take account of imported and potentially exportable inputs.

(b) This figure is inflated by the high cost of petrochemical-based raw materials used in production of synthetic textiles.

Table 3
Plant size and production costs in the
petrochemical industry in Colombia and developed countries

Product number (a)	Size of Colombian plant Ton/yr	Size of typical plant in developed countries Ton/yr	Ratio between size of developed country plant and Colombian plant = 2/1	Fixed cost of Colombian plant (US\$'000)	Fixed cost of typical plant in developed countries (US\$'000)	Fixed cost of Colombian plant per ton/yr = 4/1	Fixed cost of typical plant in developed countries per ton/yr = 5/2	Ratio between fixed cost per ton/yr in Colombian plant and typical plant in developed countries = 6/7
								8
	1	2	3	4	5	6	7	8
1	130,000	500,000	3.8	8,219	16,000	632	32	19.8
2	11,300	30,000	2.7	4,784	3,000	423	100	4.2
3	18,000	200,000	11.1	9,900	14,600	555	70	7.9
4	7,500	60,000(d)	8.0	3,600	3,000	450	50	9.0
5(b)	15,000	30,000(d)	2.0	7,000	3,500	467	83	5.6
6(b)	50,000	300,000	6.0	n.d.	15,000	n.d.	50	n.d.
7(b)	20,000	50,000	2.5	n.d.	22,000	n.d.	440	n.a.
8(b)	15,000	100,000	6.7	n.d.	1,000	n.d.	20	n.d.
9	20,000	100,000	5.0	n.d.	700	n.d.	8	n.d.
10(b)	99,000	400,000	4.0	n.d.	30,000	n.d.	35	n.d.
Average	-	-	5.0	-	-	511	101	5.1

Source: Sandoval (1971, Table 5).

(a) Products are numbered to preserve anonymity of respondent firms.

(b) Project.

(c) From "Capital cost data for processing plants," Chemical Engineering, Dec 4, 1967, p. 215.

(d) See C.I.B.A., La Industria Quimica en America Latina, p. 100.

n.d. No data available.

Footnotes

- * Part of the research on which this paper is based was undertaken while the writer was a member of the Harvard Development Advisory Service group attached to the Colombian National Planning Department in 1970-71. I wish to thank Ana Rita Cardenas, Alejandro Figueroa, Gonzalo Giraldo, Mauricio Gutierrez, Thomas Hutcherson, Juan Klein, Fernando Sandoval and Alberto Villate for helpful discussions and for assistance in data-gathering.
1. Departamento Nacional de Planeacion (1969, Anexo Table 11); reports of Andean Group petrochemicals negotiations.
 2. A more general approach would be to use social cost-benefit analysis directly. However, data limitations make this impracticable in the present case. It is unlikely that the results would be qualitatively altered if such an approach were used.
 3. D.N.P. (1969, Anexo Table 11).
 4. These calculations and all others in this paper ignore, first, that part of the fixed capital invested in petrochemicals is provided by foreign funds which would not be available for other purposes, and, second, that working capital needs are greater in labor-intensive industries than in petrochemicals. Taking these two factors into account (if reliable data were available) would soften the case against petrochemicals a little, but would certainly not destroy it. For example if 50 percent of the capital invested in petrochemicals is foreign (Table 2) and none of this would have been available for other purposes (an extreme assumption), there would still be at least ten times as many people employed in labor-intensive industries as in petrochemicals for a given domestic fixed investment.
 5. Input-output table for Colombia, 1966 and Moravetz (1971, Table 6).
 6. Sandoval (1971).
 7. Hong Kong, with population one-fourth and G.D.P. one-half of Colombia's, exported \$100 million of textiles in 1969. Taiwan, with population and G.D.P. 70 percent of Colombia's, exported \$300 million of textiles in the same year.
 8. Hutcherson (1971).

9. In petrochemicals, when the size of equipment is doubled its cost does not double; rather it rises by the smaller amount indicated by the following basic type of equation:

$$C = K (A/B)^b$$

in which the unknown cost (C) of an equipment of size A is equal to the known cost (K) of an equipment of size B multiplied by the ratio of the sizes A/B raised to the "b" power. The average value of the exponent "b" is about 0.67. Although fluid-type process plants involve some high-exponent equipment (piping, structural frames and towers), the average exponent seems to be lower (about 0.63) due primarily to the large amount of tankage and the extensive use of instruments (whose cost is not affected by the size of the plant). Nelson (1965, p. 112).

10. The Economist (1970, p. xii).
11. The Economist (1970, p. xii).
12. The 1970s could be a particularly opportune time to begin exporting large quantities of labor-intensive commodities to the U.S., Europe and other world markets: Italy and Japan, the largest two exporters of these types of goods in the 1960s, are likely to be unable to maintain their dominance as their living standards (and labor costs) rise rapidly.
13. Through the Certificado de Abono Tributario (C.A.T.).

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