

**INDUSTRIALIZATION, TRADE AND POLLUTION IN LATIN AMERICA:  
A REVIEW OF THE ISSUES**

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# Industrialization, Trade and Pollution in Latin America: A Review of the Issues<sup>1</sup>

## 1. Introduction

Industrial pollution is a growing problem in Latin America today. It is overshadowed in much of the academic literature on the environment by “green issues” such as deforestation and land degradation. However with Latin America becoming a predominantly urban society, pollution issues have become increasingly important on the political agenda.

The purpose of this paper is to analyse the growth of industrial pollution in recent years in three countries, Argentina, Brazil and Mexico. Between them, they account for almost four-fifths of the region’s manufacturing production and hence the bulk of industrial pollution in Latin America. A particular focus of the paper is the link between trade and foreign capital flows and pollution in the region. The recent opening up of the Latin American economies provides an opportunity to explore these links in detail, and to address some aspects of the broader debate over the environmental consequences of globalization (cf. OECD, 1997).

In the next section some preliminary evidence on pollution trends in Argentina, Brazil and Mexico is presented. This is followed by a methodological discussion of the ways in which the impact of industrialization on the environment can be evaluated. The next section looks at some of the theoretical debates concerning the environmental consequences of trade liberalization and foreign investment and the existing evidence on Latin America. Section 5 describes the recent changes in the pollution-intensity of manufacturing production in the three countries, while in the final section the impact of trade and investment on pollution is analysed.

## 2. Trends in Industrial Pollution in Latin America

Although there is a general perception that pollution is a problem in the major urban and industrial centres of Latin America, data on industrial pollution in the region is fragmentary and lacking in comparability both over time and between countries.

**Table 1: Air Pollution Levels in Selected Cities ca 1995**  
(micrograms per cu. mt.)

	TSP	SO2	NO2
Cordoba (Arg)	97	n.a	97
Sao Paulo (Br)	86	43	83
Rio de Janeiro (Br)	139	129	n.a.
Mexico City (Mex)	279	74	130
WHO Guidelines	90	50	50

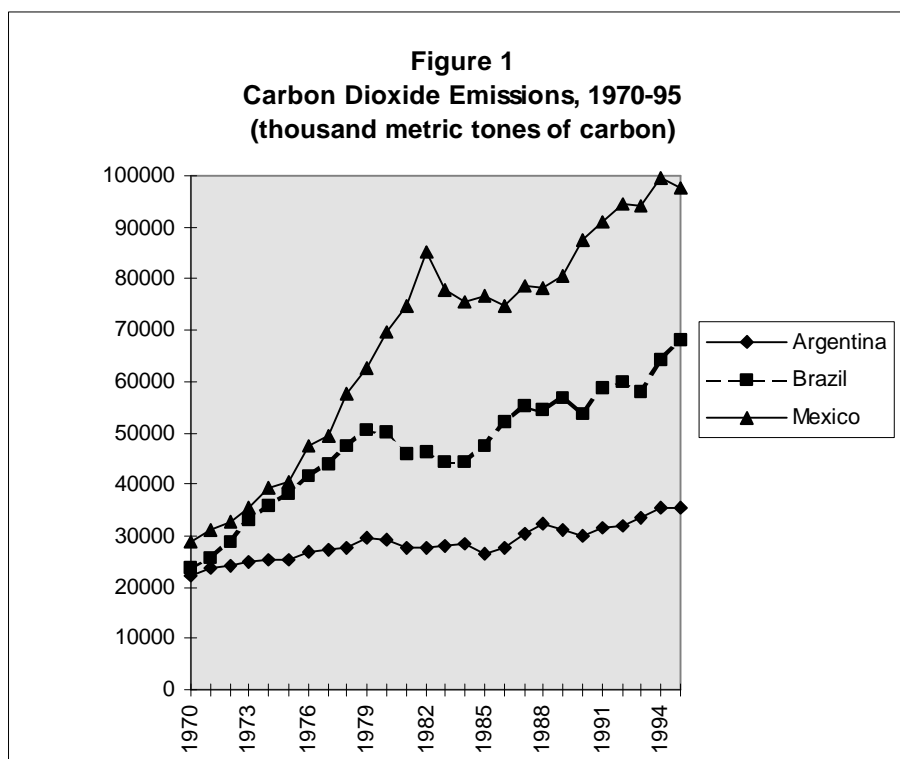
Source: World Bank, *World Development Indicators, 1998*, Table 3.12

<sup>1</sup> This paper is based in part on research carried out under a grant from the Global Environmental Change Programme of the Economic and Social Research Council in the United Kingdom whose support is gratefully acknowledged.

Data on air pollution indicates that in a number of Latin American cities, concentrations of pollutants are above the World Health Organization (WHO) guidelines for air quality standards. Only Sao Paulo of the major Argentinian, Brazilian and Mexican cities for which data is available falls within the guidelines for any of the three pollutants covered (see Table 1)

Although industry is by no means the only factor contributing to air pollution in urban areas it is, together with vehicle emissions, a major element. In Sao Paulo for instance industry accounted for 88% of sulphur dioxide emissions, 65 % of particulates and 24% of nitrogen oxides (Shaman, 1996, p.6). There are similar problems with water quality both with respect to the regions' rivers and coastal waters. In Mexico in the early 1990s 20 out of 29 main watersheds for which there was information were classified as excessively or strongly polluted (USAID, 1995, p1-10). In Brazil stretches of the Paraiba do Sul river in the state of Rio de Janeiro and several of its tributaries are badly polluted, as is Guanabara Bay (World Bank, 1996).

It is even more difficult to obtain estimates of industrial emissions and effluent, particularly over time. This partly reflects the lack of monitoring of pollution in the past in Latin America. For example although a number of inventories of emissions have been carried out in Mexico City since the early 1980s, these are not really comparable from one year to another since they use different EPA conversion factors to estimate the pollution load in different years.



Source: Gregg Marland and Tom Boden (Oak Ridge National Laboratory)

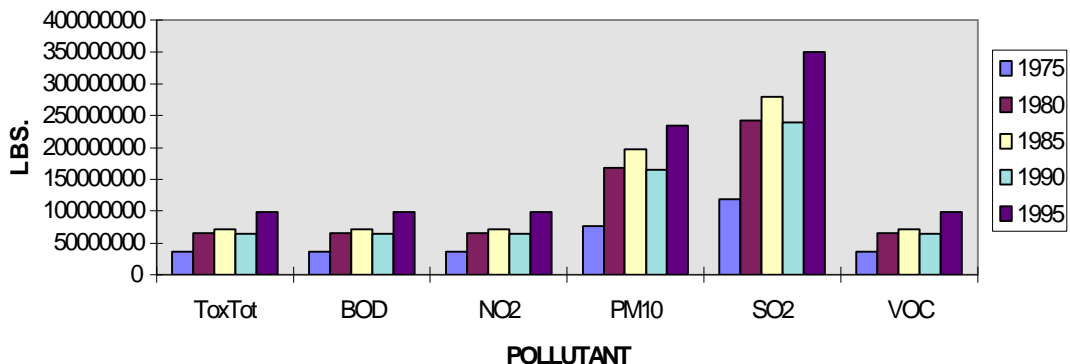
One type of emission for which international estimates are available over time is carbon dioxide. Figure 1 shows the increase in carbon dioxide emissions in Argentina, Brazil and Mexico since 1970. This shows a clear pattern in Brazil and Mexico with substantial growth in the 1970s, a drop in the early 1980s as the economic crisis hit the region and further growth from the mid-eighties. Argentina shows something of the same pattern but in a much less marked fashion.

Unfortunately similar estimates are not available for other industrial emissions for the three countries. Therefore in order to get country-wide estimates of industrial emissions for a much wider range of pollutants another set of indicators were calculated using the World Bank's Industrial Pollution Projection System (IPPS). The IPPS consists of a set of coefficients which relate emissions of pollutants to value added, output or employment. These have been calculated by the World Bank from US data on emissions and industrial production. These coefficients can then be applied to industrial data for other countries to obtain pollution estimates.

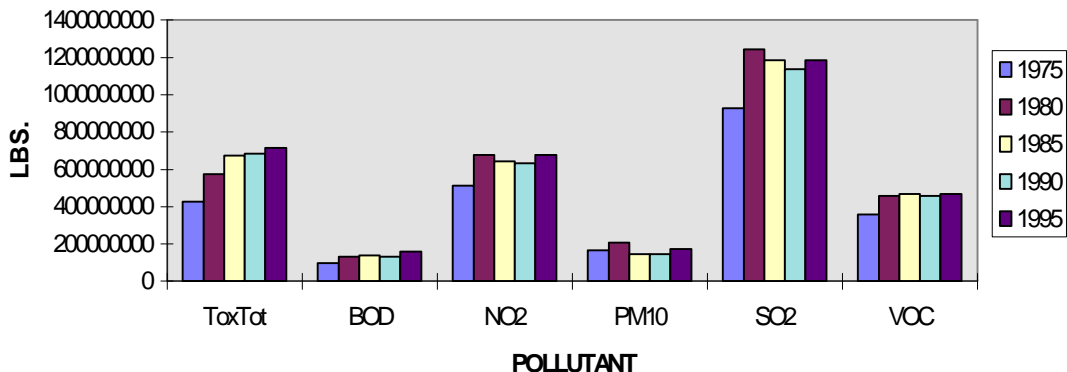
In order to estimate emissions associated with industrial production in Argentina, Brazil and Mexico, UNIDO data on industrial value added for the three countries were converted to 1987 US dollars. Because the IPPS coefficients derive from the United States which has stricter environmental regulations than is generally found in Latin America, it is likely that they underestimate the level of emissions in the region. On the other hand because fixed coefficients from 1987 were used, no account is taken of technological improvements which reduce emissions per dollar of value added and they will therefore tend to exaggerate the growth of pollution.

The growth of industrial emissions in Argentina, Brazil and Mexico from 1975 to 1995 are presented in Figures 2-4. The data represented include four major air pollutants, one water pollutant and toxic emissions. The pattern which they show is slightly different from that observed in the previous figure for carbon dioxide. The growth of pollution seems to have continued up until the mid-eighties, particularly in Argentina and Mexico. In the late eighties emissions fell only to increase again in the 1990s in all three countries. These figures need to be treated with some caution. The UNIDO figures for industrial growth in Brazil in the 1990s are suspiciously high so that the growth in emissions in the 1990s have been adjusted downwards. Moreover since unlike the data on carbon dioxide, these emissions have only been estimated at five year intervals, the exact turning points in pollution levels are not clear. What is consistently apparent however is the fact that renewed growth after the "lost decade" of the 1980s has brought with it an upturn in pollution levels.

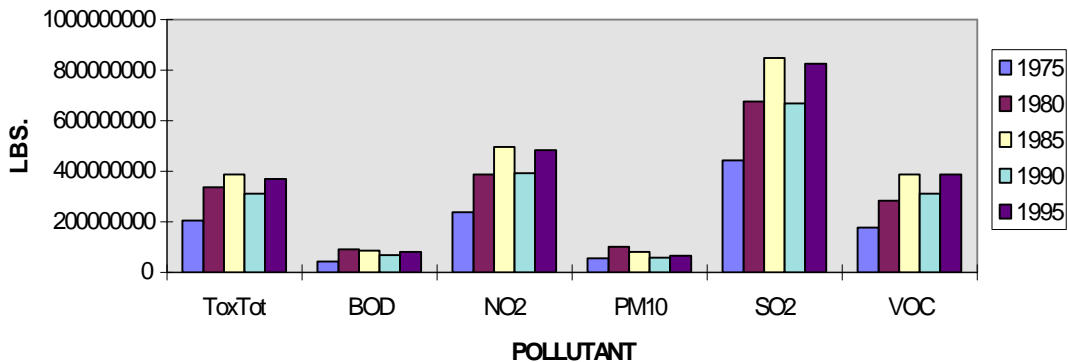
**FIGURE 2**  
**ARGENTINA: IPPS ESTIMATES OF EMISSIONS OF SELECTED**  
**POLLUTANTS, 1975-1995**



**FIGURE 3**  
**BRAZIL: IPPS ESTIMATES OF EMISSIONS OF SELECTED**  
**POLLUTANTS, 1975-1995**



**FIGURE 4**  
**MEXICO: IPPS ESTIMATES OF EMISSIONS OF SELECTED POLLUTANTS,**  
**1975-1995**



### 3. A Framework for Analysis

In analysing the impact of industrialization on pollution, it is useful to distinguish three separate effects (c.f. Grossman and Krueger, 1992; Birdsall and Wheeler, 1992). The total industrial emissions of any pollutant ( $E_j$ ) can be derived as follows:

$$E_j = \sum e_{ij} w_i Y$$

where  $e_{ij}$  - emissions of pollutant  $j$  per unit of value added in industry  $i$

$w_i$  - share of value added of industry  $i$  in total industrial value added

$Y$  - total industrial value added

Changes in the level of emissions over time can come about as a result of one of three things. First it is affected by changes in the level of industrial activity ( $Y$ ). This is what has been termed the *scale* effect. This is by definition always positive since in the absence of technological change and of changes in the relative importance of different industries, growth in output will inevitably result in a higher level of pollution.

Second, the overall level of emissions will depend on the contribution of different industries to total value added ( $w_i$ ). Clearly where more polluting industries such as petrochemicals or cement are increasing their share of production, total pollution will tend to rise. This is referred to as the *composition* effect. Changes in composition can either increase or decrease the overall level of emissions, depending on the relative growth of different industries, so that the impact of this effect on pollution is ambiguous.

Finally pollution will change with any reductions in emissions per unit of output which are achieved within an industry ( $e_{ij}$ ). This has been described as the *process* effect or *technique* effect which comes about from changes in the pollution-intensity of each industry. These changes may be the result of technological change, either explicitly aimed at reducing pollution or a by-product of efficiency enhancing technological changes, or a result of improvements in environmental management. This effect will by definition tend to reduce emissions levels.

The overall trend in industrial pollution in an expanding economy therefore depends on whether the *scale* effect of expanding output is counteracted by the *process* effect, and whether or not the *composition* effect tends to reinforce the scale effect or to offset it.

While this merely identifies the various factors which contribute to the overall level of industrial pollution, it provides a useful framework within which to think about the impact of trade and investment on pollution. One important limitation of this approach is that it concentrates solely on industrial emissions and therefore does not capture the effects of increasing emissions from transporting products on a much greater scale, which is undoubtedly one of the effects of increased trade.

### 4. Trade and Investment Flows and Industrial Pollution

A number of the debates concerning the impact of trade and investment on pollution hinge on different assumptions concerning the way in which liberalization affects the composition of the manufacturing sector and the process of production..

## ***a) Trade and Pollution***

### ***(i) Composition effects***

There is considerable controversy over whether trade leads developing countries to specialize in “dirty” industries or whether more open economies have less pollution-intensive industrial structures. One view is that since developing countries have less stringent environmental regulation than higher income countries, they will enjoy a comparative advantage in more polluting industries. Consequently trade liberalization will tend to have a negative impact on their domestic environment (Copeland and Taylor, 1994).

Against this however it has been argued that generally environmental control costs in manufacturing industry are low and that factors other than environmental considerations are more important in industrial location decisions (Leonard, 1988; Dean, 1992). In this case it is quite possible that a developing country with a less stringent environmental control system may nevertheless have a comparative advantage in less polluting industries. Indeed where there is a correlation between capital-intensity and pollution-intensity, countries with a comparative advantage in labour-intensive industries will benefit environmentally from specialising according to their comparative advantage (Birdsall and Wheeler, 1992).

In Latin America it has been claimed that there is evidence that more open economies tend to be cleaner and that;

“‘pollution havens’ can be found, but not where they have generally been sought. They are in protectionist economies.” (Birdsall and Wheeler, 1992)

In similar vein, a recent World Resources Institute Report (Runge et. al., 1997) has concluded that trade liberalization in Latin America will lead to expansion not of those industries which create major pollution problems but in those with a smaller environmental footprint such as textiles, metal products and food products.

### ***(ii) Process effects***

A second debate relates to the process effects associated with trade. It has been argued that producing for export leads to the adoption of clean technologies because of the requirements of international markets. Cases in point arise for instance where dioxin needs to be eliminated in the pulp and paper industry, and chrome in tanning. This may be reinforced in the not too distant future through the introduction of the ISO 14000 series of environmental standards, if they become a requirement for exporters. It is also argued that more open economies have greater access to the latest foreign technology and so will be in a better position to incorporate the latest waste or emissions minimising technologies, which will be diffused much more rapidly than in closed economies.

Despite these potential gains from producing for exports and having access to imported equipment, increased competition which forces cost minimisation, whether to compete in export markets, or against imports in the domestic market, may make it more difficult to adopt measures to protect the environment. The question of competitiveness is at the heart of many of the environmental concerns surrounding trade liberalization. The more subject an industry is to

international competitive pressures, the more resistant it is likely to be to attempts by regulators to impose environmental protection measures which will increase costs.<sup>2</sup>

Again the evidence from previous studies is not conclusive. There are examples of firms reducing emissions in order to meet foreign product standards e.g. in the pulp and paper industry in Chile (Birdsall and Wheeler, 1992). It is also claimed that in the pulp and paper industry the cleaner thermo-mechanical pulping process was adopted more quickly in more open economies (Wheeler and Martin, 1992) suggesting that easier access to foreign technology also has a positive environmental effect. It is not clear how far this latter finding can be generalised however since the technology concerned was cheaper as well as more environmentally friendly.

Some surveys of environmental management by firms also provide evidence on the relative behaviour of firms which produce for export compared to those which produce mainly for the domestic market. A survey of 32 Argentinian firms found evidence of a more pro-active environmental approach amongst exporters (see Chudnovsky et. al., 1997, Table 9). However a study of 90 firms in the Mexico City metropolitan area did not find a statistically significant relationship between the proportion of output exported and the degree to which the firm protected the environment (Dominguez, 1996). This was confirmed by an econometric study of 236 firms in Mexico which found that there was no link between producing for export to OECD countries and the environmental performance of firms (Dasgupta et. al., 1997).

## **b) Foreign Investment and Pollution**

### ***(i) Composition effects***

A major issue here is whether foreign investors relocate more polluting activities to developing countries to take advantage of less stringent environmental regulation. Such fears of “industrial flight” were a major factor in the pressure for the adoption of the environmental side agreement at the time of the NAFTA negotiations.

The evidence on this issue is rather mixed. There are examples where environmental regulation has been an important factor leading companies to relocate to Latin America. A much quoted instance is the relocation of furniture manufacturers from the Los Angeles region to Mexico in the late 1980s (OTA, 1992, p.100). However more aggregate studies have not generally found a clear pattern. One specific area of debate has been in relation to the *maquiladoras* in Mexico where contrasting views on the importance of environmental costs as a factor influencing industrial location have been presented by Grossman and Krueger (1992) who find no link between the pattern of investment and pollution abatement costs, and Molina (1993) who criticizes this finding.

### ***(ii) Process effects***

It is often claimed that TNCs adhere to their own corporate environmental standards which are higher than those of the developing countries in which they operate (Gladwin, 1987). Thus increased inflows of foreign capital tend to bring with them higher environmental standards. The extent to which multinationals do in practice require their subsidiaries to observe higher

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<sup>2</sup> There are of course some who argue that high environmental standards can themselves lead to technological innovations and reduced resource use which often increases competitiveness (Porter and van der Linde, 1996).



environmental practices is unclear and two surveys of such firms came to quite different conclusions.<sup>3</sup> Even when multinational companies do not have explicit corporate environmental policies, their tendency to use parent company technology, which has been developed to meet the stricter regulatory requirements of their home countries, will lead to them having less polluting production than local firms in developing countries (Ferrantino, 1995).

Empirical evidence from Latin America on this issue is relatively limited. The previously cited studies of Argentina and Mexico do not show a consistent pattern. In Argentina the subsidiaries of foreign companies were more likely to be environmentally pro-active than locally owned firms (Chudnovsky et. al., 1997, Table 11). One study of Mexico found that although there was a much higher proportion of foreign owned firms among the group of enterprises which were most environmentally advanced than amongst the least environmentally concerned firms, overall the relationship between foreign ownership and environmental performance was not statistically significant (Dominguez, 1996). Similarly the larger Mexican study failed to find any relationship between foreign ownership and environmental performance (Dasgupta et.al., 1997).<sup>4</sup>

Although the *process* effects of trade and investment flows have been discussed in this section, the remainder of the paper is primarily concerned with the *composition* effect. The issue of the process effect can best be dealt with at the firm and industry level and hence is more appropriately considered through industry case studies.

## 5. Trends in Pollution Intensity in Latin America

The data that was presented earlier as an indicator of the growth of emissions in Latin America can be used to measure the effects of changes in the composition of production on pollution. Since the estimates used IPPS coefficients which were fixed over time, the overall change in pollution intensity (i.e. pollution divided by manufacturing value added) is an indicator of the direction of the *composition* effect. In other words if measured pollution intensity falls this reflects the fact that the share of more polluting industries in manufacturing is declining.

In this context, it is of particular interest to note any differences which may arise between the period before and after the shift which took place towards more open trade and investment policies in the region. The first of the three Latin American countries considered here to

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<sup>3</sup> The majority of TNCs surveyed by the UNCTC Benchmark Corporate Environmental Survey reported having corporate environmental policies which went beyond those required by national legislation of the host country (UNCTC, 1992, p.234). However a MITI survey of Japanese TNCs found quite the opposite with the majority of firms only taking the measures required to meet local environmental standards (World Bank, 1993, Box 3.2).

<sup>4</sup> Comparisons between the environmental performance of different groups of firms only partially address the question of the impact of openness on the environment. One of the arguments concerning the possible negative environmental impact of liberalization of trade and investment is that it leads to weaker environmental standards. If this were indeed the case then the impact would be felt equally by all firms whether they were exporters or producers for the domestic market, foreign or locally owned. In this case a lack of a clear difference between two groups of firms does not necessarily mean that increased trade or greater openness to foreign investment has not had an important environmental effect.

undertake a major liberalization of its foreign trade was Mexico in 1985. It was followed by Argentina in 1989 and Brazil in 1990. (Agosin and French-Davis 1993, Table 1). Although there may be some lag between changes in trade and investment policies and their consequences in terms of the structure of production, the scale of the change was such that the effects were likely to have been evident by the mid-1990s.

Figure 5 shows the rate of growth of the pollution-intensity of Argentinian manufacturing production in three five year periods from 1980 to 1995. In the first period which precedes the economic reforms, industry is clearly becoming more polluting with only fine particulates (PM10) showing a very small decline in relation to output. The second period which also largely precedes the reforms continues to show significant increases of a number of pollutants, although there are also several which decline. Finally in the 1990s there is a clear decline in overall pollution-intensity, with the exception of metals and total suspended solids.

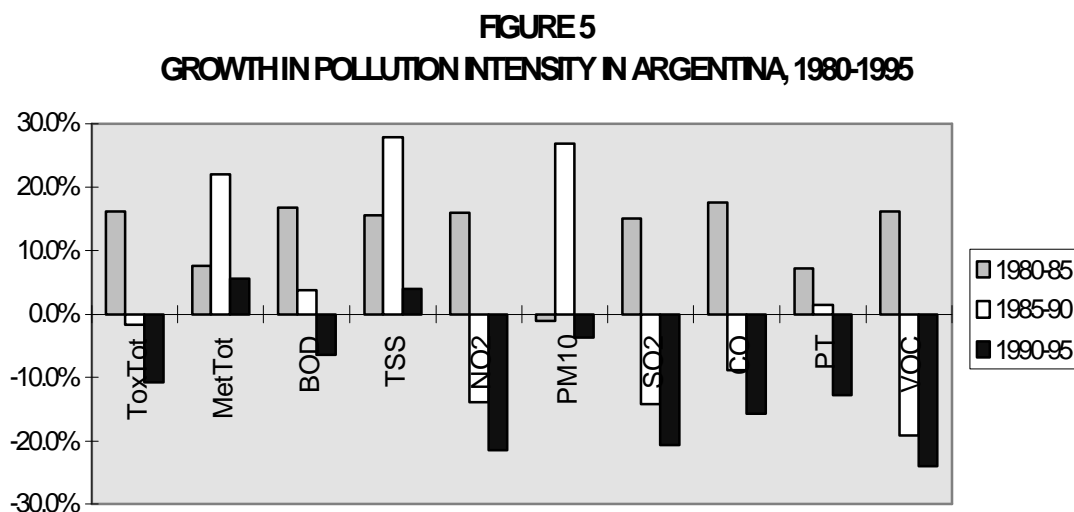


Figure 6 shows similar estimates for Brazil. In this case the trend is again predominantly for pollution-intensity to increase in the early 1980s, the only exceptions being particulates. In the late 1980s there is a more mixed picture with roughly half the indicators showing a decline. Finally in the 1990s, after the reforms have begun almost all indicators decline, again with particulates showing the opposite trend to the others.

**FIGURE 6**  
**GROWTH IN POLLUTION INTENSITY IN BRAZIL, 1980-1995**

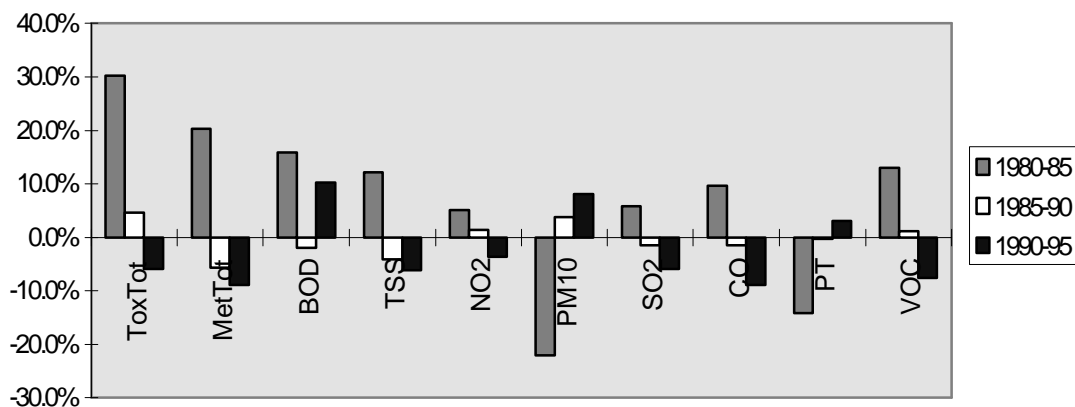
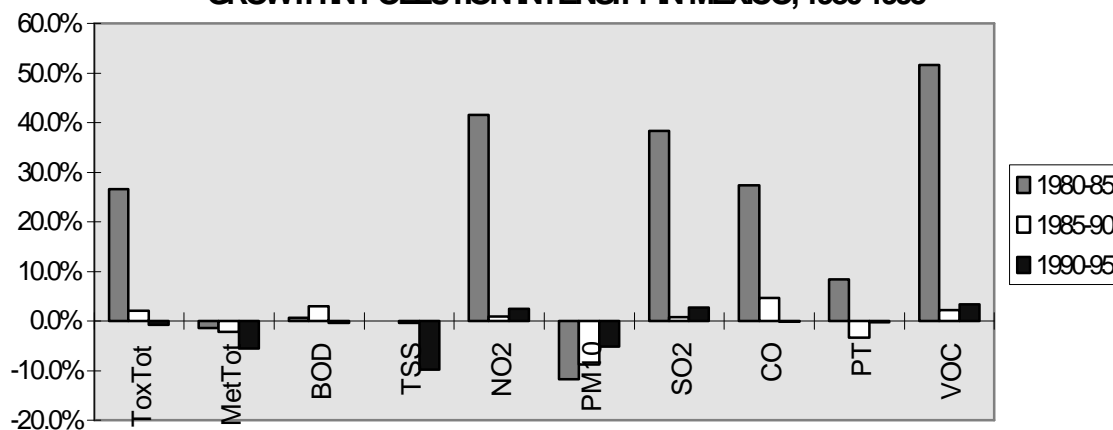


Figure 7 presents the picture for Mexico. Again the majority of indicators show pollution intensity increasing in the early 1980s. The picture from the mid-eighties is rather less clear than for Argentina and Brazil. Although a number of pollutants have declined, several air pollutants have continued to increase in the 1990s. However those cases where pollution intensity increased in the early 1990s, did so at a much slower rate than in the early 1980s.

**FIGURE 7**  
**GROWTH IN POLLUTION INTENSITY IN MEXICO, 1980-1995**



Despite the qualifications in the Mexican case, the evidence shows that in all three countries, the changes in economic policies have been accompanied by a shift towards a less pollution-intensive industrial structure than that which was found in the earlier period. In all three countries most indicators of pollution-intensity rose significantly in the early 1980s prior to the reforms and this was no longer the case in the 1990s.

## 6. The Determinants of Pollution Intensity

### *a) Pollution Intensity and the Structure of Protection*

The findings of the previous section are consistent with the view that pollution havens in Latin America were associated with protectionist policies and are not the result of more open economies (Birdsall and Wheeler, 1992). However before accepting this conclusion it would be useful to confirm that in fact protection tends to encourage the growth of the more polluting industries in an economy.

In order to do this the structure of protection in Argentina, Brazil and Mexico prior to the period of liberalization was analysed. Appropriate sectoral estimates of the effective rate of protection (ERP) were obtained for 1973 for Brazil (Coes, 1991, Table 4.1), 1980 for Argentina (Cavallo and Cottani, 1990, Table 3.19) and 1979 for Mexico (Ten Kate and Mateo Venturini, 1989, Table 4). On the basis of this data, industries were classified into those with high and low levels of effective protection.<sup>5</sup> In Brazil and Mexico industries were considered to have high levels of protection if the ERP was over 50%, while in Argentina where the overall level of protection was higher, an industry was classified as having high ERP when it was over 75%.

Having classified the two groups of industries, it was then possible to calculate the average pollution-intensity for high and low ERP industries, and then to derive a ratio between the pollution-intensity of the two groups. If protection has a “brown bias” i.e. tends to protect the more highly polluting industries, then the ratio would be greater than one. Surprisingly in the case of Argentina and Brazil, the bias was in the opposite direction with the most heavily protected industries having relatively low emissions of most pollutants (see Table 2). Only Mexico conformed to expectations with highly protected industries being relatively pollution-intensive with the exception of some total suspended solids and particulates.

**Table 2: Ratio of Pollution-intensity in High vs. Low ERP Industries**

	Argentina	Brazil	Mexico
Total Toxics	0.32	0.17	1.42
Total Metals	1.11	0.05	1.60
BOD	0.81	1.32	1.34
TSS	0.30	0.01	0.41
NO <sub>2</sub>	0.13	0.39	2.30
PM <sub>10</sub>	0.08	0.16	0.18
SO <sub>2</sub>	0.24	0.19	3.64
CO	0.23	0.11	2.01
PT	0.21	0.44	0.98
VOC	0.15	0.63	3.27

<sup>5</sup> Some industries were omitted due to the absence of estimates of effective protection. Also in some cases estimates were only available at the 2-digit level and it was assumed that the 3-digit industry shared the same characteristics in terms of protection as the 2-digit industry to which it belonged.

Source: own elaboration from IPPS and UNIDO data

This is a very paradoxical result for both Argentina and Brazil. Although the period of trade liberalization has been marked by a decline in pollution-intensity compared to the earlier period of import substitution, there is no evidence to support the view that protection in the past was particularly biased towards dirty industries. Even in the case of Mexico, there is something of a paradox in that some pollutants which appeared to be highly significant in protected industries such as nitrogen dioxide, sulphur dioxide and volatile organic compounds have continued to increase in intensity during the 1990s, while water pollutants which were more significant in the less protected industries have declined. It seems therefore that in all three countries changes in the overall pollution intensity of the manufacturing sector must be explained by factors other than trade liberalization.

***b) Pollution intensity and exports***

Another corollary of the view that greater openness will lead to a less polluting composition of industrial output, is that the more export-oriented industries will tend to be relatively clean industries. However the evidence from Latin America once more is not consistent with this hypothesis.

**Table 3: Ratio of Pollution Intensity in High vs. Low Export-orientation industries in Mexico (1990)**

Total Toxics	5.47
Total Metals	3.57
BOD	1.22
TSS	0.49
NO <sub>2</sub>	1.34
PM <sub>10</sub>	0.10
S <sub>02</sub>	1.65
CO	0.85
PT	0.54
VOC	2.05

Source: own elaboration from INEGI data and IPPS coefficients, and Ten Kate and de Mateo Venturini (1989), Table 4.

Table 3 shows the ratio of pollution-intensity in Mexico between industries which were highly export-oriented and those which produce mainly for the domestic market. Industries were regarded as export-oriented when the ratio of exports to value added was greater than 40%, and as domestic-market oriented when it was below 40%. Industries were classified according to their export performance in 1990 after the changes in the trade regime came into force, in order to test the hypothesis that those industries in which Mexico showed a strong export performance would tend to be less pollution-intensive.

The expectation that export-oriented industries would be characterised by relatively low emissions was true only in a limited number of cases, specifically for total suspended solids, particulates, and

carbon monoxide. For all other pollutants, emissions were higher in industries oriented towards exports than for those which produced mainly for the domestic market.<sup>6</sup>

***b) Foreign investment and pollution***

A second issue to be considered is whether there is a link between direct foreign investment and the pollution-intensity of industry in Latin America. If indeed relocation of industry from countries with stricter environmental regulation is an important factor, then it might be expected that foreign firms tend to concentrate in relatively pollution-intensive industries.

**Table 4: Share of Foreign Firms in Manufacturing in Latin America**

ISIC	Industry	Argentina	Brazil	Mexico
		(1983)	(1983)	(1994)
311	Food products	21.2%	18.0%	15.2%
313	Beverages	63.3%	15.0%	15.0%
314	Tobacco	99.6%	73.0%	42.0%
321	Textiles	22.4%	22.0%	21.9%
322	Wearing apparel, except footwear	6.3%	4.0%	7.6%
323	Leather products	16.0%	15.0%	7.0%
324	Footwear, except rubber or plastic	47.8%	4.0%	5.0%
331	Wood products, except furniture	16.5%	5.0%	5.8%
332	Furniture, except metal	32.9%	3.0%	7.3%
341	Paper and products	66.9%	21.0%	27.0%
342	Printing and publishing	8.3%	3.0%	8.8%
351	Industrial chemicals	83.4%	21.0%	21.9%
352	Other chemicals	57.4%	62.0%	60.5%
353	Petroleum refineries	39.9%	n.a.	0.0%
354	Misc. Petroleum and coal products	80.1%	n.a.	25.0%
355	Rubber products	69.2%	63.0%	31.6%
356	Plastic products	58.8%	17.0%	23.7%
361	Pottery, china, earthenware	6.2%	n.a.	17.7%
362	Glass and products	62.1%	n.a.	18.9%
369	Other non-metallic mineral prod.	28.6%	n.a.	4.8%
371	Iron and steel	28.2%	23.0%	18.9%
372	Non-ferrous metals	34.8%	44.0%	31.4%
381	Fabricated metal products	22.1%	23.0%	14.1%
382	Machinery, except electrical	74.3%	41.0%	52.5%
383	Machinery electric	74.0%	44.0%	58.3%
384	Transport equipment	88.4%	68.0%	64.4%
385	Professional & scientific equipment	98.5%	n.a.	64.3%
390	Other manufactured products	n.a.	29.0%	28.5%
	TOTAL	n.a.	28.5%	28.5%

<sup>6</sup> Time and data availability meant that it was not possible to carry out a similar analysis for Argentina and Brazil.

Source: Argentina - Basualdo et. al. (1988), Table 18; Brazil -Fritsch and Franco (1991), Table 1.6; Mexico - INEGI.

Argentina, Brazil and Mexico have all received substantial inflows of direct foreign investment in recent years. Unfortunately it was not possible to obtain recent data on the distribution of foreign ownership by industry, except for Mexico. However earlier data can be used to give an indication of the kinds of sectors in which foreign capital has tended to be concentrated (see Table 4).

In order to test whether or not foreign firms tend to concentrate in the more pollution-intensive industries in the three countries, Spearman's rank correlations were calculated between the share of foreign ownership in an industry and emissions per dollar of value added for the pollutants listed in Table 3 above. None of the rank correlations calculated in this way were significant at the 5% level in any of the three countries. Thus there is no evidence to support the view that foreign capital has tended to concentrate in "dirty" industries.

Although this evidence does not indicate whether or not there has been a shift in the composition of foreign investment towards more or less polluting industries in the period of the economic reforms, it does suggest that factors other than environmental considerations are the major determinants of the sectoral distribution of foreign capital. It seems unlikely therefore that liberalization has had significant beneficial or negative effects on pollution in terms of the sectoral distribution of foreign investment.

### *c) Major industries affecting pollution intensity*

An alternative way of analysing the decline in pollution-intensity in the region is to try to identify the key industries which account for the bulk of the changes in pollution-intensity during the period. Since what we are measuring here is the *composition* effect on the level of pollution, this can best be done by identifying the industries which are highly polluting and whose contribution to manufacturing value added has declined in the period.

**Table 5: Highly Polluting Industries whose Share of Manufacturing Declined**  
Argentina (1990-1995)

Paper and Paper Products	-0.7%
Oil refineries	-4.4%

#### Brazil (1990-95)

Industrial & other chemicals	-2.0%
Petroleum refineries	-0.7%
Ferrous & non-ferrous metals	-0.7%

#### Mexico (1985-95)

Other non-metal minerals	-0.7%
Ferrous metals	-0.7%

Source: own elaboration from UNIDO data

In terms of contributions to the decline in the overall pollution intensity of production, a small number of industries stand out. In Argentina the decline in the relative importance of oil refineries within industrial production was the most significant factor contributing to the overall reduction in pollution intensity. In Brazil, reductions in the share of industrial chemicals, other chemicals and oil refineries (ISIC 351-353) accounted for the decline in toxics while iron and steel and non-ferrous metals were responsible for declining relative metal pollution. Both sets of industries contributed to the decline in the indicators for air pollution. Finally in Mexico where the decline in pollution-intensity was least marked, again two industries contributed to this, other non-metallic mineral products (primarily cement) and ferrous metals.

This suggests that the factors which led to changes in the composition of manufacturing with important effects on pollution, are quite specific to a small group of industries, and may perhaps be better explained by particular developments in those industries rather than liberalization *per se*<sup>7</sup>. In some cases such as oil refining in Argentina, chemicals, oil refining and iron and steel in Brazil, and iron and steel in Mexico, these are sectors which have historically had a substantial state ownership, so that this may have contributed to their reduced importance in recent years, but it was not possible to explore this further here.

## 6. Conclusion

The central issue which this paper has addressed is whether or not increased openness to trade and foreign capital in Latin America since the mid-eighties have, as some claim, had beneficial effects in terms of industrial pollution. Although there is some evidence that industry has become less pollution-intensive in recent years, we were not able to show conclusively that this was a consequence of the reforms which have taken place.

It is important to bear in mind the limitations of this exercise. First of all, by concentrating on the ratio of pollution to output, one should not lose sight of the fact that although pollution-intensity may be declining for most types of emissions, the growth of output means that the absolute level of pollution continues to increase. Second, by concentrating solely on emissions from the manufacturing sector, there is a danger of forgetting that increased trade in manufactures also has an environmental effect through the growth of transport where a higher proportion of goods are being shipped around the world. Third the scale of the changes involved are relatively small. Despite very radical changes in economic policy in the region, the reductions in pollution-intensity rarely exceed a couple of percentage points a year over the period since the reforms were introduced. It is not surprising therefore that the overall level of pollution is likely to increase despite the composition effect, except in times of recession.

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<sup>7</sup> This also assumes that the decline in the share of certain industries in manufacturing value added are not merely the result of relative price changes.



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