

# Has trade *liberalization created* pollution havens *in Latin America?*

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This paper asks whether the recent trade liberalization in Argentina, Brazil and Mexico has led to increased transfer of polluting activities to Latin America. Using a factor content of trade approach, it shows that prior to liberalization, all three countries specialized in relatively pollution-intensive manufactures. Following liberalization, Argentina and Brazil have increased their specialization in such industries, while Mexico has moved in the opposite direction. It is suggested that these differences are a result of the structure of protection in the pre-liberalization period and the increased stringency of environmental enforcement in Mexico in the 1990s.

# I

## Introduction

The fear that trade liberalization is incompatible with sustainable development was a major concern articulated by the protesters at the World Trade Organisation (WTO) meeting in Seattle in 1999. One of the main elements in the environmentalist concern is a belief that developing countries will become “pollution havens” attracting “dirty” industries because of their less stringent environmental standards (Mabey and McNally, 1999). Supporters of trade liberalization, on the other hand, argue that it will have beneficial environmental impacts both globally and within developing countries (Esty, 1994, pp. 63-69).

There are a number of theoretical models of North-South trade which predict that less stringent environmental regulations will lead to an increase in polluting production in the South when trade is liberalized.<sup>1</sup> Since weaker environmental regulation leads to lower relative costs for the pollution-intensive industry, the South will have a comparative advantage in the “dirty” good. On the other hand, the North with its stricter environmental regulations will tend to specialize in relatively “clean” products.<sup>2</sup>

A crucial assumption of these models is that the key difference between the North and South is the level of environmental regulation. Those who believe that trade liberalization can have a positive effect on the environment have pointed out that environmental control costs in manufacturing industry are generally low and that factors other than environmental considerations are more important determinants of comparative advantage (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. Where there is a correlation between capital intensity and pollution intensity, countries with a comparative advantage in labour-intensive industries will benefit environmentally from

specializing according to their comparative advantage. Indeed, pollution will tend to increase in the North, because of its specialization in capital-intensive industries, and be reduced in the South (Antweiler, Copeland and Taylor, 1998). This is associated with the view that the structure of protection in developing countries has a “brown bias”. In other words, it is suggested that, under import substitution regimes, highly polluting industries tend to receive higher protection than less polluting industries (Birdsall and Wheeler, 1992).

The overall impact of trade liberalization on the environment depends not only on the composition of output, but also on its scale and on the technology used (Grossman and Krueger, 1992). In so far as liberalization leads to the growth of industrial production, then it will tend to increase pollution. On the other hand, where trade reform leads to the adoption of less polluting production processes—for example, because of the increased availability and lower cost of imported technology or because production for export markets requires the use of such technologies—then pollution per unit of output will tend to fall. A full evaluation of the impact of trade liberalization on a country’s environment would therefore require a consideration of all three: scale, composition and process effects.<sup>3</sup>

The focus of the present paper is more limited. Whereas the impact of the scale effect on pollution is clearly to increase it<sup>4</sup> and the technology effect is generally regarded as tending to reduce pollution, the composition effect is ambiguous. The “pollution haven hypothesis”<sup>5</sup> suggests that where trade is liberalized, there will be a tendency for the South, with its less

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<sup>1</sup> See, for example, Baumol and Oates (1988) and Copeland and Taylor (1994).

<sup>2</sup> The terms “dirty” and “clean” in this context refer to whether the industries producing the good are highly polluting or not.

<sup>3</sup> See Beghin and Potier (1997) for a survey of studies of the effects of trade liberalization on manufacturing sector pollution which covers all three effects.

<sup>4</sup> There is of course the environmental Kuznets curve argument that above certain levels of per capita income, pollution levels will tend to decline. However, this is achieved by the composition and technology effects outweighing the scale effect.

<sup>5</sup> See Jensen (1996) for a discussion of different formulations of the pollution haven hypothesis. He points out that a number of authors emphasize the deliberate use of weak environmental regulation to attract capital as constituting a pollution haven. However, such a definition, which depends on the motivation of

stringent environmental regulation, to become more specialized in polluting industries. Put another way, it implies that the composition effects associated with trade liberalization will tend to increase pollution in the South. Since the present paper does not address the impact of trade liberalization on either the scale of industrial production or on technology, it cannot show whether or not trade liberalization increases or decreases the level of industrial pollution locally. Its aim is to examine whether trade liberalization has led to greater or less specialization in pollution-intensive industries and hence whether the composition effects of trade liberalization are positive or negative for the environment.

The trade liberalization that has taken place in Latin America since the second half of the 1980s means that it is a good area in which to examine the claims and counterclaims that have been made regarding the impact of greater openness on pollution. Since three countries,

Argentina, Brazil and Mexico, account for over three quarters of industrial production in the region, it was decided to concentrate on these countries. The paper examines whether trade liberalization has been associated with increased specialization in more polluting industries in the Latin American countries.

The major shift in economic policy regime that took place in Argentina, Brazil and Mexico from the second half of the 1980s is described in section II. Section III provides a critical summary of a number of earlier studies of the links between trade and pollution in Latin America. Section IV discusses an alternative approach to these linkages, based on a factor content model of trade in which pollution is regarded as a factor of production. The empirical part of the paper (section V) looks at the pollution intensity of exports and imports in the three countries and the way in which these have changed following liberalization. Section VI offers some conclusions.

## II

### Trade liberalization in Latin America

The period since the mid-1980s has seen a major liberalization of the Latin American economies. Although this has included a number of other elements such as privatization, financial deregulation, tax reforms and changes in the labour market, the most rapid and striking changes have been in the opening of the region's economies through trade liberalization and changes in policies towards foreign direct investment (FDI).

Of the three largest Latin American countries, Mexico was the first to open up its economy in the mid-1980s. Argentina and Brazil followed as part of a wave of countries which began to liberalize around 1990.<sup>6</sup>

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policy makers, cannot be tested empirically by analysing trade patterns. He offers an alternative definition: "due to differences in the acceptable levels of emissions to the decision makers, some countries may gain a comparative advantage in the production of pollution intensive goods" (Jensen, 1996, p. 320). This is the interpretation given to the pollution haven hypothesis in this paper. It is also the sense in which the term is used in the well known paper by Birdsall and Wheeler (1992).

<sup>6</sup> Different authors give different exact dates for the start of trade liberalization in each country, but they are all agreed that the key dates are around 1985 in Mexico and 1990 in Argentina and Brazil. See Agosin and Ffrench-Davis (1993, table 1), Edwards (1995, table 1-1) and Burki and Perry (1997, chapter II.A).

Trade liberalization involved the reduction of the average level of import duties, a more uniform level of tariffs (reduced dispersion), a reduction in the proportion of trade covered by non-tariff barriers, and reduced taxes on exports. The average tariff was reduced between the mid-1980s and the mid-1990s from over 50% to 14% in Argentina, from over 80% to 13% in Brazil, and from over 40% to 14% in Mexico (Burki and Perry, 1997, table 2.2; IDB, 1997, figure 17). By the early 1990s, the proportion of items covered by non-tariff barriers was less than 4% in Mexico, 1.5% in Brazil and 0.2% in Argentina (Burki and Perry, 1997, table 2.2).

At the same time that trade barriers were being dismantled, these economies also relaxed their controls on inward investment. Again, Mexico was the first of the three countries to open up to foreign capital. From 1984 the regulatory framework became less restrictive and in 1989 a new set of rules repealed all previous regulations governing foreign investment and widened the range of operations where 100% foreign ownership was permitted. In 1993 a new law was passed which consolidated these changes (Ros, Draisma and others, 1996) and a year later the implementation of the North

American Free Trade Agreement (NAFTA) further opened up the Mexican economy to both trade and investment from the United States and Canada. In Argentina from 1989 onwards, restrictions on foreign investment in a number of sectors including information technology, telecommunications and electronics were removed. In 1993 a new Foreign Investment Act was passed which further opened up the economy to foreign capital and removed all restrictions on profit remittances (Chudnovsky and Lopez, 1997). By 1994, Argentina had totally deregulated foreign investment (Edwards, 1995, table 7-10). In Brazil, change was less rapid than in Mexico or Argentina. The new Constitution of 1988 in fact imposed more controls on the activities of foreign firms. However, in the 1990s controls on outflows of capital were removed and the entry of foreign firms into the information technology industry was permitted. The constitutional reforms of 1993 and subsequent amendments approved after 1995 further liberalized policy towards foreign investment (Chudnovsky and López, 1997).

The results of the trade opening were clearly visible in all three countries during the 1990s. The share of trade as a percentage of gross domestic product (GDP) increased first of all in Mexico after the mid-1980s and

TABLE 1

**Argentina, Brazil and Mexico: Trade<sup>a</sup> and foreign direct investment (FDI)<sup>b</sup> as a share of gross domestic product (GDP)**  
(Percentages)

	1980	1990	1995	2000
Argentina				
Trade	15.4	14.5	21.4	25.7
FDI	6.9	6.4	10.8	25.6
Brazil				
Trade	12.9	12.6	18.2	21.9
FDI	7.4	8.0	6.0	33.1
Mexico				
Trade	27.6	32.9	46.6	77.7
FDI	3.6	8.5	14.4	16.9

Source: For the trade figures: ECLAC (2001), tables 58 and 61. For the FDI figures: UNCTAD (2002), annex, table B6.

<sup>a</sup> By "trade" is meant total trade (imports + exports) as a share of GDP.

<sup>b</sup> By "FDI" is meant the total stock of foreign direct investment as a percentage of GDP.

then in Argentina and Brazil in the 1990s (table 1). Similarly, foreign investment as a share of gross fixed capital formation increased substantially in the post-reform period.

### III

## Previous studies of trade and pollution in Latin America

Two kinds of previous studies can throw some light on the links between trade policies and industrial pollution in Latin America.<sup>7</sup> One type of study focuses on the pollution intensity of industrial production as a whole and the way this varies between countries and over time.

<sup>7</sup> The studies considered here are all ex post studies based on actual trade patterns. There have also been several attempts to estimate the likely impact of trade liberalization on pollution using computable general equilibrium (CGE) models, both for individual countries and for the world as a whole. These are not discussed here since they tend to operate with very broad sectors and are in any case ex ante studies of the predicted effects of liberalization, so that the results depend on the particular specification of the model. For a review of some of these studies, see Beghin and Potier (1997).

The second type of study looks more explicitly at trade and particularly at exports to see how polluting they are, and how this has changed over time.

Within the first group, an influential study by two World Bank economists in the early 1990s concluded with the statement that: "pollution havens' can be found, but not where they have generally been sought. They are in protectionist economies." (Birdsall and Wheeler, 1992, p.167).

They based this on a finding that more open economies in the region tended to have a lower rate of pollution growth than more protected economies.

A critique of this study, however, has pointed to a number of weaknesses (Rock, 1996). First, it only considers toxic emissions, which are not necessarily correlated with conventional air or water pollutants.

Second, it bases its measure of trade openness on the Dollar Index, which has itself been subject to criticism (Rodrik, 1994). Third, Birdsall and Wheeler compare the rate of growth of pollution intensity rather than the absolute level in open and closed economies. Lastly, it has been suggested that the lower growth of pollution in more open economies may be a statistical artefact.<sup>8</sup> Rock's own estimates (not just for Latin America) show that more open economies tend to have a more polluting composition of output.

A more recent World Bank study (Mani and Wheeler, 1999) has shown a steady increase in the share of polluting industries in Latin American production since the early 1960s, which is in marked contrast to the decrease in the share of such industries in Europe, North America and Japan. This implies that the dominant trend in Latin America has been for production to become more pollution-intensive. This is supported by a study of Mexico, which found a significant increase in the toxic intensity of production up to the late 1980s (Ten Kate, 1993).

From the point of view of analysing the impact of trade liberalization on pollution, a major limitation of these studies is that they generally cover a period up to the mid or late 1980s, or at the very latest the beginning of the 1990s. Since, as was seen above, liberalization only began in the mid-1980s in Mexico and at the beginning of the 1990s in Argentina and Brazil, it is necessary to look at more recent data in order to evaluate what occurred in terms of pollution intensity during the 1990s. A second limitation is that all the studies have concentrated on toxic emissions and, as was pointed out above, these are not necessarily representative of all forms of pollution. Lastly, since they look at industrial production as a whole, the trends observed are not necessarily just a reflection of the impact of trade on pollution, but may be picking up a number of other influences.

From the point of view of analysing the impact of trade liberalization, the second set of studies, those which have looked directly at the links between trade and pollution in Latin America, are more relevant. A World Resources Institute study estimated the total pollution attributable to export production in various Latin American countries, mainly in the early 1990s.

The study also looked at the change in the proportion of output exported in different industries, concluding tentatively that there was a slight tendency for export expansion to be concentrated in low pollution-intensity sectors relative to high-pollution sectors (Runge and others, 1997). The data used for both Argentina and Brazil were extremely limited, but in the case of Mexico the share of exports in the production of high pollution-intensity industries fell significantly in the early 1990s.

A more detailed recent ECLAC study of nine Latin American countries found that, in absolute terms, there had been a tendency for the volume of exports from "dirty" industries to increase since the early 1980s in all the countries studied. However, the share of these industries in exports declined significantly in the late 1980s or the early 1990s for all countries apart from Brazil (Schaper, 1999). The recent trend has therefore been towards less pollution-intensive industries.

Another ECLAC study of eight of the nine countries covered by Schaper found a more mixed pattern, with three countries (Brazil, Colombia and Costa Rica) seeing an increase in the share of manufactured exports coming from polluting industries (Schatan, 1999). In the five remaining countries, however, the growth in pollution associated with exports was a result of an increase in the volume of exports, rather than a change in composition towards more polluting industries.<sup>9</sup>

There have also been a limited number of studies of individual countries that have looked at the relationship between export structure and pollution. In Argentina, the share of pollution-intensive industries in exports of manufactures both to the Organisation for Economic Co-operation and Development (OECD) countries and to all destinations declined between 1990 and 1997 (Chudnovsky, Porta and others, 1996, table V.1; Chudnovsky, Cap and others, 1999, tables 9 and 10).

In Brazil, which is characterized by a relatively high participation of "dirty" industries in its exports, these industries increased their share of exports significantly during the 1980s (Jha, Markandya and Vossenaar, 1999, table 4.3) and continued to be particularly dynamic during the first half of the 1990s

<sup>8</sup> Specifically, it is pointed out that the variable used to measure trade orientation is an interaction term between the rate of per capita income growth and the so-called Dollar Index of trade orientation. Rock (1996) suggests that what this variable is picking up is the impact of the growth rate rather than trade orientation.

<sup>9</sup> These two studies differ in the export classification used, with one using the Standard International Trade Classification (SITC) and the other the International Standard Industrial Classification of All Economic Activities (ISIC), in the universe considered (total versus manufactured exports), and in the time period covered. One of the studies of Brazil (Young, 1999; Young and others 2001) and one study of Mexico (Aroche, 2000).

(Ferraz and Young, 1999). Further evidence of Brazil's specialization in relatively polluting industries is the fact that the average pollution intensity of exports is greater than that of the manufacturing sector as a whole for most indicators of pollution in both the 1980s and the 1990s (Young, 1998; MMA, 2001). It has also been noted that exports are considerably more pollution-intensive than imports (Young, Lustosa and others, 2001, table 4.3).

In the case of Mexico, the concerns about the environmental impacts of NAFTA led to a number of studies during the early 1990s which looked at the structure of Mexican trade (Grossman and Krueger, 1992; Low, 1992). These found that Mexican exports were not heavily concentrated in pollution-intensive industries and that United States imports from Mexico were not related to pollution abatement costs in the former. A study of the period prior to the signing of NAFTA found that, on balance, trade liberalization in Mexico during the 1980s and early 1990s had a positive environmental impact (Aroche, 2000), while a study of the period since NAFTA came into force found that the structure of Mexican exports had become less pollution-intensive (Schatan, 2000).

The picture that emerges from these studies of trade-environment linkages in Latin America does not therefore present much support for the hypothesis that "pollution havens" have been created through the transfer of polluting production to the region. Indeed, both in Argentina and Mexico and in other countries in the region, the evidence suggests that in recent years the trend has been away from specialization in "dirty" industries.

There are, however, several limitations of these previous studies which make it necessary to consider the issue further. First, almost all the trade studies concentrate solely on exports.<sup>10</sup> A fuller analysis of the implications of trade liberalization for specialization in pollution-intensive industries requires an analysis of a country's import patterns as well as exports. This paper will therefore consider the pollution intensity of imports<sup>11</sup> as well as exports.

Second, many of the studies focus on the share of pollution-intensive industries in manufacturing exports from the region.<sup>12</sup> This presents a number of problems. The definition of "dirty industries" differs from study to study. Different indicators are used to classify industries by pollution intensity. Some industries use the share of pollution abatement costs as an indicator while others use emissions data. Moreover, the cut-off point above which industries are regarded as highly polluting is essentially arbitrary. An arbitrary allocation of industries can be avoided by using emissions coefficients for all industries and applying them to the levels of exports and imports to measure the average pollution intensity of trade, as is done in the present paper.

A third limitation of some of the studies is the level of aggregation at which they have been carried out. The study by Runge and others (1997) is at the two-digit level of the International Standard Industrial Classification (ISIC), which consists of such broad aggregates as "non-metal products" and "metal products". The studies of Argentina by Chudnovsky, Cap and others (1999), Brazil by Ferraz and Young (1999) and both the Latin American and Mexican studies by Schatan (1999 and 2000) are at the three-digit level of the ISIC, which subdivides manufacturing industry into 28 sectors. Even the three-digit classification puts together industries such as tanning and leather finishing (3231) and leather products (3233), although the former has toxic emissions per million dollars of output more than 200 times greater than the latter (Hettige, Martin and others, 1995, table 5.5).<sup>13</sup> The current study reduces this problem by estimating pollution from trade data for 82 industries classified at the four-digit level of the ISIC.

<sup>10</sup> An exception are some of the studies of Brazil (Young, 1999; Young, Lustosa and others 2001) and one study of Mexico (Aroche, 2000).

<sup>11</sup> As Aroche (2000) indicates (p. 24), "it is important to consider imports, since they implicitly substitute production that would have generated pollution in the country and which is shifted to the place where the imported goods are produced".

<sup>12</sup> Schaper (1999), Chudnovsky, Cap and others (1999), Jha, Markandya and Vossenaar (1999) and Low (1992) all use this variable. Runge and others (1997) look at changes in the share of exports accounted for by "dirty" industries in Latin America, while Grossman and Krueger (1992) use imports from Mexico as a share of United States shipments by industry as the dependent variable.

<sup>13</sup> This is less of a problem in the case of the studies which used the SITC at the three-digit level.

## IV

### An alternative approach to trade and pollution

#### 1. Pollution as a factor of production

In view of these limitations, this paper adopts a different approach to analysing the impact of trade liberalization on industrial pollution. The starting point of this approach is to think of emissions as an input into the production process. Although emissions are often regarded as an output of production, they reflect the fact that environmental resources have been used up in production (Rauscher, 1997, p. 30). Thus, it is possible to think of traded goods as embodying a certain quantity of environmental resources.<sup>14</sup> The implication of this approach is that trade flows involve international transfers of environmental resources. If a country's exports generate more pollution than its imports, then that country is a net exporter of environmental resources. Conversely, if it specializes in relatively "clean" products, then it will be an importer of environmental resources.

This conceptualization of pollution makes it parallel to the way in which other inputs such as skill, labour and capital are regarded in the "factor content of trade" literature. This approach has been used to test the Heckscher-Ohlin theorem and to estimate the impact of trade on the demand for factors of production. It has its origins in Leontief's famous study of United States trade which gave rise to the "Leontief paradox".

#### 2. The general factor content model

The general factor content model estimates factor content coefficients for country *i* exports as:<sup>15</sup>

$$[1] \quad z_{xi} = A_i x_i$$

where  $z_{xi}$  is a ( $q \times 1$ ) vector of factor quantities per million dollars of exports,  $A$  is a ( $q \times r$ ) matrix of coefficients of each factor used per million dollars of output in each of the country's  $r$  manufacturing sectors, and  $x$  is an ( $r \times 1$ ) vector of sectoral shares of the country's manufacturing exports. Similarly, the factor

content of imports can be calculated as an import-weighted average of sectoral factor input coefficients  $z_{mi}$ . A country's exports are then found to be relatively intensive in a factor for which  $z_{xi} > z_{mi}$ .

Once it is recognized that pollution can be regarded as an environmental resource input into production, then it is logical to use emissions coefficients per dollar of output to calculate the environmental resource content of trade. The effect of trade on a country's utilization of environmental resources can also be calculated in the same way as the demand for labour. The total impact on pollution is then:

$$[2] \quad Z_i = X_i(z_{xi} - z_{mi})$$

where  $Z_i$  is a vector of different emissions and  $X_i$  is the total (scalar) value of country *i*'s exports of manufactures.

There are a number of issues that need to be addressed when this model is operationalized in order either to test factor content theories of international trade, or to estimate the impact of trade on factor demand. These include the type of coefficient to use, whether to use home country or international coefficients and how to deal with trade imbalances.

The first question is whether to use factor inputs per dollar of value added or per dollar of output. The emissions of a particular industry or firm are likely to be more closely related to the value added within that industry than to gross output. On the other hand, trade data are measured in terms of gross output, not value added (except often in the case of export processing zones). There is a dilemma here, since, as Wood (1994, p. 72) points out, "if gross output is used, the effects on factor demand are blurred; but if value added is used, the linkage with trade flows is obscured."

In practice, the tendency is to use coefficients based on gross output.

The other aspect involved in choosing coefficients is whether to use those of the home country or the trading partner. This is clearly a real issue, since differences in stringency of regulation will lead to considerable differences in emissions per unit of output between developed and less developed countries. The appropriate choice of coefficient depends on the precise

<sup>14</sup> Lee and Roland-Holst (1993), who used the concept of embodied effluent trade, adopted a similar approach.

<sup>15</sup> This presentation follows Wood (1994, pp. 67 and 68).

question that is being addressed. If the aim were to measure the effect of trade on the actual pollution load in a country, then it would be appropriate to apply domestic coefficients to both exports and imports on the assumption that imports could be produced locally with the same level of pollution per unit of output as in import-competing industries.

However, the objective here is somewhat different: it is to evaluate whether or not trade liberalization has led to a greater specialization in the Latin American countries in industries which are pollution-intensive in the North. Thus, it is appropriate to use coefficients from developed countries as an indicator of pollution intensity. This is fortunate because the major source of detailed data on emissions per dollar is the United States, and these are the coefficients that are used.<sup>16</sup>

Lastly, a country's trade in manufactures is unlikely to be in balance. There is therefore a question of whether to take this into account in estimating the effects on factor demand or not. Latin American countries have experienced large swings in their trade balances in recent years, so that this would tend to distort the changes in environmental resource transfers on a year-to-year basis. The conventional approach is to look at balanced trade, and this is implicit in equation [2] above, where import- and export-weighted emission coefficients are applied to the value of exports (Wood, 1994, p. 69).

### 3. Formulation of the hypotheses

The issue of "pollution havens" in Latin America can be looked at from a number of points of view. A first question is whether exports are more pollution-intensive overall than imports. If so, this implies a net transfer of environmental resources from Latin America to the rest of the world. This would mean that Latin America has a revealed comparative advantage in pollution-intensive industries, although it has to be borne in mind that since actual trading patterns reflect existing trade restrictions, this does not necessarily mean that the region would have a comparative advantage in such industries under free trade.

<sup>16</sup> This is another reason why this analysis cannot be taken to measure the impact of trade liberalization on pollution in the liberalizing country. Since environmental regulation is more stringent in the United States than in Latin America, the use of United States coefficients underestimates the actual pollution load associated with exports in Latin America. However, assuming that the relative pollution intensities of industries do not differ greatly between countries, the calculations do indicate the direction of change in actual pollution.

A second question is whether trade liberalization leads to greater specialization in pollution-intensive industries. This can be examined by looking at the way in which the relative pollution intensity of exports and imports has changed since liberalization. If there has been an increase in this ratio, then it can be assumed that the "pollution haven" hypothesis, in the broad sense of shifts in the location of polluting production, is valid. As indicated above, previous studies of trade and pollution in Latin America have only looked at the composition of exports. This can give rise to misleading results because there is evidence that world trade in relatively polluting industries has in recent years grown less quickly than for less polluting ones (Xu, 1999, table 1). It is important therefore, in evaluating any hypothesis about specialization, to look at imports as well as exports. This is of course the approach followed in conventional factor content studies of international trade. The few studies which have employed a factor content approach to environmental issues have also looked at both exports and imports (Kalt, 1988; Robison, 1988; Lee and Roland-Holst, 1993).

A third question is whether trade liberalization leads to increased or reduced pollution in the Latin American countries. This might at first sight seem to be just a slightly different way of addressing the point made in the previous paragraph, but that is not the case. An analogy with the employment effects of trade liberalization may help illustrate the point. If exports are more labour-intensive than import-competing production, a matched increase in exports and imports will lead to an increase in employment even if the average labour intensity of exports does not increase. Similarly, even if a country does not increase its specialization in polluting industries, total pollution can still increase.

Thus we can formulate three distinct hypotheses:

- Hypothesis 1: Latin American countries will tend to specialize in relatively polluting industries so that  $z_{xi} > z_{mi}$  at a point in time.
- Hypothesis 2: Following liberalization, Latin American countries will tend to increase their specialization in polluting industries so that  $z_{xi}/z_{mi}$  will be greater after liberalization than it was before it.
- Hypothesis 3: Following liberalization, the combined effect of the increased volume of trade (scale effects) and the changing composition of trade is to increase the level of domestic pollution in Latin America.



# V

## Trade liberalization and pollution havens in Argentina, Brazil and Mexico

### 1. Data

In order to test these hypotheses, data is required on emissions coefficients and on exports and imports. Most previous studies which have used pollution coefficients have tended to use one indicator, usually related to toxic emissions. However, it has been noted that there is no necessary correlation amongst all indicators of pollution intensity, so that the use of a single indicator can be misleading (Hettige, Martin and others, 1995). Therefore, it was decided to use as wide a range of pollutants as was practicable for the analysis. The coefficients used were those of the Industrial Pollution Projection System (IPPS),<sup>17</sup> which have been calculated by the World Bank on the basis of United States data measuring emissions of a wide range of pollutants per dollar of output, value added or person employed.<sup>18</sup>

These included toxic pollution, toxic metal pollution, six conventional air pollutants (sulphur dioxide, nitrogen dioxide, carbon monoxide, volatile organic compounds, fine particulates and total particulates) and two water pollutants (biochemical oxygen demand and total suspended solids). Output-based coefficients were selected for this exercise since, as was indicated above, exports and imports are measured in terms of gross output rather than their value added.

These coefficients were then applied to figures for imports and exports of manufactures, reclassified by the four-digit level of the ISIC, which were made available by ECLAC. The reason for limiting the trade data to manufactured goods was because the “pollution haven” hypothesis applies mainly to activities which are not tied to a particular geographical location. Other

sectors such as mining or agriculture are less likely to be affected by differences in environmental regulation since they are geographically less mobile.<sup>19</sup>

### 2. Results

The first question to consider is whether or not the three Latin American countries specialize in relatively polluting industries or not, and thus whether they are net exporters of environmental resources. As indicated above, this can be done by comparing the average pollution intensity of a dollar of exports with that of a dollar of imports. Table 2 shows the ratio of pollution per dollar of exports to imports for each pollutant at the beginning of each country’s liberalization process and in 1996, the latest year for which trade data were available.

The 1996 data show a very sharp contrast between Argentina and Brazil on the one hand and Mexico on the other. In the two South American countries, exports are more polluting than imports for eight of the 10 pollutants covered, the exceptions being toxics and biochemical oxygen demand (BOD) in the case of Argentina and toxics and volatile organic compounds (VOC) for Brazil. In the case of Mexico, however, imports were more pollution-intensive for all indicators apart from fine particulates (PM10). Thus the first hypothesis, that the Latin American countries are net exporters of environmental resources is largely supported in Argentina and Brazil, but not in the case of Mexico.

Table 2 also provides data on the ratio of pollution intensity of exports to imports prior to liberalization. In the case of Argentina and Brazil, these refer to 1990, while for Mexico, which began to liberalize earlier, 1985 is taken as the point of comparison. The contrast between the South American countries and Mexico is just as sharp when it comes to the changes which have taken place in the relative pollution intensity of exports

<sup>17</sup> The use of coefficients derived from United States pollution data is consistent with the purpose of assessing whether or not Latin American countries have increased their specialization in industries which are pollution-intensive in developed countries.

<sup>18</sup> See Hettige, Martin and others (1995) for details of the IPPS. The coefficients are available at the World Bank’s New Issues in Pollution Regulation (NIPR) web page (<http://www.worldbank.org/html/prdei/ipps/ipps.html>).

<sup>19</sup> Warhurst and Hughes-Witcomb (2001) discuss the pollution haven hypothesis in the context of Latin American mining and conclude that it does not hold.

TABLE 2

**Argentina, Brazil and Mexico: Relative pollution intensity of exports to imports  
at the start of liberalization**

	Argentina		Brazil		Mexico	
	1990	1996	1990	1996	1985	1996
Toxics	0.54	0.86	0.70	0.88	0.88	0.67
Metals	1.21	1.27	2.17	2.68	1.31	0.99
Sulphur dioxide (SO <sub>2</sub> )	1.47	1.61	1.77	1.87	1.78	0.83
Nitrogen dioxide (NO <sub>2</sub> )	1.02	1.19	1.29	1.31	1.42	0.67
Carbon monoxide (CO)	1.03	1.03	2.03	2.14	1.16	0.74
Volatile organic compounds (VOC)	0.90	1.13	0.97	0.94	1.43	0.78
Fine particulates (PM10)	4.69	6.79	4.50	4.08	3.48	1.62
Total suspended particles (TSP)	3.19	4.29	2.56	2.88	1.80	0.96
Biochemical oxygen demand (BOD)	0.70	0.80	1.08	1.37	0.65	0.42
Total suspended solids (TSS)	1.66	1.55	4.39	4.89	0.74	0.88

Source: Prepared by the author on the basis of ECLAC trade data and International Pollution Projection System (IPPS) coefficients.

and imports since they began to open up their economies. In Argentina and Brazil, eight of the 10 indicators increased over the period, while in the case of Mexico all but one fell. Thus, the second hypothesis seems to be largely corroborated for Argentina and Brazil, but clearly rejected in Mexico. It is also worth noting that prior to liberalization, the situation in Mexico was not unlike that in Argentina and Brazil, since in the mid-1980s exports tended to be more polluting than imports for the majority of pollutants.

The third hypothesis addresses the impact of liberalization on emissions within the Latin American countries. This can be thought of as the combined effect on pollution of the *scale* of trade and changes in the *composition* of trade. If exports are more polluting than imports initially, then an increase in the level of trade must lead to a net increase in emissions so that the scale effect will be positive.<sup>20</sup> Since at the start of liberalization this condition held for most indicators in all three countries, and since shifts in composition have tended to increase relative pollution intensity in Argentina and Brazil, it should follow that total emissions increased in both. In the case of Mexico, where exports became relatively less pollution-intensive over time, the combined impact of scale and composition effects is ambiguous.

<sup>20</sup> Note that this is different from the situation where output is being considered. In that case the *scale* effect is positive by definition since, other things being equal, an increase in production cannot lead to less pollution. Where trade is concerned, and therefore both exports and imports are increasing, then whether the scale effect increases or decreases pollution depends on whether or not exports generate more emissions than import substitutes.

Table 3 shows the net change in emissions for each pollutant between the start of liberalization (1985 for Mexico and 1990 for Argentina and Brazil) and 1996. This was calculated by applying the IPPS four-digit emission coefficients to the structure of exports and imports in the base year and in 1996, and then calculating the change between the two years. As indicated above, in order that the results were not affected by changes in the balance of trade in manufactures in each year, the calculation was based on the assumption that total manufactured imports were equal to manufactured exports. In other words the change in emissions was calculated as:

$$[3] \quad Z'_i - Z_i = X'_i(z'_{xi} - z'_{mi}) - X_i(z_{xi} - z_{mi})$$

where ' denotes the terminal year figure and symbols without ' refer to the base year.

The contrast between Argentina and Brazil on the one hand, and Mexico on the other, could not be starker. In the two South American countries, nine of the 10 pollutants showed an increase in domestic emissions<sup>21</sup> following liberalization, whereas in Mexico the same number showed a reduction, the exception being fine particulates. Thus in Argentina and Brazil, as expected, the combined effect of increased levels of trade and changes in composition led to an increase in pollution, while in Mexico the effects of changes in composition towards less polluting industries more than outweighed the increased level of trade. Thus Mexico shows the

<sup>21</sup> This implies either a larger surplus in terms of environmental resources exported, or a smaller deficit.

TABLE 3

**Argentina, Brazil and Mexico: Changes in net emissions associated  
with trade following liberalization**  
(Thousands of pounds)

	Argentina (1990-1996)	Brazil (1990-1996)	Mexico (1985-1996)
Toxics	23,112	23,571	-60,102
Metals	179	5,598	-1,504
Sulphur dioxide (SO <sub>2</sub> )	7,804	33,428	-65,843
Nitrogen dioxide (NO <sub>2</sub> )	5,309	7,880	-50,347
Carbon monoxide (CO)	43	29,974	-56,377
Volatile organic compounds (VOC)	5,345	-2,268	-27,862
Fine particulates (PM10)	8,222	6,420	3,143
Total suspended particles (TSP)	12,623	17,749	-7,521
Biochemical oxygen demand (BOD)	745	8,226	-19,389
Total suspended solids (TSS)	-9,670	92,011	-38,600

Source: Author's calculations based on International Pollution Projection System (IPPS) coefficients and ECLAC trade data.

type of change predicted by those who believe that there are win-win opportunities to be gained with trade liberalization.

### 3. Interpretation

The consistent contrast between Mexico and the South American countries which this analysis reveals raises the question of why such differences occur. As indicated above, one of the reasons why some authors have predicted that trade liberalization would lead to less polluting production in developing countries is because they believe that under import substitution, protectionist policies tended to favour "dirty industries" and that this "brown bias" would be removed. How far was this true of the three Latin American countries in the period before the recent trade opening?

In order to answer this question, 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, 1991, table 3.19) and 1979 for Mexico (Ten Kate and Mateo Venturini, 1989, table 4). On the basis of these data, industries were classified into those with high and low levels of effective protection.<sup>22</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 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 is 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 (table 4). Only Mexico conformed to expectations, with highly protected industries being relatively pollution-intensive, with the exception of total suspended solids and particulates.

This pattern of protection may help explain the mixed results found in the three countries after liberalization. In Mexico, where "dirty" industries were highly protected prior to liberalization, changes in trade policy led to reduced emissions as these industries tended to contract relative to less polluting industries.<sup>23</sup> On the other hand, in Argentina and Brazil, where there was no such "brown bias" in the structure of protection, exports remained more polluting than imports as the "pollution haven" hypothesis implies.

<sup>22</sup> Some industries were omitted due to the absence of estimates of effective protection. Also, in some cases estimates were only available at the two-digit level and it was assumed that the three-digit industry shared the same characteristics in terms of protection as the two-digit industry to which it belonged.

<sup>23</sup> It is noticeable that the only pollutant for which changes in trade flows between 1985 and 1996 led to an increase in emissions was fine particulates (see table 3). This stands out in table 4 as a case where, contrary to other pollutants, emission levels per unit of output were much higher in less protected industries.

TABLE 4

**Argentina, Brazil and Mexico: Pollution-intensity ratio  
between high and low ERP industries**

	Argentina 1980	Brazil 1973	Mexico 1979
Total toxics	0.32	0.17	1.42
Total metals	1.11	0.05	1.60
Biochemical oxygen demand (BOD)	0.81	1.32	1.34
Total suspended solids (TSS)	0.30	0.01	0.41
Nitrogen dioxide (NO <sub>2</sub> )	0.13	0.39	2.30
Fine particulates (PM10)	0.08	0.16	0.18
Sulphur dioxide (SO <sub>2</sub> )	0.24	0.19	3.64
Carbon monoxide (CO)	0.23	0.11	2.01
Total particles (TP)	0.21	0.44	0.98
Volatile organic compounds (VOC)	0.15	0.63	3.27

*Source:* Author's calculations based on International Pollution Projection System (IPPS) coefficients and United Nations Industrial Development Organization (UNIDO) data.

A second factor which may partly account for the differential impact of liberalization on pollution intensity between the countries is that environmental regulation in Mexico was tightened significantly in the early 1990s, at the time of the NAFTA negotiations, particularly in terms of monitoring and enforcement (Poder Ejecutivo Federal, 1996, pp. 119-125). This

was a response to fears in the United States that under free trade Mexico would become a "pollution haven", which threatened to derail the agreement (Hogenboom, 1998, chapter 6). Stricter environmental regulation would tend to reduce the comparative advantage which Mexico had in pollution-intensive industries in the 1980s.

## VI Conclusion

This paper set out to investigate whether or not the fears of environmentalists concerning the likely impact of trade liberalization on industrial pollution had been confirmed by the experience of the main Latin American countries since they began to liberalize their trade. In particular, the paper focused on the "pollution haven" hypothesis, interpreted in terms of the tendency for countries with less stringent environmental regulations to become more specialized in pollution-intensive industries.

The cases of Argentina and Brazil indicate that liberalization has been associated with a shift towards greater specialization in polluting industries and a tendency for the level of domestic pollution to increase. The Mexican case, however, shows the opposite: a trend towards specialization in less polluting sectors and reduced domestic pollution. It was suggested that this could be a reflection of the differences in the pattern of

protection before liberalization, which meant that "dirty" industries had been more highly protected in Mexico than in the South American countries. It was also pointed out that in Mexico, trade liberalization was accompanied by a tightening of environmental regulation in order partly to allay United States fears concerning "pollution havens" and "industrial flight".

In concluding, a number of caveats are in order. Although the analysis has been based on much more disaggregated data than any previous study of trade and environment in Latin America (four-digit ISIC), this may still be too high a level to capture some of the processes that are taking place within industries. Thus, for example, in the Brazilian tanning industry it has been found that there has been increased specialization in the production of wet blue for the export market (Odegard, 2000). The production of wet blue is the most polluting part of the tanning business, as well as having

a relatively low value added. Tanners in developed countries are choosing to outsource supplies of wet blue and concentrate on higher value added and less polluting processes in their domestic markets. Thus, there is a clear case of “pollution transfer” to Brazil in this industry. However, this is not apparent when working with aggregate data, even at the four-digit level, where ISIC 3231 (tanneries and leather finishing) includes all leather-making processes.

A second caveat relates to what the paper does not attempt to do. It does not provide a full evaluation of whether trade liberalization has led to increased pollution in Latin America. Such an analysis would require consideration, not only of the *scale* and *composition* effects of increased trade on pollution, but also of the *process* effects (Grossman and Krueger, 1992). The data used in this paper, which is based on fixed emissions coefficients, preclude an analysis of the process effects of liberalization. In so far as the paper does discuss the impact on domestic pollution in Latin America, it should be emphasized that it abstracts from these effects. However, since the main concern is to consider the distribution of relatively polluting activities, this does not invalidate the discussion of the pollution haven hypothesis.

A complete evaluation of the impact on domestic pollution would have to consider a number of further possible links between trade and pollution. On the positive side, it has been suggested that production for export markets exposes firms to pressures to reduce their pollution and improve their environmental management systems. It has also been said that trade liberalization leads to better access to imported technology and cleaner processes. Against this, it may be the case that the increased competition associated with liberalization makes firms less able or willing to

internalize environmental costs and thus proves a drag on efforts to reduce pollution. Similar issues arise around the role of increased foreign investment. Unfortunately, there is not space to address these issues in this paper.<sup>24</sup>

A further reason why the paper cannot be taken as a full evaluation of the environmental effects of liberalization is that it has not considered the implications of liberalization for environmental policy. For some critics, trade liberalization tends to give rise to a “race to the bottom” in terms of environmental standards, since firms obtain a competitive advantage from less stringent regulation. A more moderate view sees environmental regulation becoming “bogged down” as a result of increased trade openness. A full discussion of the effects of trade liberalization on pollution in Latin America would, at the very least, need to consider whether or not such effects operated and thus potentially contributed indirectly to increased pollution.

What the paper has done is to use a factor content of trade methodology to look at the relative pollution intensity of exports and imports in semi-industrialized Latin American countries. This showed that at the beginning of the 1990s, Argentina, Brazil and Mexico all specialized in relatively “dirty” industries. However, since then Mexico has moved in the opposite direction to the Southern Cone countries. The latter have increasingly shifted to more polluting industries, whereas Mexico has increased its comparative advantage in low-pollution industries. In the case of Mexico, the lack of conformity with the predictions of the pollution haven hypothesis reflects a strong bias in protection in favour of dirty industries before liberalization and stricter enforcement of environmental regulation in the 1990s.

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<sup>24</sup> See Jenkins (2000) for a review of some of the evidence on these issues.

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