DOES MEXICO SPECIALIZE IN POLLUTING AND INJURIOUS INDUSTRIES?

EMPIRICAL EVIDENCE FROM NAFTA-RELATED US-MEXICAN TRADE

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Abstract

Trade expansion, along with weaker environmental protection in developing countries, have raised concerns that developing countries may specialize in the more polluting or injurious industries. I examine the pollution intensity of US-Mexican bilateral trade in the manufacturing sector using detailed measures of air, water, metal and toxic pollution intensities, shares of pollution abatement costs, and injury rates for about 350 4-digit Standard Industrial Classification industries. At this resolution, I do not find strong evidence that the intensity of US net imports from Mexico is larger in the more polluting or injurious industries or that this intensity shows a larger increase for the more polluting or injurious industries during the NAFTA transition. Moreover, for the top 25 polluting industries ranked by most measures of pollution intensity, on net, the US exports products to Mexico. NAFTA potentially assisted environmental protection by reducing tariffs on Mexican imports of pollution abatement equipment from pre-NAFTA rates that were as high as 20%. Trade data between 1989 and 1999 show an increase in these imports.

JEL classification: Q2, O1, F1.

Key words: Pollution, worker injury, trade, US-Mexico, Free Trade Agreement, NAFTA, FTAA, pollution-haven.

1. INTRODUCTION

The expansion of trade between developed and developing countries, along with weaker environmental and worker protection in the latter, has raised concerns that trade may encourage developing countries to specialize in manufacturing industries that create more pollution and worker injury or in short, 'dirty' industries. Understanding whether such specialization has occurred is important for public policy. First, in those developing countries where weaker environmental and worker protection do not reflect the preference of a well-informed public, such specialization can result in economic inefficiency [1]. Mechanisms that ensure that the balance between environmental costs and economic benefits reflects public preference would be crucial. Second, public protests against trade expansion and the proposed Free Trade Agreement of the Americas (FTAA) have been fueled in part by a belief that such specialization has occurred [2], despite the lack of empirical evidence [3,4,5].

The US-Mexican bilateral trade serves as a case study of the stereotype North-South trade and of the potential environmental impact of the FTAA. Mexico's weaker environmental and worker protection than that of the US raises the question of whether Mexico specializes in 'dirty' industries. The North American Free Trade Agreement (NAFTA), in force since January 1994, has also raised concerns that Mexico may specialize further in 'dirty' industries. By guaranteeing the access of Mexican products to the US market and the security of investments in Mexico [6], NAFTA may encourage the use of Mexico as a production base for pollution intensive production destined for the US market. Pollution intensive industries that tend to be capital intensive may have hesitated to locate in Mexico before these guarantees were made. However, it is unclear whether environmental savings are sufficient to offset other production considerations to result in the location of 'dirty' industries in Mexico.

This study addresses three issues: first, whether the intensity of US net imports from Mexico is greater in the 'dirtier' industries within the manufacturing sector and whether this intensity has shown greater increase in the dirtier industries during the transition from pre-NAFTA to post-NAFTA years. It asks the related questions of whether the ranking of polluting industries is comparable in the US and Mexico and whether a given industry emits more pollutants per production unit in Mexico than the US. Second, it asks whether NAFTA potentially improved environmental protection by reducing tariffs on pollution abatement equipment and whether Mexican imports of these products has grown over time. Third, it reviews popular claims that the ambient air pollution in Mexican border cities has worsened post-NAFTA.

This study contributes to the previous literature in several ways. First, it examines the pollution intensity of US-Mexican trade patterns both before and after NAFTA. Available post-NAFTA studies [6, 7] do not provide an empirical analysis of these trade patterns. Second, to detect Mexico's potential specialization in 'dirty' industries, it uses detailed and multiple physical and monetary measures of pollution intensities and injury rates at the 4 digit Standard Industrial Classification (SIC) level. Thus, it extends the previous work by Grossman and Krueger [8], which has been widely cited as evidence against Mexico's specialization in 'dirty' production. This extension is useful as that study's small sample size of 143 3-digit industries and its single coarse pollution measure raise some concerns. Third, by using an industry fixed effect model to examine the changes in net import intensity during the NAFTA transition, this study avoids some of the difficulties in interpreting the relationship between pollution and import intensities in a cross-section of industries.

The rest of the paper is organized as follows. Section 2 outlines the potential relationship between trade and the environment; section 3 describes the empirical framework to test if Mexico specializes in 'dirty' industries; section 4 compares the pollution intensities in Mexico and the US; section 5 reports the regression results; section 6 describes Mexico's imports of pollution abatement equipment; section 7 describes the ambient air pollution levels in the Mexican border cities; and section 8 concludes.

2. TRADE AND ENVIRONMENT

This study examines two channels by which trade may influence environmental quality, i.e. the composition of production in Mexico [9,10] and Mexican imports of pollution abatement equipment from the US.[1] The pattern of US net imports from Mexico provides a good view of Mexico's overall export patterns because the US is Mexico's major trading partner. The US accounted for 65% of Mexico's exports in 1987, 76% in 1992 [11] and 88% in 1998[2] [12].

Mexico enacted a comprehensive set of environmental laws in 1988, i.e. the General Law of Ecological Equilibrium and Protection of the Environment [13]and increased its enforcement efforts since 1993, but Mexico's enforcement of environmental laws has always been less strict than that of the US. Mexico could specialize in 'dirty' industries if the savings from the cheaper release of pollution in Mexico and the cheaper worker compensation for injurious work were significant enough to offset other production considerations, such as the need for skilled workers, the immobility of sunk physical capital, and the high costs of transporting hazardous products to the US. NAFTA's guarantees of secure access to the US market for products made in Mexico may indirectly encourage the location of 'dirty' industries to Mexico. Pollution intensive industries that tend to be moderately or highly capital intensive may not have located in Mexico in the pre-NAFTA period as a result of the non-tariff barriers to the US markets, such as standards and quantitative restrictions [14]. With NAFTA's guarantee of secure markets, these industries could have reassessed their decisions and located in Mexico.

[1] Trade can also influence environmental quality by increasing output and thus output-related pollution levels, and by increasing income and thus income-related demand for environmental quality.
[2]A significant proportion of Mexican manufactured exports is destined for the US. Since 1991 onwards,

However, a priori, the net impact of NAFTA and the NAFTA-related environmental initiatives on Mexico's trade patterns is unclear. During the debates prior to the passage of NAFTA, the Mexican government launched improvements in its environmental enforcement efforts. The improvements narrowed the gap between the private costs of pollution release in the US and that in Mexico, though they did not eliminate this gap[3] [15]. The Mexican Federal Attorney-General for the Environment (PROFEPA) raised its annual number of complete inspections of establishments between the pre-NAFTA and the post-NAFTA years[4] [15]. The Mexican government also implemented an environmental auditing program for public-sector industries and large private industrial groups[5] [15].

NAFTA also coincided with the environmental side agreement, the North American Agreement on Environmental Cooperation (NAAEC). Under the NAAEC, citizens of NAFTA countries can submit complaints to the Council for Environmental Cooperation (CEC) if their domestic governments fail to enforce domestic environmental laws. A NAFTA government can also submit complaint against another NAFTA government that has shown 'persistent failure to enforce its environmental laws' [7]. Nevertheless, one other event that coincided with NAFTA, the Mexican government's devaluation of the peso in December 1994, would not influence the relationship between pollution and US net import intensities, as the devaluation would have similar effects on US imports in both the more and less polluting industries.

3. EMPIRICAL FRAMEWORK

To rank the pollution intensities across industries, I use US measures of pollution

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manufactured exports make up 74% of Mexico's total exports and this figure rises to 83.7% by 1995 [33].

[3]PROFEPA inspected an average of about 50% of establishments under its jurisdiction since 1993 [15].

[4]PROFEPA increased its inspections of establishments (including non-manufacturing establishments) from 4,600 in 1992 to 11,800 in 1997 [15].

[5]The effective phase of the audit program that began in November 1992 is likely to have coincided with NAFTA. The number of firms undertaking audits and committing to action plans to achieve compliance has increased from 246 and 99 in 1992-4 to 571 and 388 in 1995-7, respectively [15].

intensities. It is likely that some industries are more polluting than others in both the US and Mexico as a result of a global technological constraint. A comparison of US and Mexican pollution intensities suggests that this assumption is reasonable (see section 5.1).

3.1 CROSS SECTION MODEL

The first question pertaining to Mexico's specialization is whether the intensity of US net imports from Mexico is greater for the more polluting industries. I examine trade patterns at three points in time – 1987, 1992 and 1996 – that corresponds to Mexico's initial trade liberalization in the 1980s and the NAFTA transition in the 1990s.

The cross-section model estimated is similar to that presented in Grossman and Krueger [8] and the theoretical basis underlying Grossman and Krueger's empirical analysis has been developed in Levinson and Taylor [16]. The dependent variable is the ratio of US net imports from Mexico to US domestic production, which indicates the extent to which a given industry has located its production in Mexico [16]. The variables of interest are various measures of monetary and physical pollution intensities and injury rates. Control variables are measures of industries' characteristics. The estimated model is:

$$Y_i = D_i \beta_1 + X_i \beta_2 + P_i \beta_3 + \varepsilon_i \qquad \text{[Model 1]}$$

where Y is ratio of US net imports from Mexico to US domestic production for the study year; D is a vector of 2-digit industry dummies; X is a vector of industry characteristics such as physical capital intensity and human capital intensity; P is a vector of measures of physical pollution intensity (measured for 1987), shares of pollution abatement costs (measured for 1989) and injury rates (measured for 1989). The observations are about 350 4-digit industries for a given study year. The null hypothesis is that Mexico does not specialize in 'dirty' production, i.e. $\beta_3 = 0$. If Mexico does specialize in the more polluting industries, β_3 would be positive and the null would be rejected.

The physical and human capital intensity variables are defined as in Grossman and Krueger [8]. The physical capital intensity of an industry is the ratio of the payment to physical capital to the industry's value-added. The human capital intensity variable is defined analogously. The payment to physical capital is the difference between value-added and payroll expenses [8]. The payment to human capital is the share of the payroll paid to labor with more than high school education [8]. I assume payments to unskilled labor is the multiple of the number of employees and the wages of workers with less than high school education and that these workers work 2000 hours annually.

Nevertheless, the limitation of this cross-section model is that inter-industry differences that are not controlled for sufficiently may confound the relationship between pollution intensity and import intensity. In view of this shortcoming, this study also estimates an industry fixed effect model that answers a related question.

3.2 INDUSTRY FIXED EFFECT MODEL

The second question pertaining to Mexico's specialization is whether US net import intensity has shown greater increase in the more polluting (or injurious) industries relative to the less polluting (or injurious) industries between the pre-NAFTA and the post-NAFTA years.[6] Two separate sets of regressions are estimated. The first set compares the pre-NAFTA years (1991-3) with the years immediately following NAFTA (1994-6) while the second set compares the pre-NAFTA years with the period several years after NAFTA (1997-9). I examine this second period because trade may expand only after a time lag that firms need to set up production and trade ties.

The estimation model is:

[6] I do not address the causal question of whether NAFTA per se intensified Mexico's specialization in

$Y_{i,t} = D_i \ \beta_1 + N_t \beta_2 \ + P_i \times N_t \beta_3 + \varepsilon_{i,t}$ [Model 2.1]

where Y is ratio of US net imports from Mexico to US domestic production; D is the vector of 4-digit industry dummies; N is the NAFTA dummy that takes the value 1 for the years during which NAFTA is in effect, and 0 otherwise; and P is the vector of measures of pollution and injury intensities as defined in Model 1. The observations are for industry i at time t.

The coefficient on the NAFTA variable captures the average growth of industries during the transition from the pre to the post NAFTA period. The 4-digit SIC industry dummies control for inter-industry differences in the pre-NAFTA net import intensities. The explanatory variables of interest are the interaction variables, i.e., the interaction of the pollution intensity variables (or injury rates variable) with the NAFTA dummy. These interaction variables capture the increase in the net import intensity of the more polluting (or injurious) industries relative to that of the less polluting (or injurious) industries during the NAFTA transition. The null hypothesis is that the net import intensity do not show greater increase in the more polluting (or injurious) industries relative to the less polluting (or injurious) industries, i.e. $\beta_3 = 0$.

A second specification of the model adds further control variables so that the increase in the net import intensities can vary among industries that differ in their human and physical capital intensities. These control variables are the interaction of dummies of quintiles of physical capital intensity (or human capital intensity) with the NAFTA dummy. The dummies for the highest quintile of human capital intensity and physical capital intensity are omitted. The estimated model is:

$Y_{i,t} = D_i \ \beta_1 + N_t \beta_2 \ + P_i \times N_t \beta_3 + X_i \times N_t \ \beta_4 + \varepsilon_{i,t}$ [Model 2.2]

where X is the vector of dummies indicating 4 different quintiles of human capital intensity and 4 different quintiles of physical capital intensity (measured for 1991). The omitted dummies are those that indicate the lowest quintile of human or physical capital intensities. Other variables are

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polluting industries.

defined as in Model 2.1.

4. DATA

Data for US exports to Mexico and US imports from Mexico are from the NBER trade CDs for the years 1987-1994 [17,18] and from the US Census Import and Export CDs for the years 1995-9 [19,20]. Wages for workers with less than high school education is from the State of Working America [21]. Data on employment, payroll, domestic shipments, and value-added for US industries are from the NBER's productivity database for the years 1987-1996 [22], the Census of Manufacturers for the year 1997 [23] and the Annual Survey of Manufacturers for the years 1998-9 [24]. Using a similar method applied by Battelsman and Gray [22], I have built a concordance to convert the 1998-9 data, which are in the North American Industrial Classification System (NAICS), to the 1987 SIC classification.

5. POLLUTION INTENSITY

Physical measures of pollution intensity are from the World Bank Industrial Pollution Projection System (IPPS) project [25]. The IPPS project examined the population of about 200,000 US manufacturing firms and combined economic information from the 1987 US Census of Manufacturers with the US Environmental Protection Agency's (EPA) information on air, water and solid waste emissions in 1987.

The pollutants measured in the IPPS project are more strictly regulated in the US than in Mexico. Air pollution intensity measures are available for the EPA's 6 criteria air pollutants, i.e., particulate matter (PM), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2) volatile organic compound (VOC) and PM-10 (particulate matter below 10 micron). The two measures for water pollution are the total suspended solids (TSS) and the biological oxygen demand (BOD). Toxic materials include all chemicals listed as toxic under the 1987 Toxic

Release Inventory. Metal pollutants include metals released to air, water, or as solids. Each of the four measures of air, water, toxic and metal pollution intensities are expressed as a ratio of the sum of the weight of the pollutants produced within a 4-digit SIC industry to the value-added within that industry.[7]

The monetary measure for pollution intensity is the ratio of pollution abatement operating costs to the value-added in that industry (PAOC) in 1989. The pollution abatement operating costs include payments to treat or to dispose of air, water and solid waste, but exclude capital expenditure [26]. The injury rates are the number of cases of occupational injury recorded in a US industry per 1000 employees in 1989 [27].

5.1 POLLUTION AND INJURY RANKING ACROSS INDUSTRIES

Two patterns emerge from Charts 1-6 that plot the top 25 polluting industries ranked by their toxic, air, metal and water pollution intensities. First, high levels of physical and monetary pollution intensities are concentrated in the top few polluting industries, while the most of the industries have far lower pollution intensities. This fact would suggest that only a few industries would consider the differences in pollution abatement costs among sites as a crucial variable in their location decision. Second, the top 25 polluting industries are generally industries that are intensive in physical capital, such as metals, chemicals, and petroleum refining. This fact suggests that Mexico's comparative disadvantage in physical capital and industries' sunk physical capital would be a disincentive for these industries to locate in or relocate to Mexico, respectively.

According to Chart 1, the top 25 industries in air pollution generate between 281 to 45 g of air pollution per dollar value-added, while the rest of the industries produce a mean of only 3 g per dollar value-added. Similarly, according to Chart 2, the top 25 polluting industries in toxic

[7] Measures that aggregate pollutants based on their relative health and environmental risk are not available.

pollution generate between 214 to 9 g of toxic pollutants per dollar value-added, while the rest of the industries produce a mean of only 1 g per dollar value-added. Chart 4 shows that the figures for water pollution (measured by BOD) are between .10 and .001 g per dollar value-added for the top 25 industries and .00005 g per dollar value-added for the rest of the industries. Unsurprisingly, as seen in Chart 3, the distribution of metal pollution intensity is even more skewed as only a subset of industries use metals. The top 5 polluting industries generate between 198 and 6 g per dollar value-added, while the rest of the industries produce a mean of only .22 g per dollar value-added. Chart 5 shows that, like physical pollution intensity, the share of pollution abatement operating costs is concentrated in the top few industries. The share for the top 25 industries averages about .06, about 6 times greater than the mean for the rest of the industries of about .009. In contrast to the concentrated distribution for pollution intensities, injury rates are more evenly distributed across industries, i.e. Chart 6 shows that the top 25 industries experience twice the mean injury rates for the rest of the industries.

Multiple measures of pollution intensity provides a more the complete picture of the pollution intensity of an industry because the types of pollutants are industry-specific. As seen in Table 7, industries rank highly on some measures of pollution intensity but low on others. Among the 10 industries that rank among the top 25 industries in both air and toxic pollution intensities, only 5 industries rank among the top 25 industries in all three air, toxic and metal pollution intensities and only one industry ranks among the top 25 industries in all four air, toxic, metal and water pollution intensities.

However, the use of multiple measures to provide a complete picture of the pollution intensity of an industry needs to be balanced with the potential multi-colinearity among these various measures of pollutants. The intensity of pollutants that are complements in the manufacturing process would be strongly or moderately correlated. Table 8 reveals that the correlation is high or moderate among some measures, e.g., between toxic pollution intensity and metal pollution intensity (.52), but low among other measures, e.g. between water and toxic pollution intensity (.05) and air and metal pollution intensity (.08). A similar pattern can be seen among the components of air pollution with high correlation among some measures, e.g. between particulate matter and nitrogen dioxide (.65) but low correlation among other measures, e.g. between particulate matter and volatile organic compounds (.17).

5. 2 COMPARISON OF MEXICAN AND US POLLUTION INTENSITIES.

Ranking of pollution intensity measures

To compare the ranking of the pollution intensities of industries located in the US and in Mexico, I examine the correlation between air pollution intensities measured for industries located in Mexico in 1997 and that measured for industries located in the US in 1987. Data on air pollution per employee[8] are available for the 29 manufacturing industries classified using the International Standard Industrial Classification version 2. The World Bank IPPS project compiled the air pollution intensities for a subset of facilities in the Metropolitan Area of the Valley of Mexico (MAVM) in 1997.[9] The ranking of industries in the MAVM is likely to indicate the ranking of industries in Mexico as a whole despite the stronger environmental enforcement in the MAVM. This stronger enforcement will not likely change the ranking of industries from extremely polluting to extremely clean, or vice versa.[10]

Most industries ranked similarly in the US and Mexico, i.e. they are 'most polluting', 'moderately polluting' and 'least polluting', both in Mexico and in US. Industries that are 'most

[8] The alternative comparison of pollutants per value-added is of interest as the capital to labor ratios differ between Mexican and US-based industries. Unfortunately, data on pollution per value-added is not available for Mexico.
[9] Some firms in the US and Mexico report total emissions that are based calculated emission factors. These calculations are based on a method developed by the EPA and they take into account the plants' energy consumption, pollution abatement equipment and other inputs.
[10] However, the relative ranking among the moderately polluting industries may be affected. Consider two moderately polluting industries, A and B. Under weak enforcement, industry A releases more end of pipe pollution than industry B. Under strong enforcement, industry A may decide that it is cheaper to adopt a new production technology (rather than simply reduce its end of pipe emissions). These changes may make

polluting'[11] both in Mexico and the US include petroleum refinery, miscellaneous petroleum & coal industries, non-ferrous metals, paper and products, industrial chemicals, and iron and steel. Industries that are 'least polluting' both in Mexico and the US are apparel and footwear except leather. For three of the four air pollution measures, the US and Mexican air pollution intensities are strongly or moderately correlated. The correlation between these intensities for nitrogen dioxide is 0.91, for particulate matter is 0.57, for carbon monoxide is 0.49, and all these relationships are significant at the 5% level. These findings suggest that it is reasonable to rank industries as 'dirty' or 'clean' in both the US and Mexico, and that the use of US measures in this study to rank the pollution intensity of industries is a reasonable method.

However, for one of the air pollutants, sulphur dioxide intensities measured for the US and the sulphur oxides measured for Mexico show a correlation of only 0.29 and is statistically insignificant at the 10% level. While for the lack of correlation for this pollutant may be explained by the differences in the set of pollutants measured – the Mexican measure includes a larger set of sulphur oxides – this finding suggests that there are limitations to using US data to proxy for developing country data. Unfortunately, fine resolution data for developing countries are unavailable at present.

Absolute pollution levels

Another important comparative question is whether an industry emits more pollution in Mexico than in the US. Chart 9 provides a comparison of the absolute pollution intensities in the US and Mexico for various industries. According to Chart 9, from the point of view of Mexico's environmental protection, a positive finding is that for the 'dirty' industries, the absolute air pollution intensity for an industry in the MAVM in 1997 is lower than that in the US in 1987. One possible explanation is that, compared to US industries in 1987, this subset of Mexican

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industry A less polluting than industry B.

[11] Industries are classified as 'most polluting' if they rank among the top 10 polluting industries in two or more measures of pollution intensity.

industries in 1997 has incorporated more pollution abatement, either as a result of newer plant vintage or newer pollution abatement technology.[12] Nevertheless, this finding may be limited to the MAVM area that has the strictest environmental enforcement in Mexico.

However, a negative finding for Mexico's environmental protection pertains to industries that are moderately polluting (e.g. textiles) and least polluting (e.g. apparel and footwear excluding leather). Absolute air pollution intensities for these industries in the Metropolitan Valley of Mexico in 1997 are greater than the respective industries in the US in 1987. One possible explanation is that firms have responded to the weaker environmental enforcement in Mexico by releasing greater amounts of end-of-pipe pollution in Mexico. This finding suggests that Mexican policies to reduce overall pollution levels need to widen its focus to these industries that are generally viewed as 'least' or 'moderately' polluting.

6. REGRESSION RESULTS

6.1 CROSS SECTION MODEL

To begin with, I replicate the estimation in Grossman and Krueger [8] by aggregating the observations at the 4 digit SIC level to the 3 digit SIC level. As seen in Table 11 column 1, this replication yields similar results to that study, i.e., US net import intensity is higher in industries with lower human capital shares and the coefficient for the share of pollution abatement costs is insignificant. The next columns show the results from the cross-section model using the full sample (columns 2,4,6) and a sub-sample of industries, i.e. the 64% of the original sample that have metal and water pollution intensity measures[13] (columns 3, 5, 7).

Overall, I do not find strong evidence that, within the 2-digit industries, the US net import intensity is consistently higher in the 'dirtier' 4-digit industries. Table 11 reveals that most

[12] Another possible explanation is that these Mexican industries comprise less polluting sub-industries than their US counterparts.

[13] The Census suppressed data for the rest of the industries (Wheeler, pers. comm.)

measures of pollution intensity, i.e. the various components of air and water pollution, injury rates, and shares of pollution abatement costs, do not show a significant positive correlation with US net import intensity. For two measures of pollutants, i.e. toxic and metal pollution intensity, some of the specifications yield a positive co-relationship between pollution and net import intensities, but the sizes of the estimated coefficients are small. The models for 1987 and 1996 estimate positive and significant coefficients for metal and toxic pollution intensities, but the model for 1992 estimates coefficients that are much smaller and statistically insignificant.

One way to interpret the size of these coefficients is to compare the correlation between a mean increase in toxic or metal pollution intensity and US net import intensity with the correlation between of a mean increase in human capital share and US net import intensity. Based on this interpretation, the size of the coefficients for metal or toxic pollution intensity is much smaller than that for human capital intensity. According to Table 10 and 11, increases in the toxic pollution intensity and metal pollution intensity by their mean values are correlated with an increase in net import intensity of .0012 and .0008 percentage points, respectively. In contrast, an increase of human capital intensity by its mean value is correlated with a reduction in net import intensity of .0074 percentage points. In light of the potential multi-colinearity among various measures of air and water pollution intensity, I re-estimated these models using one measure for total air pollution intensity and only one of the measures for water pollution intensity. This specification did not yield different results.

6.2 INDUSTRY FIXED EFFECT

I do not find strong evidence that the net import intensity has shown a larger increase in the more polluting industries relative to the less polluting ones during the NAFTA transition. Tables 12 and 13 reveal that most of the coefficients for pollution intensity are not statistically different from zero. Although the coefficients for two measures of pollution intensity are positive in some specifications, they are small in size.

As seen in Table 12 column 1, an increase in carbon monoxide intensity by its mean value is correlated with an increase in net import intensity by only .0007, i.e., about 3% of the average within-industry increase in net import intensity of .023 between 1991-3 and 1994-6. The models that allow increases in net import intensities to vary among industries with different physical capital and human capital intensities, as seen in Table 13 columns 1 and 3, yield similarly small coefficients. Table 12 column 2 reveals that an increase in metal pollution intensity by its mean value is correlated with only a 2% increase in the net import intensity between 1991-3 and 1994-6. However, as seen in Table 12 column 4 and Table 13 column 4, this coefficient for metal pollution intensity is insignificant in the models that examine the transition between 1991-3 and 1997-9.

There is some evidence that during the NAFTA transition, the net import intensity shows a larger increase in industries with lower injury relative to those with higher rates. According to Table 13 columns 3, a decrease in injury rates by its mean value is correlated with an increase of about 25% of the average within increases in the net import intensity between 1991-3 and 1997-9.[14] I do not find evidence of a strong link between shares of pollution abatement costs and increases in net import intensity. As seen in Table 12 column 1, an increase in share of pollution abatement costs is correlated with a only reduction of 9% of the average within increases in the net import intensity between 1991-3 and 1994-7, and the coefficients for these shares are insignificant for the models that examine the transition between 1991-3 and 1997-9. When these models are re-estimated using fewer measures for pollution intensity, the results do not change significantly.

7. TRENDS IN THE NET IMPORT INTENSITY FOR POLLUTING INDUSTRIES

[14]The estimated coefficients from other models are fairly similar, as seen in Table 12 col. 1 and Table 13

The intensity of US net imports from Mexico in the more polluting industries between 1987-1999 is plotted in Charts 14-20.[15] Because industries, whether they are more or less intensive in physical capital may consider locating new facilities in Mexico, I consider the top 25 polluting industries, regardless of their physical pollution intensity. As seen in Charts 14-16, for these industries, on net, it is the US that exports goods to Mexico and not vice versa. Nevertheless, as industries that are less intensive in physical capital are more likely to relocate, I also consider those industries that have lower physical capital shares and that are among the top 50 polluting industries, as seen in Charts 17-20. For most of these industries, on net, it is again the US that exports goods to Mexico. However, as seen in Chart 20, for the seven industries that are intensive in air pollution (and have a lower physical capital intensity), on net, the US imports these goods from Mexico. Nevertheless, the US net import intensity for these industries has been falling over time.

8. MEXICAN IMPORTS OF POLLUTION ABATEMENT EQUIPMENT

Mexico's imports of pollution abatement equipment from the US, its largest supplier of pollution abatement equipment, provide a good overview of Mexico's total imports of such equipment. For example, the US holds 64% of the market share in air pollution control [28]. NAFTA's elimination of the tariffs on Mexico's imports of pollution abatement equipment, from pre-NAFTA rates that are as high as 20%, (as seen in Table 21), has made these imports cheaper for manufacturing firms and municipalities that provide waste treatment facilities. NAFTA-related bodies such as the NAFTA Development Bank further assists environmental protection by providing long-term loans and loan guarantees for environmental infrastructure projects within 100 kilometers of the U.S.-Mexico border [29]. However, the events that occurred soon after NAFTA, the peso-devaluation and financial regulation promulgated thereafter, have

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col. 1.

discouraged these imports by raising the costs of foreign and Mexican private funding that had previously financed environmental projects [29].

Using the US International Trade Administrator's master list of US export codes for pollution abatement equipment (Zeytoun, pers. comm.), I examine Mexican imports of pollution abatement equipment from the US. Chart 22 reveals that Mexican imports of most types of pollution abatement equipment have increased over time and have recovered from a temporarily devaluation-related dip in 1995. Between 1989 and 1999, these import equipment for hazardous waste management, soil and water remediation, wastewater management and air pollution management has increased substantially, i.e. 5, 5, 3, and 2 times respectively. Nevertheless, the multipurpose nature of these products may lead to an overstatement of these imports.[16]

9. AMBIENT POLLUTION IN MEXICAN BORDER CITIES

Despite popular claims that NAFTA has increased ambient air pollution in the Mexican border region, the available data are insufficient to support such a claim. Air pollution data from the EPA's Aerometric Information Retrieval System, a unique source of public information, reveal that only two monitoring stations operated both before and after NAFTA. Nevertheless, the data do indicate that Mexican border cities suffer from severe ambient air pollution in the post-NAFTA period. Table 23 reveal that border cities, particularly Mexicali, experience numerous violations of the carbon monoxide and the ozone standards.[17] One of the stations in Ciudad Juarez and another in Tijuana experience a large number of violations for carbon monoxide pollution and ozone pollution, respectively. Sulphur dioxide pollution appears to be less of a problem, as none of the stations show violations of the sulphur dioxide standard. The concentration of lead in the air cannot be reliably assessed as few observations are recorded

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[15] The peso devaluation is likely to explain the 'outlier' peak in 1995.

[16] Firm-based data on the adoption of pollution abatement equipment are unavailable [34].

[17] The Mexican air quality standards for these pollutants are similar to the US standards [35].

annually.

10. DISCUSSION AND POLICY IMPLICATIONS

The empirical analysis does not provide strong support for the assertion that Mexico specializes in 'dirty' industries. I do not find strong evidence that the intensity of US net imports from Mexico is larger in the 'dirtier' industries relative to the 'cleaner' industries or that this intensity shows a larger increase in the 'dirtier' industries relative to the 'cleaner' industries during the NAFTA transition. For most pollutants, I do not consistently find a significant positive correlation between measures of pollution intensity and US net import intensity. For the few cases of pollutants for which I occasionally find a positive correlation, the sizes of the coefficients are small. Moreover, examining the top 25 polluting industries ranked by most measures of pollution intensities, I find that it is the US that exports products to Mexico and not vice versa. The lack of strong evidence that Mexico has specialized in polluting industries corresponds with the facts on the distribution of pollution intensity across industries. High levels of pollution intensities and shares of pollution abatement costs are concentrated among few industries, suggesting that only few industries would consider environmental savings to be a significant factor in their location decisions.

Comparison of US and Mexican pollution intensities suggest that some industries tend to be dirtier than others both in the US and Mexico – air pollution intensities for industries located in Mexico and those located in the US show moderate to strong correlation. From Mexico's environmental protection perspective, a positive finding is that for the most polluting industries, the pollutant per employee is lower in Mexico in 1997 than in the US in 1987, possibly because of newer plant vintage and abatement technology in Mexico. However, for the moderate and less polluting industries, the pollutant per employee is higher in Mexico than in the US, possibly because of greater end-of-pipe pollution releases in Mexico.

This study also finds that trade liberalization has assisted environmental protection in Mexico by reducing tariffs on Mexican imports of pollution abatement equipment. Mexican imports of such equipment have grown over time. Finally, this study finds that data are not available to support popular claims that ambient air pollution levels have worsened in Mexican border cities during the NAFTA transition, though it is true that in the post-NAFTA period, these border cities experience significant pollution levels. Nevertheless, there are limitations to this study. It cannot detect Mexico's specialization in polluting sub-industries and it may mislabel a polluting industry as clean if by 1987 that industry had shifted the most polluting sub-industries or the most polluting stages of production to sites outside the US.

Taken altogether, these findings, i.e., the lack of strong evidence for Mexico's specialization in dirty industries and the benefits of cheaper imports of pollution abatement equipment, suggest that a blanket opposition to trade on environmental grounds would be misguided. Nevertheless, the significant industry-related ambient air pollution levels in Mexican cities and the fact that some of the industries, which are generally regarded as less polluting, are releasing more pollution per unit production in Mexico call for changes in Mexico's public policy. In particular, mechanisms to ensure that Mexicans can make informed decisions on their preferred level of environmental protection are crucial. Potentially effective measures are public disclosure programs, similar to those implemented in the US and Indonesia [30,31].

Mexico should make public its databases on firms' emissions and compliance records. At present, Mexico's databases on firms' compliance records are not readily accessible to the public. These databases include the PROFEPA's Environmental Compliance Indicators' Project and the Environmental Enforcement and Tracking System in the Mexico City Metropolitan Area [15]. Only 5% of firms report their emissions to the Mexican Pollution Release and Transfer Registry. The Mexican government has announced that it would seek legislation that requires firms to report their emissions and that makes these data publicly accessible (Phipps, pers.

comm).

The public will also benefit from greater transparency in the NAFTA environmental adjudication process. Current procedural rules on citizens' complaints against domestic governments may prevent the investigation of legitimate complaints and the dissemination of information[18] [7]. NAFTA tribunal proceedings that adjudicate Chapter 11 provisions, i.e. allegations that NAFTA governments breach investment rules, are not open to the public[19] [32]. As a result, the public cannot evaluate whether these decisions can weaken environmental protection, as alleged by some environmentalists [32], or whether these decisions are based on legal principles of equal treatment of domestic and foreign investors and scientific basis for environmental laws [7].

The findings in this study suggest that the FTAA is unlikely to lead Latin American countries, which share Mexico's level of environmental protection, to specialize in 'dirty' industries. For lower income Latin American countries that have weaker environmental protection than Mexico, the finding, that the most polluting industries tend to be intensive in physical capital, suggests that it is unlikely that pollution-intensive industries will migrate en masse to these countries that are abundant in unskilled labor. Nevertheless, to ensure that the public in these countries can make well-informed decisions, mechanisms that allow the public to obtain environmental information and to register their preferences are crucial.

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[18] At present, the CEC does not investigate the facts behind a complaint, even if the complaint is legitimate, unless two-thirds of its members agree to this investigation [7]. The CEC publicizes the facts they gather about the complaint only if two-thirds of its members agree to this [7].
[19] Only recently, the tribunal has accepted written briefs from third parties [32].

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Personal communication.

Erica Phipps, North American Council for Environmental Cooperation; Ellen Zeytoun, US International Trade Administration; David Wheeler, World Bank Policy Research Division.

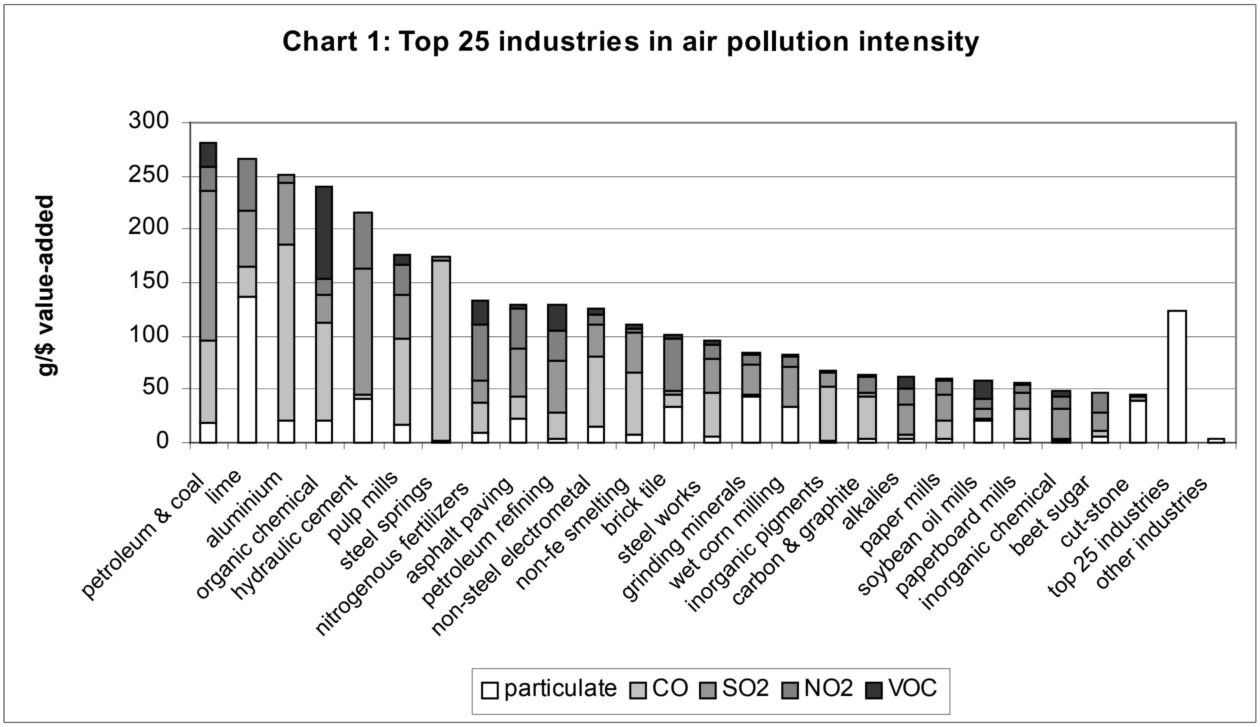
Chart 1: Top 25 industries in air pollution intensity
g/$ value-added
300
250
200
150
100
50
0
petroleum & coal
lime
aluminium
organic chemical
hydraulic cement
pulp mills
steel springs
nitrogenous fertilizers
asphalt paving
petroleum refining
non-steel electrometal
non-fe smelting
brick tile
steel works
grinding minerals
wet corn milling
inorganic pigments
carbon & graphite
alkalies
paper mills
soybean oil mills
paperboard mills
inorganic chemical
beet sugar
cut-stone
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other industries
particulate
CO
SO2
NO2
VOC

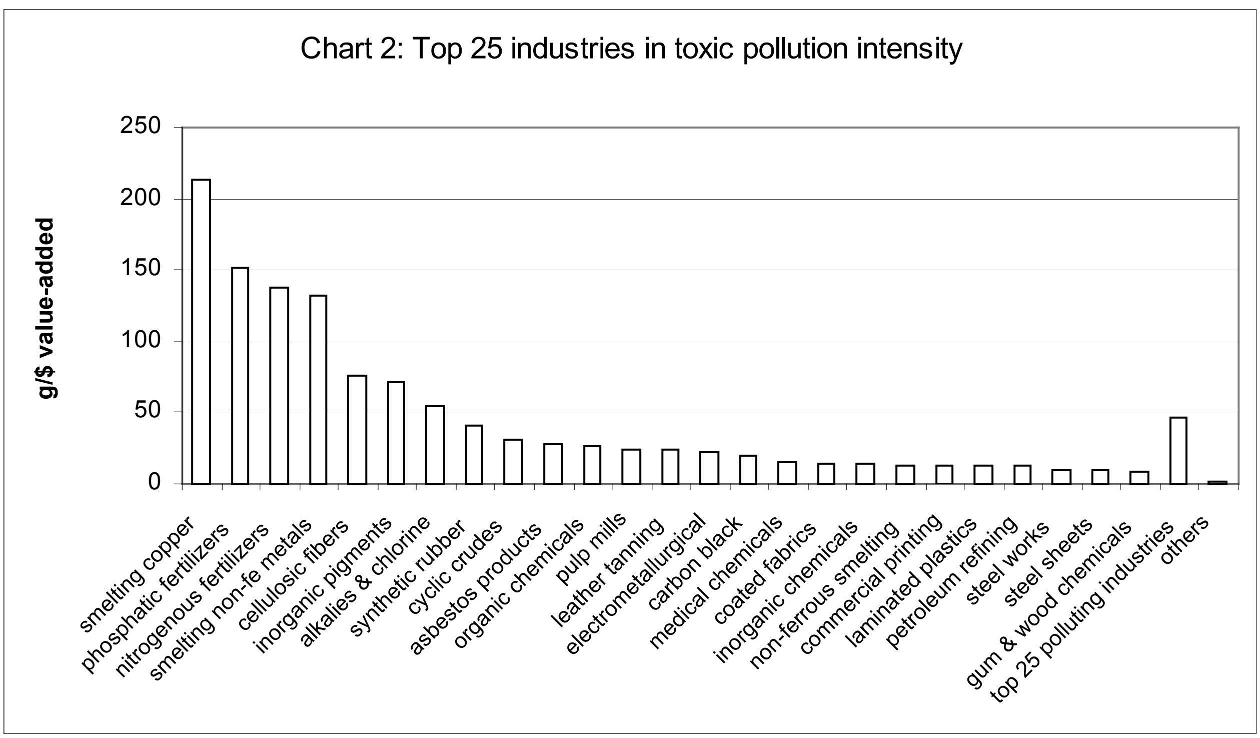


Chart 2: Top 25 industries in toxic pollution intensity
g/$ value-added
250
200
150
100
50
0
smelting copper
phosphatic fertilizers
nitrogenous fertilizers
smelting non-fe metals
cellulosic fibers
inorganic pigments
alkalies & chlorine
synthetic rubber
cyclic crudes
asbestos products
organic chemicals
pulp mills
leather tanning
electrometallurgical
carbon black
medical chemicals
coated fabrics
inorganic chemicals
non-ferrous smelting
commercial printing
laminated plastics
petroleum refining
steel works
steel sheets
gum & wood chemicals
top 25 polluting industries
others

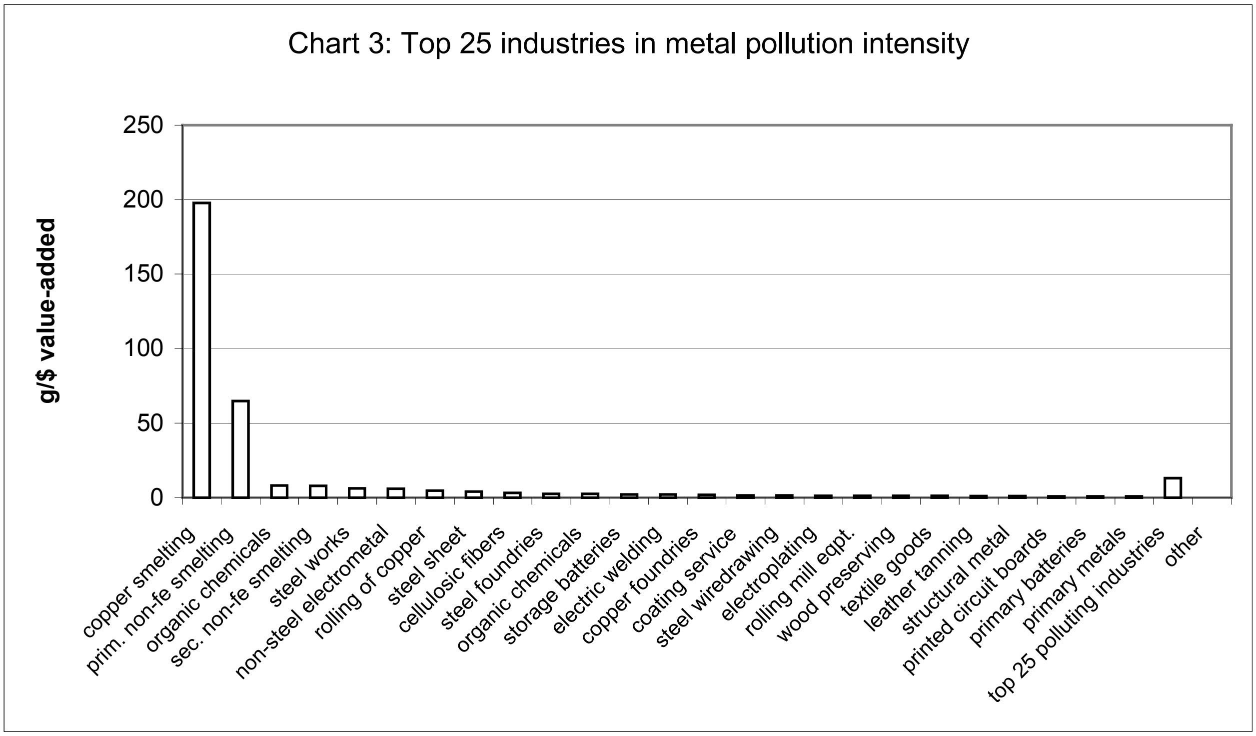


Chart 3: Top 25 industries in metal pollution intensity
g/$ value-added
250
200
150
100
50
0
copper smelting
prim. non-fe smelting
organic chemicals
sec. non-fe smelting
steel works
non-steel electrometal
rolling of copper
steel sheet
cellulosic fibers
steel foundries
organic chemicals
storage batteries
electric welding
copper foundries
coating service
steel wiredrawing
electroplating
rolling mill eqpt.
wood preserving
textile goods
leather tanning
structural metal
printed circuit boards
primary batteries
primary metals
top 25 polluting industries
other

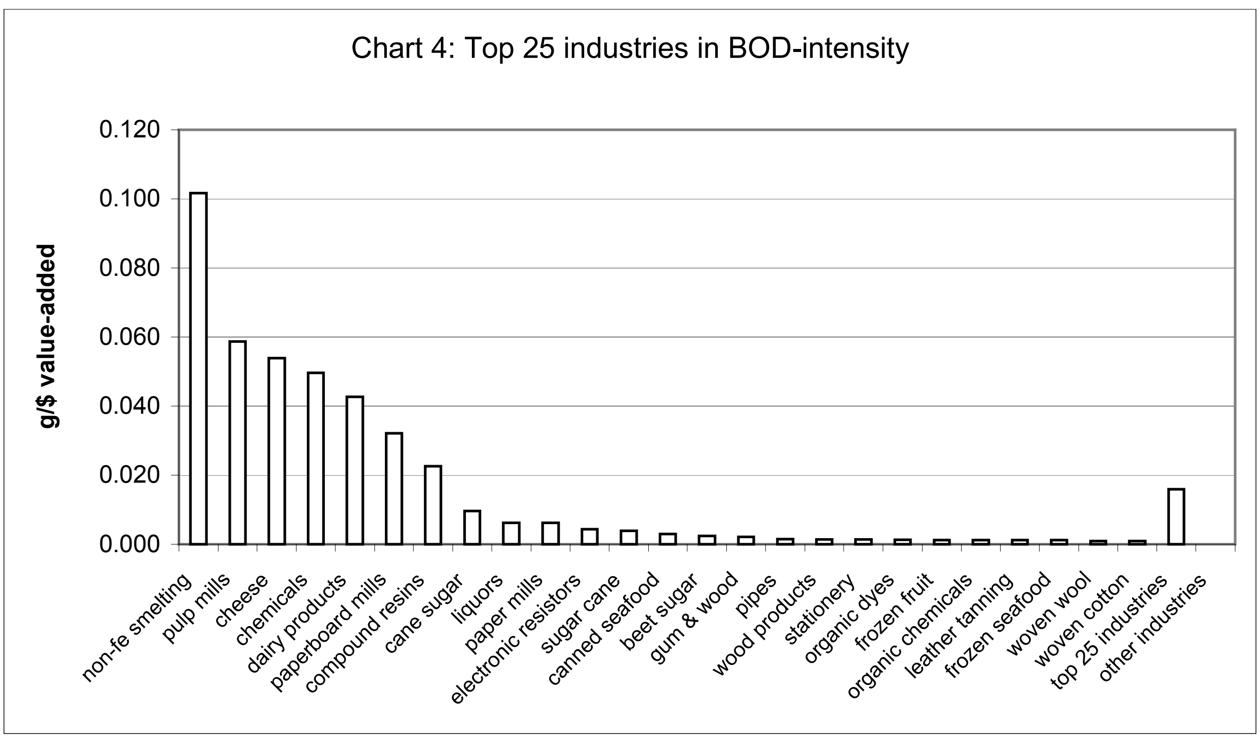


Chart 4: Top 25 industries in BOD-intensity
g/$ value-added
0.120
0.100
0.080
0.060
0.040
0.020
0.000
non-fe smelting
pulp mills
cheese
chemicals
dairy products
paperboard mills
compound resins
cane sugar
liquors
paper mills
electronic resistors
sugar cane
canned seafood
beet sugar
gum & wood
pipes
wood products
stationery
organic dyes
frozen fruit
organic chemicals
leather tanning
frozen seafood
woven wool
woven cotton
top 25 industries
other industries

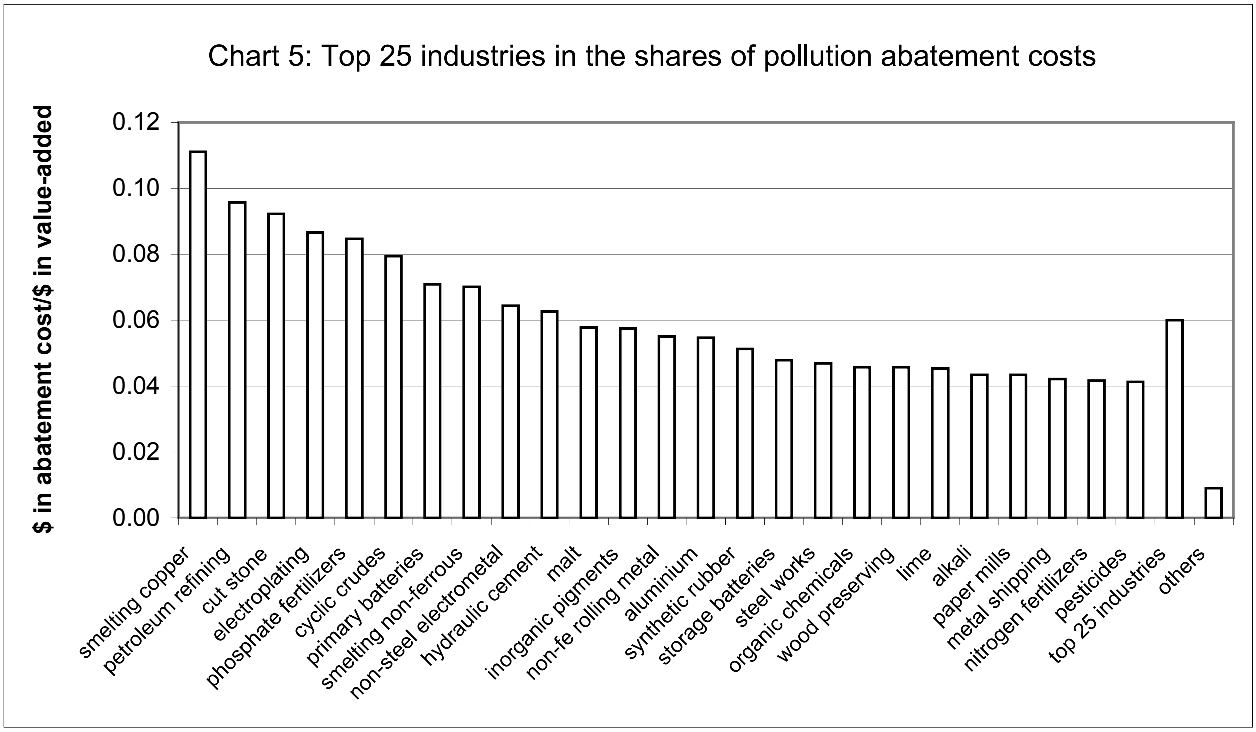


Chart 5: Top 25 industries in the shares of pollution abatement costs
$ in abatement cost/$ in value-added
0.12
0.10
0.08
0.06
0.04
0.02
0.00
smelting copper
petroleum refining
cut stone
electroplating
phosphate fertilizers
cyclic crudes
primary batteries
smelting non-ferrous
non-steel electrometal
hydraulic cement
malt
inorganic pigments
non-fe rolling metal
aluminium
synthetic rubber
storage batteries
steel works
organic chemicals
wood preserving
lime
alkali
paper mills
metal shipping
nitrogen fertilizers
pesticides
top 25 industries
others

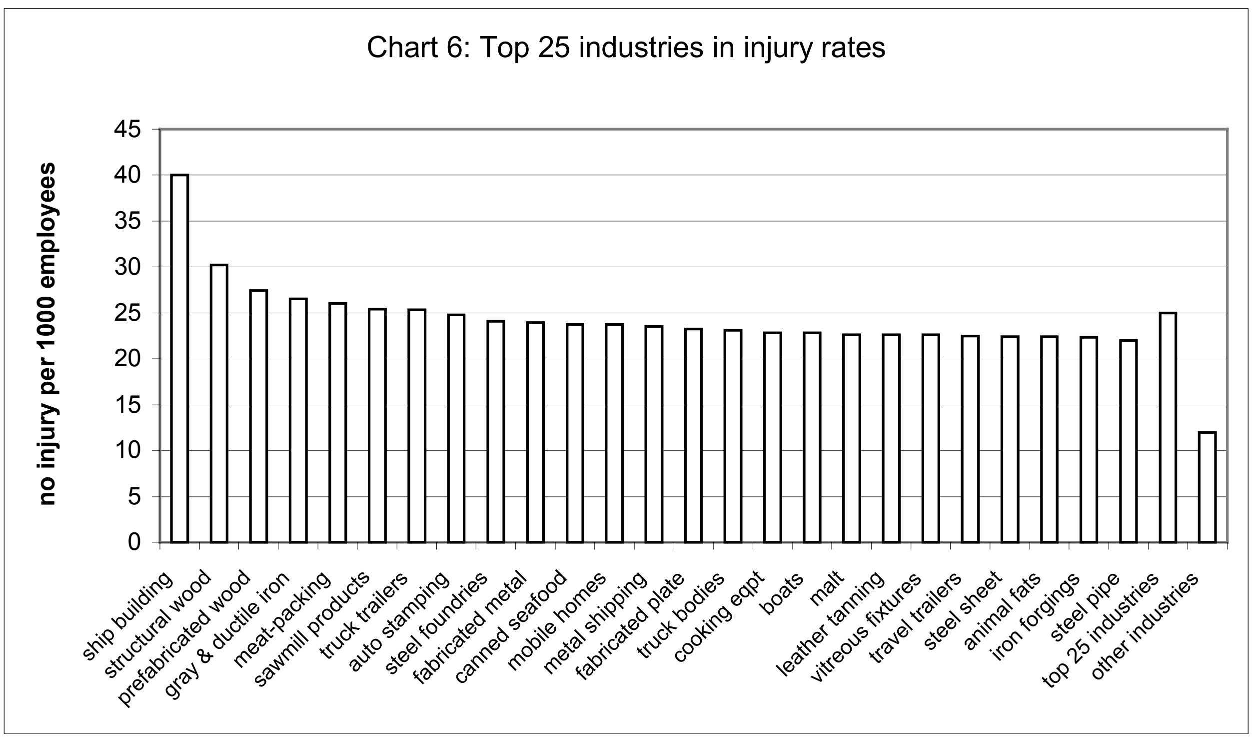


Chart 6: Top 25 industries in injury rates
no injury per 1000 employees
45
40
35
30
25
20
15
10
5
0
ship building
structural wood
prefabricated wood
gray & ductile iron
meat-packing
sawmill products
truck trailers
auto stamping
steel foundries
fabricated metal
canned seafood
mobile homes
metal shipping
fabricated plate
truck bodies
cooking eqpt
boats
malt
leather tanning
vitreous fixtures
travel trailers
steel sheet
animal fats
iron forgings
steel pipe
top 25 industries
other industries

Table 7: Rank of selected industries for various measures of pollution intensities

Industries		Air	Toxic	Metal	Water BOD	PAOC	Injury
		Rank in descending order of pollution intensity					
Organic chemical	a c	4	25	173	15	96	318
Pulp mills	a c	6	12	120	2	31	168
Nitrogenous fertilizers	a	8	3	30	55	24	301
Petroleum refining	a	10	22	72	28	2	386
Non-steel electrometal	a b	11	14	6	162	9	-
Non-ferrous smelting	a b c d e	12	19	4	1	8	26
Steel works	a b	14	23	5	102	17	129
Inorganic pigments	a b	17	6	3	53	12	357
Alkalies	a	19	7	92	51	21	354
Inorganic chemical	a b	23	18	11	54	30	378

Notes: PAOC = share of pollution abatement operating costs
(a) top 25 industries in air and toxic pollution intensities
(b) top 25 industries in air, toxic and metal pollution intensities
(c) top 25 industries in air, toxic and water pollution intensities
(d) top 25 industries in air, toxic, metal and water pollution intensities
(e) top 50 industries in air, toxic, metal, water pollution intensities, share of pollution abatement costs (PAOC) & injury rates

Table 8: Correlation among various measures of pollution intensities

	Air	Toxic	Metal	BOD	PAOC
Air	1				
Toxic	0.31	1			
Metal	0.08	0.52	1		
BOD	0.32	0.05	0.07	1	
PAOC	0.47	0.45	0.09	0.25	1
Injury	-0.01	-0.13	0.03	0.06	-0.05

Air Pollutant				
	Particulate	CO	SO_2	NO_2
Particulate	1			
CO	0.29	1		
SO_2	0.55	0.49	1	
NO_2	0.65	0.34	0.69	1
VOC	0.17	0.37	0.32	0.33

Water Pollutant	
	BOD
BOD	1
TSS	0.66

BOD = Biological oxygen demand
TSS = Total suspended solids
VOC = Volatile organic compounds

Mexican industries are more polluting than US ones.

Y-axis = Ratio of Mexican to US poll. Intensities.

Mexican industries are less polluting than US ones.

Y-axis = - Ratio of US to Mexican poll. intensities

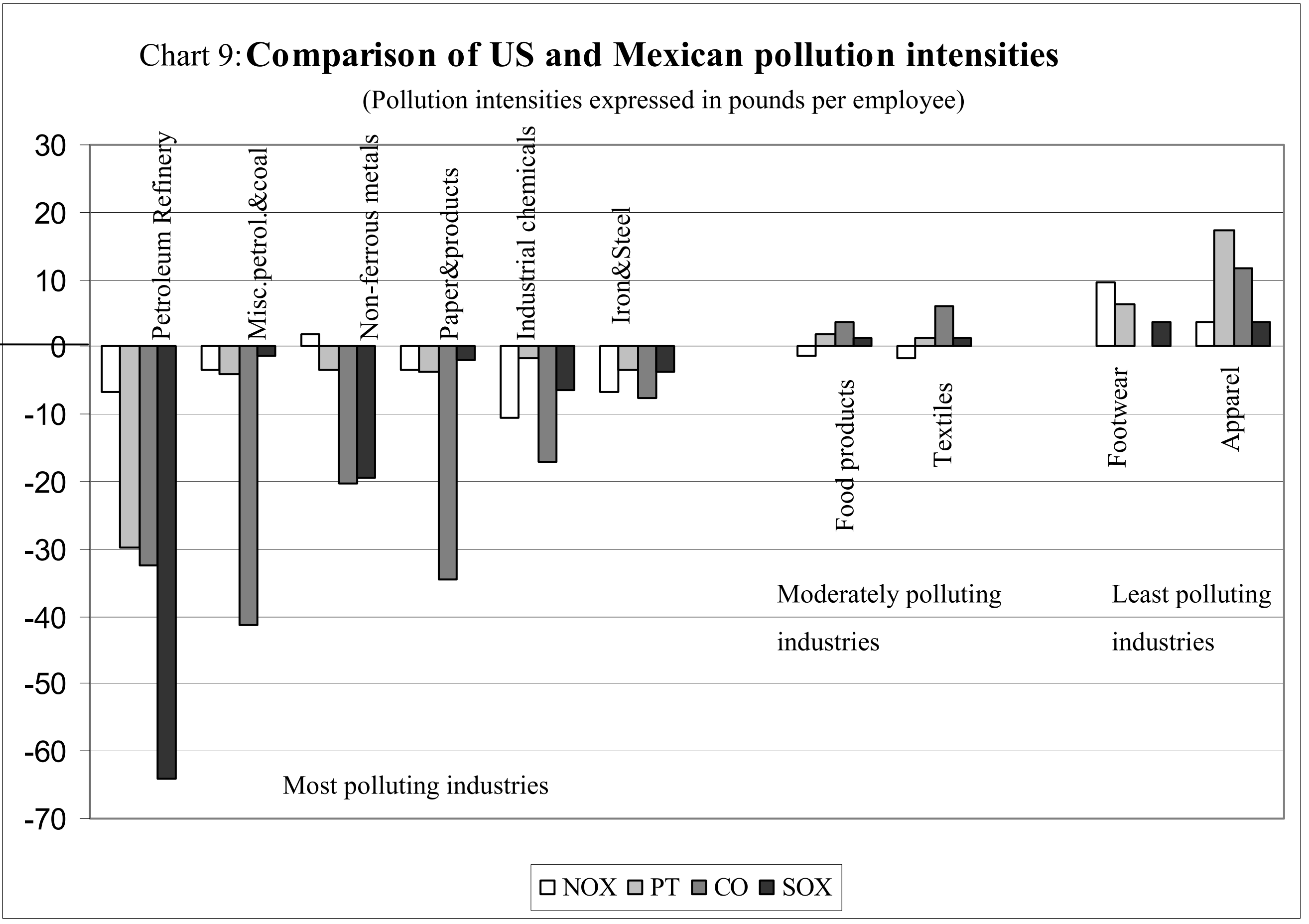


Table 10: Summary statistics

	Mean	Std. Dev.
Ratio of US net imports to US domestic production		
1987	-0.0015	0.029
1992	-0.011	0.024
1996	0.00009	0.04
Physical capital share (in 1991)	0.6	0.11
Human capital share (in 1991)	0.15	0.07
Physical pollution intensity (in 1987) in gram per dollar value-added.		
Air pollution intensity		
Total air	9.1	27.3
Particular matter	1.2	3.9
Carbon monoxide	2.4	12.4
Sulphur dioxide	2.2	7.2
Nitrogen oxide	1.7	5.4
Volatile organic compounds	1.6	5.6
Toxic pollution intensity	3.3	14.1
Metal pollution intensity	0.53	4
Water pollution intensity		
Biological oxygen demand	0.0015	0.0089
Total suspended solids	0.011	0.96
Injury rates	13	5.4
Share of pollution abatement operating costs	0.01	0.01

Table 11: Cross section estimates of the intensity of US net imports from Mexico

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	1987	1987	1987	1992	1992	1996	1996
Dependent variable: the ratio of US net imports from Mexico to US domestic production							
Human capital	-.042**	-.049+	-.086*	-.050+	-.00061	-.068	-.031
intensity	(.020)	(.033)	(.051)	(.031)	(.040)	(.061)	(.11)
Physical capital	-.016	-.018	-.031	-.0054	.023	-.0097	.046
intensity	(.017)	(.022)	(.035)	(.020)	(.027)	(.038)	(.069)
Injury rates	-.0002	-.00034	-.00018	.00023	.00064*	.00049	.0012
	(.0003)	(.00037)	(.00051)	(.00031)	(.00037)	(.00056)	(.00090)
Abatement costs	.088	-.19	.053	-.081	-.080	-.30+	-.11
intensity	(.11)	(.14)	(.18)	(.11)	(.13)	(.21)	(.31)
Particulate matter		-.00024	-.00049	-.00024	-.00029	-.00032	-.00018
		(.00059)	(.00080)	(.00048)	(.00057)	(.00089)	(.0014)
Carbon monoxide		.000094	.00011	.000038	.000058	-.000066	-.00017
		(.00019)	(.00023)	(.00016)	(.00016)	(.00029)	(.00040)
Sulphur dioxide		-.000056	-.00027	.000024	-.00014	.00028	.00033
		(.00040)	(.00049)	(.00033)	(.00034)	(.00060)	(.00084)
Nitrogen oxide		-.000055	.00023	-.00014	-.000021	-.00048	-.00027
		(.00041)	(.00050)	(.00034)	(.00035)	(.00062)	(.00087)
Volatile organic		.000036	.00010	.000079	.000081	.00016	.00019
		(.00031)	(.00035)	(.00026)	(.00025)	(.00047)	(.00060)
Toxic pollution		.00038**	.000095	.000056	.000044	0.00034*	-.000032
intensity		(.00013)	(.00017)	(.00011)	(.00012)	(.00019)	(.00030)
Metal pollution			.0016**		.00014		.0019*
intensity			(.00058)		(.00041)		(.0010)
BOD intensity			-.021		.017		-.012
			(.31)		(.020)		(.048)
TSS intensity			-.0020		-.13		-.016
			(.028)		(.22)		(.54)

2-digit SIC dummies	excl	incl	incl	incl	incl	incl	incl
(only SIC dummies that are significant at .10% or .05% are reported)							
25-industry				-.021**			
[furniture fixtures]				(.0085)			
28-industry		-.018**	-.018+				
[chemicals]		(.0082)	(.011)				
32-industry				.019**	.018**	.024**	
[stone clay glass]				(.0070)	(.0087)	(.012)	
35-industry		-.027**	-.024**	-.014**	-.016**		
[non-metalic mineral]		(.0077)	(.011)	(.0066)	(.0083)		
36-industry		.019**		-.029**	-.030**	.030**	.040**
[electronic]		(.0074)		(.0062)	(.0079)	(.011)	(.019)
constant	.016 (.012)	incl.	incl.	incl.	incl.	incl.	incl.
R-squared	.01	.22	.26	.23	.30	.08	.07
No. obs.	140	353	227	353	227	352	226

Table 12: OLS estimates of the correlates of the intensity of US net imports from Mexico in the pre-NAFTA and post-NAFTA periods.

	(1)	(2)	(3)	(4)
Post-NAFTA years	1994-6	1994-6	1997-9	1997-9
Pollution measures	air&toxic	all	air&toxic	all
Dependent variable:	ratio of US net imports from Mexico to US domestic production			
Post-NAFTA dummy	.023**	.022**	.022	-.0048
	(.0033)	(.0046)	(.016)	(.028)
Industry dummies	incl.	incl.	incl.	incl
Injury rates	-.00066**	-.00052*	-.0014	-.00047
X post-NAFTA	(.00023)	(.00030)	(.0011)	(.0019)
Share of PACE	-.21**	-.30**	.063	.21
X post-NAFTA	(.10)	(.13)	(.49)	(.79)
Particulate matter	-.000056	-.00012	.00022	.00010
X post-NAFTA	(.00020)	(.00022)	(.00096)	(.0013)
Carbon monoxide	.00026**	.00028**	.00049	.00051
X post-NAFTA	(.00010)	(.00010)	(.00047)	(.00062)
Sulphur dioxide	.000007	.000058	-.00010	-.000060
X post-NAFTA	(.00017)	(.00017)	(.00078)	(.0011)
Nitrogen oxide	-.00031	-.00013	-.00076	-.00034
X post-NAFTA	(.00033)	(.00035)	(.0015)	(.0021)
Volatile organic	-.00041+	-.00039	-.00054	-.00026
X post-NAFTA	(.00026)	(.00027)	(.0012)	(.0017)
Toxic pollution	.00014	.000026	.000045	.0000060
X post NAFTA	(.00011)	(.00014)	(.00051)	(.00083)
Metal pollution		.00099**		.00088
X post-NAFTA		(.00047)		(.0028)
BOD		-.21		-.32
X post-NAFTA		(.26)		(1.56)
TSS		.0023		-.0024
X post-NAFTA		(.023)		(.14)
Constant	incl.	incl	incl	incl.
No. of obs.	2541	1473	2515	1467
R-squared	.31	.32	.47	.36

Table 13: OLS estimates of the correlates of US net import intensity from Mexico in the pre-NAFTA and post-NAFTA periods, allowing the increase in this intensity to differ among industries with varying physical and human capital intensities.

	(1)	(2)	(3)	(4)
Post-NAFTA years	1994-6	1994-6	1997-9	1997-9
Pollution measures	air&toxic	all	air&toxic	all
Dependent variable:	ratio of US net imports from Mexico to US domestic production.			
Post-NAFTA dummy	.027**	.011	.097**	.096+
	(.0054)	(.010)	(.025)	(.062)
Industry dummies				
Injury rates	-.0006**	-.0005+	-.0019*	-.0018
X post-NAFTA	(.0002)	(.0003)	(.0011)	(.0020)
Share of PACE	-.14	-.26*	.10	.056
X post-NAFTA	(.10)	(.13)	(.49)	(.80)
Particulate matter	-.00008	-.00009	-.000004	-.00005
X post-NAFTA	(.0002)	(.0002)	(.0010)	(.0013)
Carbon monoxide	.0003**	.0003**	.0009*	.0010+
X post-NAFTA	(.0001)	(.0001)	(.0005)	(.0006)
Sulphur dioxide	.00005	.00007	-.00001	-.00017
X post-NAFTA	(.0002)	(.0002)	(.0008)	(.0010)
Nitrogen oxide	-.0002	-.0002	-.0007	-.00041
X post-NAFTA	(.0003)	(.0003)	(.0015)	(.0021)
Volatile organic	-.0004	-.0003	-.0010	-.0003
X post-NAFTA	(.0003)	(.0003)	(.0012)	(.0017)
Toxic pollution	.0002*	.00005	.0003	-.0001
X post NAFTA	(.0001)	(.0001)	(.0005)	(.0008)
Metal pollution		.0009*		.0025
X post-NAFTA		(.0005)		(.0029)
BOD		.0020		-.54
X post-NAFTA		(.27)		(1.62)
TSS		-.011		.045
X post-NAFTA		(.023)		(.14)

human capital quintile-2	-.0027	.017**	-.015	.033
X post-NAFTA	(.0041)	(.0079)	(.020)	(.048)
human capital quintile-3	-.0083**	.011	-.025	.016
X post-NAFTA	(.0041)	(.0079)	(.020)	(.048)
human capital quintile-4	-.011**	.0056	-.032*	.0095
X post-NAFTA	(.0042)	(.0080)	(.020)	(.048)
human capital quintile-5	-.012**	.0057	-.12**	-.12**
X post-NAFTA	(.0044)	(.0083)	(.021)	(.050)
physical capital quintile-2	.0076*	.0011	-.0022	-.030
X post-NAFTA	(.0039)	(.0053)	(.018)	(.032)
physical capital quintile-3	.0080**	.0074	-.063**	-.13**
X post-NAFTA	(.0040)	(.0056)	(.019)	(.034)
physical capital quintile-4	.0042	.0060	-.030	-.061+
X post-NAFTA	(.0042)	(.0062)	(.020)	(.038)
physical capital quintile-5	-.011**	-.0091	-.062**	-.096**
X post-NAFTA	(.0046)	(.0073)	(.022)	(.044)
Constant	incl.	incl.	incl	incl.
No. of obs.	2541	1473	2515	1467
R-squared	.32	.33	.48	.48

Notes: The quintile with the highest physical or human capital share is quintile 5.

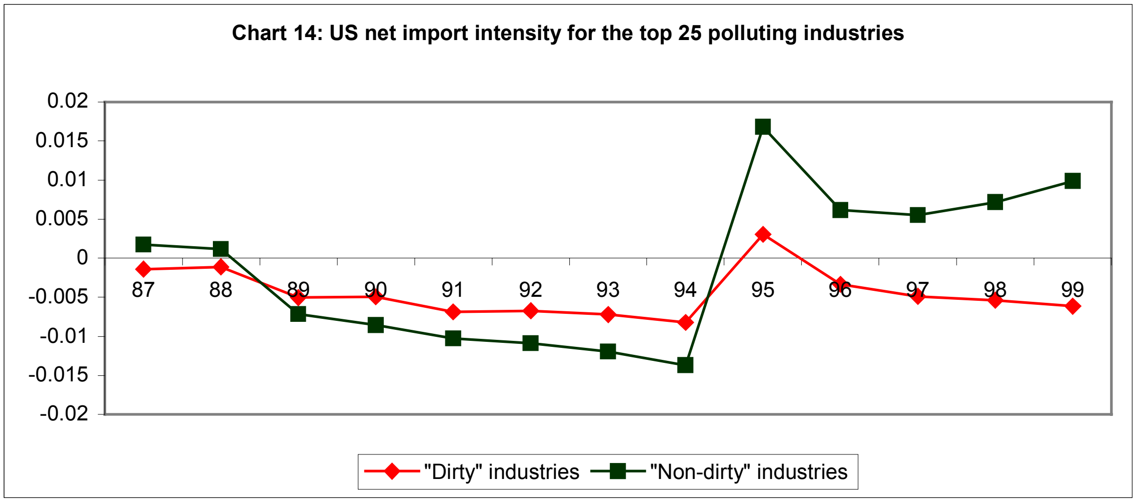


Chart 14: US net import intensity for the top 25 polluting industries
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
87 88 89 90 91 92 93 94 95 96 97 98 99
"Dirty" industries
"Non-dirty" industries

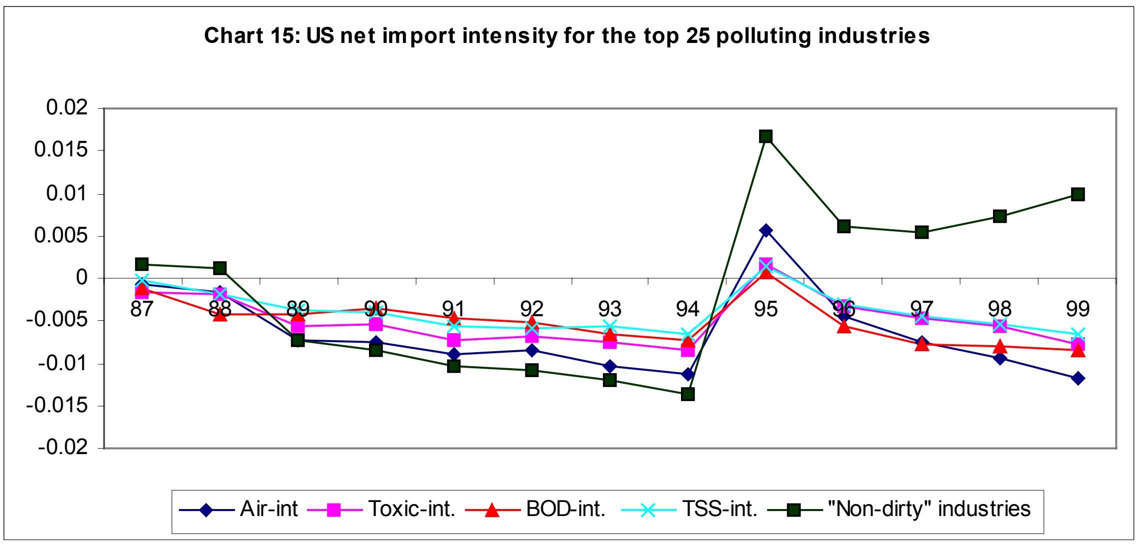


Chart 15: US net import intensity for the top 25 polluting industries
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
87 88 89 90 91 92 93 94 95 96 97 98 99
Air-int
Toxic-int.
BOD-int.
TSS-int.
"Non-dirty" industries

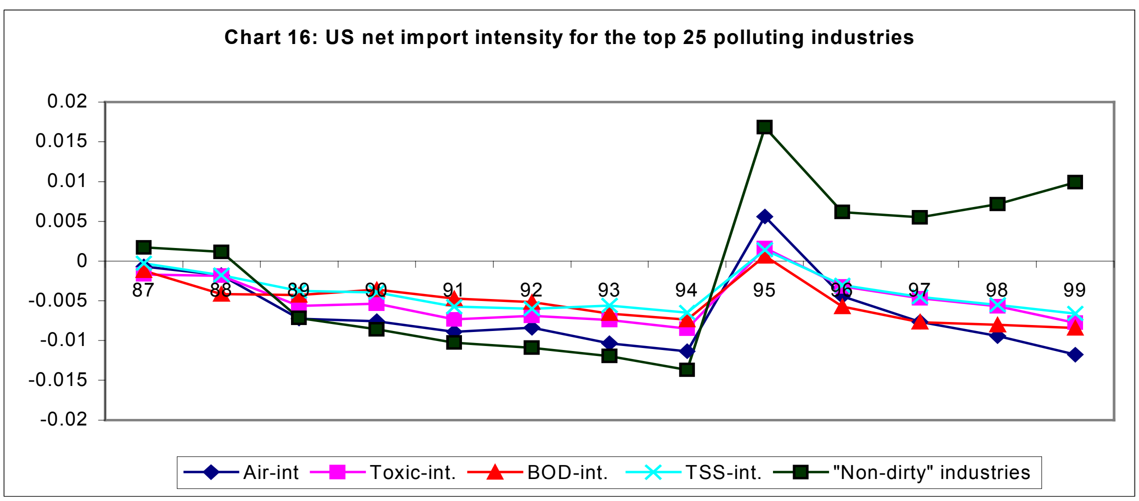


Chart 16: US net import intensity for the top 25 polluting industries
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
87 88 89 90 91 92 93 94 95 96 97 98 99
Air-int
Toxic-int.
BOD-int.
TSS-int.
"Non-dirty" industries

Chart 17: US net import intensity for polluting industries with lower physical capital share

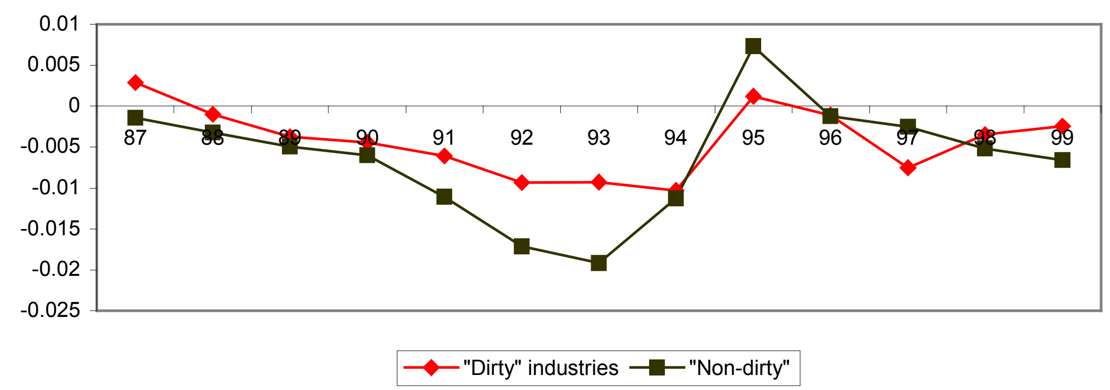


Chart 18: US net import intensity for polluting industries with lower physical capital share

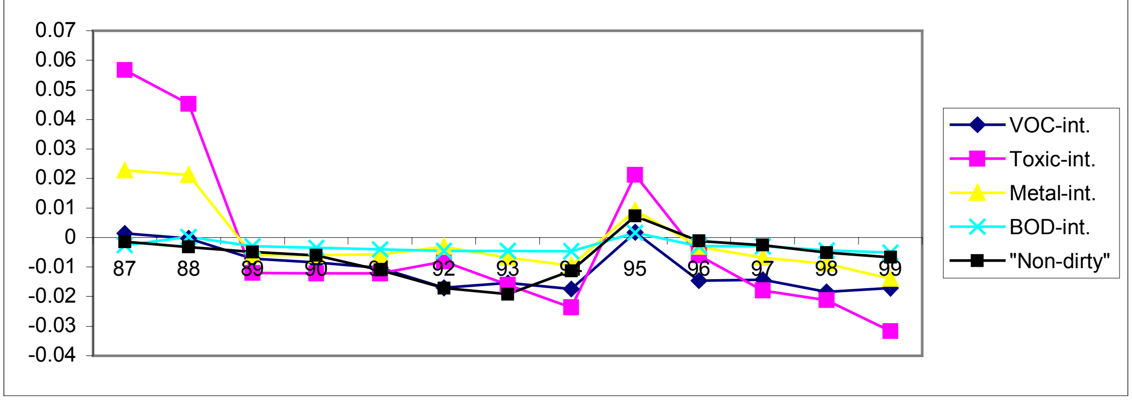
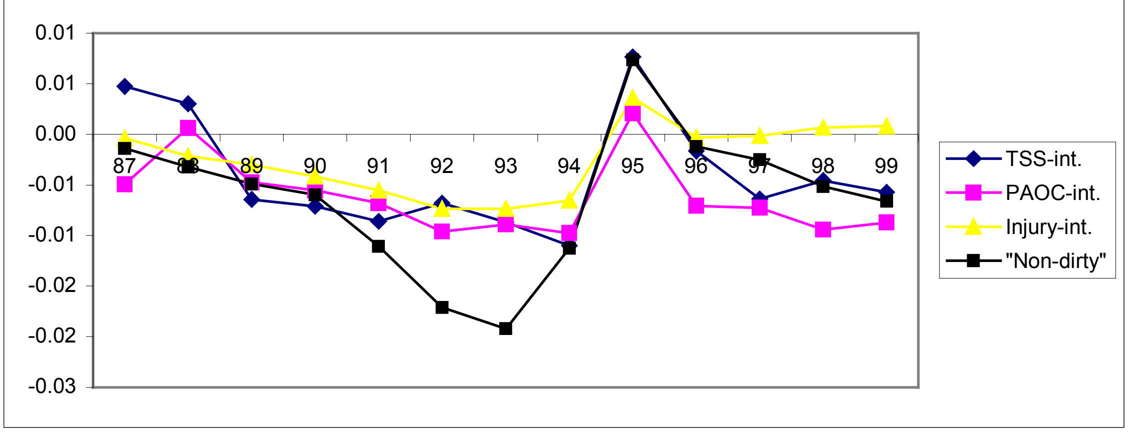


Chart 19: US net import intensity for polluting industries with lower physical capital share



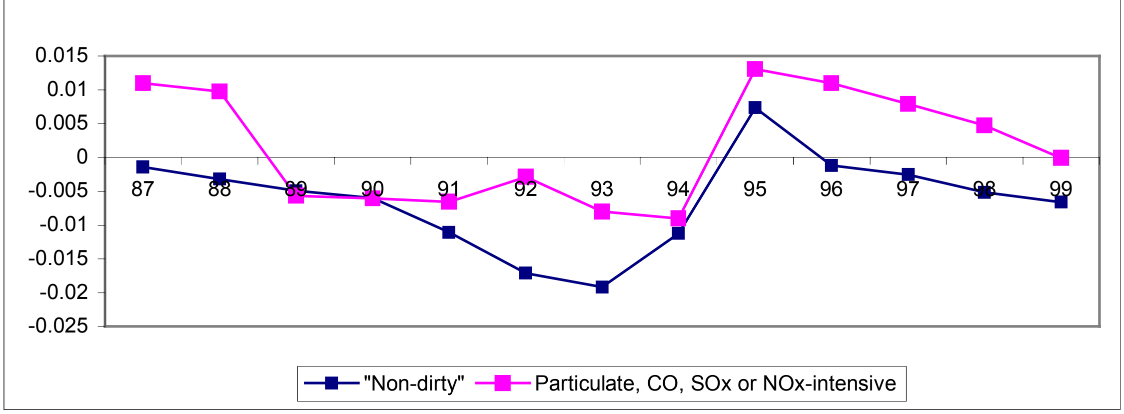


Chart 20: US net import intensity for polluting industries with lower physical capital share

Table 21: NAFTA related tariff reductions on Mexican imports of pollution abatement equipment

	Pre-NAFTA	1994	1998		Pre-NAFTA	1994	1998
Air pollution control eqpt	20%	18%	0%	**Water pollution eqpt**			
Dust collectors	20%	18%	0%	Flow meters	15%	12%	0%
Catalytic converters	10%	0%	0%	Barometers	10%	0%	0%
Gas analyzers	15%	0%	0%	Control valves	15%	13.5%	0%
Gas emissions testing eqpt	15%	0%	0%	Purifiers &deaerators	15%	12%	0%
Air filters	10%	0%	0%	Chlorinators	10%	8%	0%
Monitory emissions eqpt	10%	8%	0%	Centrifuges	15%	0%	0%
				Rotary pumps	20%	0%	0%
	Solid/hazardous waste disposal products						
Stabilizers	15%	0%	0%	Tank cars	10%	0%	0%
Containers	15%	13.5%	0%	Radiation detectors	10%	0%	0%
Garbage crushing machines	20%	0%	0%	Recycling equipment	15%	0%	0%

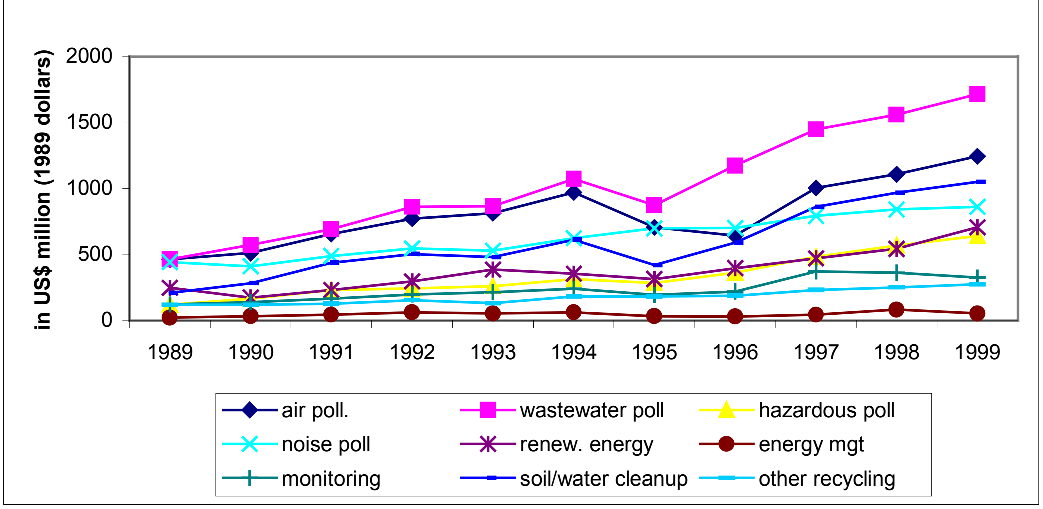


Chart 22: Mexican imports of pollution abatement equipment from the US

Table 23: No of annual violations of the air quality standard in Mexican border cities

City	Ciudad Juarez				Tijuana				Mexicali				Rosarito
Stations	1	2	3	4	1	2	3	4	1	2	3	4	
						CARBON MONOXIDE							
Year						Pre-NAFTA years							
1990	2												
1991	0	9											
1992	1	0											
1993	0	3											
						Post-NAFTA years							
1994	0	0											
1995	0	2			0								
1996	0	0	8		0	3	0						0
1997	0	0	19		0	2	0		21	38	44	46	0
1998	0	2	22		0	1	0		27	49	64	86	0
1999		0	10	0	0	0	0	0		24	24	38	0
2000		0	0	0									
						OZONE							
Year						Pre-NAFTA years							
1990	0												
1991	4.9	4.5											
1992	2	4.8											
1993	1.2	0											
						Post-NAFTA years							
1994	8.6	9.4											
1995	0	2.3			0								
1996	2.2	1.2	2.4		0	0	0						0
1997	2.7	7	2.3		1	1	0		9.4	8.1	10.6	9	2
1998	4.9	0	1.1		0	0	0		10.2	4.4	2.3	10.8	0
1999		0	0	0	0	0	0	12		14	8.3	19.9	0
2000		3.6	3.6	4.3									

Notes: Some figures are in fractions because AIRS uses an interpolation technique based on the actual number of violations to calculate actual number of violations. This technique is applied because observations differ across stations. Black cells indicate data in unavailable. The standard used is 9 ppm for the 8 hour maximum carbon monoxide concentration and.125 ppm for the 1 hour maximum ozone concentration.