MEXICO'S MANUFACTURING EXPORTS AND THE ENVIRONMENT UNDER NAFTA

Claudia Schatan

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ABSTRACT

This paper investigates whether the Mexican exporting industry has become more or less pollution oriented after NAFTA was launched and whether its exports have found a special comparative advantage in the most polluting areas. The analysis includes an insight of the Mexican export structure tendency, considering its technological content; an estimate of the industrial pollution increase linked to the export activity over the pre and post NAFTA period, as well as its decomposition in a "scale effect" and a "composition effect"; and finally, an analysis of the export most polluting sectors' competitiveness in the United States market.

The results of the study indicate that since NAFTA was launched there has not been a shift of the most polluting industry towards Mexico, albeit an intensification of such trade in some of these sectors between the latter country and its northern neighbor. Furthermore, Mexico has tended to specialize in technologically sophisticated products, which are comparatively less polluting than the more traditional manufactured export goods. Consistent with this characteristic was the result of the decomposition of the estimated pollution expansion linked to Mexican exports into two effects for the period 1992/93 – 1997/98. The positive and predominant "scale effect" and the negative "composition effect" indicate that the pollution expansion was a consequence of Mexican export's high rate of expansion rather than a greater weight of polluting sectors.

The former results have to be weighed with care since the reorientation of Mexican exports to technologically sophisticated products is only partial, as the country only accomplishes a portion of total production processes in the country and, often, particularly in the maquila industry, generates new environmental problems. Also, the most polluting branches of the Mexican exports, though growing at a lower rate than Mexican total exports, are still quite competitive in U.S. markets for those products.

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1. Introduction

One of the most controversial topics in the discussions that preceded the North American Free Trade Agreement (NAFTA) was the potential role of Mexico as a "pollution haven", given its lower environmental standards compared to its Northern counterparts. Five years after the Treaty's take-off, considerable changes can be observed in the Mexican economy, being its foreign sector the one that has suffered the greatest transformation. Exports expanded by 23.4 % on average between 1994 and 1998 practically doubling total sales abroad in that period. Within such total, manufactured exports including the maquila activities grew 24% annually and primary products did so by 14.5% (BADECEL, 1999). The Mexican export expansion to the U.S. was much more pronounced than the Canadian one over the same period, which averaged 7.1% annually.

Although it is impossible to know exactly how much of the Mexican export performance was stimulated by the devaluation suffered by the peso in December of 1994, which was the start of a deep economic crisis in the country, and how much was the result of the NAFTA favorable conditions for Mexican exports heading to the U.S., the latter undoubtedly had an important role as it gave way to lower tariffs (these fell from around 2.5% in 1990-1993 to 0.45% in 1998[2]), elimination of quotas, substantial increase in FDI in manufactured export activities, among other things.

Trade liberalization had started (since 1987) several years before NAFTA was signed in 1994 and, therefore, that treaty deepened an ongoing process. As a consequence

[2] See Dussel, 2000.

of trade openness there mainly was a reorientation of the manufacturing sector toward the foreign market.[3]

This paper intends to investigate whether the Mexican exporting industry has become more or less pollution oriented after NAFTA was launched and whether its exports have found a special comparative advantage in the most polluting areas. In what follows, the second section of the paper gives an overview of recent trends in the Mexican and Canadian export sector, including its specialization change according to the technological level of exports. In the third section, an estimate of the emissions originated in Mexican exports between the pre and post NAFTA period is presented as well as a calculation of the "scale" and the "composition" effects which, in principle, explain the variation of the estimated pollution during the period under study. Fourthly, an analysis of the Mexican and Canadian most polluting sectors competitive position in the U.S. market is done. Fifth, some links between foreign direct investment (FDI), manufacturing exports and environment will be developed. The paper ends with a short conclusions section.

2. Export trends

Mexico has experienced a dramatic change both in its export dynamism as well as in its export structure since the seventies, but this tendency deepened during the nineties, particularly following NAFTA's start and the December 1994 devaluation. As seen in Table 1, in Mexico in 1977 73% of total exports consisted of primary products and natural resources intensive goods, while in 1996 this proportion had fallen to 22%[4]. In the same way, the high and the intermediate technology exports became much more conspicuous

[3] The present paper does not intend to characterize the Mexican economy as a whole, but only its export sector.

over the same period. In the first case, its participation went up from 10% in 1977 to 30% in 1996 and in the second case, from 5% to 27%.

This tendency is much more pronounced than that experienced by Canada. Primary goods and natural resources intensive goods exports participation from that country to the U.S. fell from 63% to 41% between 1977 and 1996. The intermediate technology exports rose from 25 to 32% and the high technology exports reached only 10% of total exports by 1996 (see Table 1).

As compared to the rest of Latin America, Mexico was perhaps the only country that experienced the mentioned above deep export structure changes. Brazil, the other most industrialized country in Latin America besides Mexico, had 80% of its total exports in the primary goods and natural resources intensive goods category in 1977 and in 1996 the participation of these goods was still 61% of total exports [5] [6].

In Mexico the high technology sectors that concentrated the export drive were mainly the computers and other electronic equipment and the automobile industry, while it was the pharmaceutical industry and other branches of the chemical industry that did so in the intermediate technology industry. Apparel was outstanding as to export expansion in the lower technology level (Mortimore, Buitelaar and Bonifaz, 2000). With the exception of the chemical industry and to a lesser extent iron and steel, most of the particularly dynamic manufactured exports during 1994 – 1998 were not intensive in natural resources nor were they particularly polluting.

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[4] In 1977 59% of total Mexican exports were primary goods and 15% were natural resources intensive products, while in 1996 these had fallen to 15% and 7% respectively (see Table 1).
[5] Calculations based in CANPLUS, CEPAL.
[6] For an analysis of the impact of economic reforms on the environment in Latin American countries, see Schaper (1999) and Schatan (2000).

TABLE 1

PRIMARY PRODUCTS, NATURAL RESOURCES INTENSIVE PRODUCTS AND TECHNOLOGY LEVEL OF MEXICAN AND CANADIAN EXPORTS

PRODUCT PARTICIPATION ACCORDING TO TECHNOLOGY VECTOR OF MEXICAN EXPORTS

	1977	1980	1985	1990	1991	1992	1993	1994	1995	1996
A. Primary Products	59.3	60.3	51.3	28.9	27.1	23.3	19.8	17.5	15.8	15.4
B. Natural Resources Intensive Goods	13.8	13.7	11.8	9.5	8.4	7.8	7.5	7.6	7.3	7.4
C. Low Technology	8.9	6.3	7.7	12.9	13.5	14.3	14.9	15.7	16.4	16.8
D. Intermediate Technology	5.4	4.2	10.9	19.5	21.5	23.4	24.5	25.3	26.4	26.9
E. High Technology	9.9	11.6	15.7	25.3	25.9	27.4	29.5	30.2	30.3	29.9
F. Others	2.6	3.9	2.6	4.0	3.7	3.8	3.8	3.8	3.7	3.7
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

PRODUCT PARTICIPATION ACCORDING TO TECHNOLOGY VECTOR OF CANADIAN EXPORTS

	1977	1980	1985	1990	1991	1992	1993	1994	1995	1996
A. Primary Products	30.1	25.9	19.5	16.8	17.1	16.5	15.7	14.9	14.7	14.7
B. Natural Resources Intensive Goods	32.7	34.4	26.8	28.7	27.4	26.5	25.8	25.9	25.6	25.8
C. Low Technology	6.3	7.2	7.7	8.1	8.3	8.8	9.5	10.1	10.7	10.9
D. Intermediate Technology	24.8	22.5	33.2	31.3	31.2	32.2	33.5	33.6	32.9	32.3
E. High Technology	3.2	4.8	6.5	9.2	9.8	9.7	9.2	9.3	9.8	10.1
F. Others	3.0	5.2	6.4	6.0	6.2	6.3	6.4	6.2	6.2	6.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Calculations based on CANPLUS (CEPAL) and Péres and Alcorta (1998).

Another important characteristic of Mexican export is the increasing participation of the maquila industry. In fact, the exports originated in the maquila activity reached, on average, 41.5% of total exports between 1993 and 1998[7] (Dussel Peters, 2000). Interestingly, by 1996, 83% of the apparel exports, 75% of the plastic products exports, 73% of electric machinery and electronic exports (including computers, TV, etc. and its parts), 65% of the transport industry (including automobiles and autoparts) exports came from the maquila industry.[8]

[7] This percentage refers to gross exports and not the value added of the maquila industry.
[8] Information from Instituto Nacional de Geografía e Informática (INEGI), Mexico.

Finally, it is interesting to observe the export/import coefficients in the Mexican manufacturing industry since it can give some indication of the shift in export specialization[9]. Sectors which experience an important increase in this coefficient may be presenting a greater specialization in that kind of exports, while those which experienced a fall in such indicator may be experiencing an import penetration of that good. The sectors which underwent the greatest increase in X/M coefficient between 1992 and 1998 were footwear (324), beverages (313), furniture (332) and transport equipment (384) (including the automobile industry) (see Table 2), all of which are not particularly polluting. The most polluting industries, i.e., the chemical industry (351), non-ferrous metals (372), leather products (323), paper and cellulose (341) as well as oil refinery (353) experienced a fall in its X/M coefficient. Only a few of the most polluting sectors – other chemicals (352), iron and steel (371) had a slight rise in that indicator. That is, though its exports were quite dynamic, its imports were more so, which suggests that there was no shift of this very polluting industry toward Mexico as a result of NAFTA, but rather, an intensification of trade (Table 2).

The chemical sector (including the petrochemical area) deserves special attention, given the fact that it is the most polluting industry of all. Notwithstanding this sector's exports were not as dynamic as the electronics and automobile branches, it still grew at very high rates in the nineties (17.7% in the case of Mexico and 14.4% in the case of Canada, annually between 1990 and 1998, and even more so in the case of Mexico after NAFTA, i.e. in 1995 - 1998). There was a tendency for chemical exports from Mexico and

[9] It was not possible to calculate these coefficients for Canada because BADECEL does not count with Canadian imports and exports in ISIC, Rev. 2 classification, which is necessary to identify each category with pollution emissions of the Industrial Pollution Projection System (IPPS).

Canada, but especially from the first country, to concentrate in the most dynamic chemical US markets.

The chemical and petrochemical industry, nevertheless, does not seem to have the "pollution haven" seeking drive. In fact, it has always been of a global character and much of its international trade is intra-firm. In 1994, two thirds of this US industry's exports went to US based companies' foreign branches, while more than half of US chemical imports came from foreign affiliates to parent US based companies (Mowery and Nelson, 1999). The US chemical industry based from the beginning its competitiveness in its natural resources endowment, initially wood and mineral resources and later oil. Petrochemicals have been the greatest strength of this sector in the United States and in 1940 it accounted for 71% of the world refining capacity (Mowery and Nelson, 1999).

The oil shocks of the 1970s, reduced demand, increased costs and lowered the profitability of petrochemicals in the US. Many of them, which had become "commodities", started being produced in Mexico, whose abundance of oil made it particularly attractive as well as its state subsidized price for the petrochemical industry. The chemical industry in the United States (as well as in other industrialized countries) has since upgraded its production towards higher value added goods occupying new nitches of international competitiveness. US chemical and petrochemical enterprises are usually trying to narrow down their specialization, according to the comparative advantage they have been able to develop since the seventies, with high technology, while leaving mass production of commodities to developing countries (Mowery and Nelson, 1999).

A first approach to the topic of exports and pollution in Mexico suggests a quick tendency of this country to specialize in technologically sophisticated products, which are comparatively less polluting than the more traditional manufactured export products.

Hence, there does not seem to be a shift of the most polluting industry toward Mexico. In the cases where commodities, such as the chemical industry (351), have expanded their exports at a high rate, so have their imports, which suggests a greater intensification of trade but not a shift of such production from other countries to Mexico.

TABLE 2

Mexican Manufactured X/M Coefficients a/

		1992	1993	1994	1995	1996	1997	1998
Food products	311	0.20	0.22	0.23	0.48	0.51	0.49	0.50
Beverage	313	1.11	1.03	1.20	3.33	3.63	4.10	4.54
Tobacco	314	25.30	50.33	13.74	18.38	23.84	6.82	6.56
Textiles	321	0.56	0.49	0.46	0.77	0.74	0.72	0.61
Apparel	322	0.87	0.93	0.95	1.45	1.59	1.72	1.80
Leather Prods.	323	0.69	0.78	0.72	0.91	0.79	0.70	0.57
Footwear	324	1.18	1.25	1.00	3.12	7.72	7.03	5.60
Wood Prods.	331	0.53	0.62	0.53	1.03	1.28	1.23	0.98
Furniture	332	1.51	1.69	1.61	2.34	3.03	3.15	3.02
Paper and cellulose	341	0.29	0.26	0.15	0.23	0.23	0.23	0.23
Printed materials	342	0.31	0.31	0.26	0.46	0.48	0.54	0.54
Chemical Industy	351	0.52	0.47	0.46	0.64	0.49	0.42	0.36
Other Chemicals	352	0.44	0.40	0.42	0.67	0.61	0.65	0.64
Oil Refinery	353	0.41	0.52	0.38	0.48	0.39	0.31	0.27
Oil and Coal Prods	354	0.11	0.10	0.09	0.35	0.29	0.33	0.42
Rubber Prods	355	0.12	0.17	0.19	0.29	0.23	0.24	0.24
Plastic Prods	356	0.28	0.33	0.28	0.28	0.28	0.28	0.28
Cerámic	361	1.25	1.27	1.39	1.86	1.59	1.69	1.74
Glass	362	1.15	1.17	0.94	0.98	0.76	0.76	0.90
Other Non Metalic Minerals	369	1.02	0.98	0.81	1.41	1.52	1.46	1.36
Iron and Steel	371	0.35	0.48	0.48	1.28	0.92	0.89	0.67
Non Ferrous Metals	372	1.07	1.10	0.93	1.61	1.21	0.91	0.69
Metal Prods	381	0.44	0.49	0.47	0.47	0.54	0.58	0.56
Non electric machinery	382	0.33	0.39	0.45	0.69	0.70	0.74	0.75
Electric machinery	383	1.05	1.10	1.11	1.21	1.17	1.14	1.11
Transport equipment	384	0.79	0.94	0.96	1.81	2.24	1.86	1.82
Scientific and professional instruments	385	0.54	0.58	0.52	0.68	0.73	0.86	0.92
Other Manufactures	390	0.93	0.93	0.91	1.61	1.54	1.32	1.26
Total		0.61	0.68	0.68	0.98	0.98	0.94	0.92

a/ Includes maquiladora imports and exports.
Source: BADECEL

3. Pollution and Manufactured exports in Mexico

The purpose of this section is to estimate the polluting impact of export expansion at an aggregated and a disaggregated level in the post NAFTA period 1992/93-1997/98, i.e. just before the agreement was signed and the latest period for which data was available. A distinction will be made between the pollution expansion generated by a "scale effect" and that caused by a "composition effect"[10].

3.1. Methodology and sources of information.

In this section the paper will analyze the pollution change for 28 manufacturing sectors over the period 1992/93-1997/98. The information on exports was taken from BADECEL data basis, ISIC Rev. 2 classification with a 3 digit aggregation. The information on the pollution by sector was taken from the Industrial Pollution Projection System (IPPS), World Bank (Hettige, Martin, Singh y Wheeler, 1995), which is also available in the ISIC Rev. 2 classification. This information consists of the number of tons that each sector emits per US$ 1,000 of 1987 produced (in our case we limit the analysis to production for exports). This figure, multiplied by the amount of dollars exported (in thousands), provides an estimate of the tons of pollution produced for the years considered in the study[11].

Since BADECEL exports from Mexico information includes the maquila since 1992, it was necessary to subtract such amount from each export category. The reason for this is that the international fragmentation of the producing process leaves completely undetermined what amount of the total pollution process is generated in Mexico. At the

[10] If we could count with observed information on pollution variation between the two periods under study and our estimated pollution variation, the difference would mostly be a "technological effect", i.e., the change in pollution attributable to a change in technology. This effect could not be calculated because we lack information for that purpose.

same time, the fact that the maquila industry is frequently located in sites with little infrastructure and few sanitary services changes considerably the profile of environmental problems of this industry if compared to the IPPS criteria.

The source for maquila exports for each sector was taken from INEGI, which uses the Standards International Trade Classification (SITC). Since it was impossible to convert the latter into the ISIC Rev. 2 classification, the percentage of maquila exports in each INEGI sector where these kind of exports exist was taken as an approximation and applied to the closest ISIC sectors for the BADECEL information. Therefore, the latter exports minus maquila is an approximation.

The methodology used was the following:

$$\Delta P = (ti*xi_2 - ti*xi_1) = \text{scale effect} + \text{composition effect}$$

$$= \{[xi_1 * (X_2 / X_1)] * ti - (xi_1 * ti)\} + \{[(xi_2 * ti) - (xi_1 * ti)] - [(xi_1 * (X_2 / X_1)) * ti - (xi_1 * ti)]\}$$

$$\text{Scale effect} = \{[xi_1 * (X_2 / X_1)] * ti - (xi_1 * ti)\}$$

$$\text{Composition effect} = \{[(xi_2 * ti) - (xi_1 * ti)] - [(xi_1 * (X_2 / X_1)) * ti - (xi_1 * ti)]\}$$

Where:

ΔP : is the pollution change between period 1 and period 2.
ti : total pollution index for sector i.
xi_1: manufactured exports of sector i in period 1.
xi_2: manufactured exports of sector i in period 2.

$X_1 = \Sigma xi_1$
$X_2 = \Sigma xi_2$
$i = 1,2,\ldots\ldots, 28.$

The exports of period 1 of each of the 28 industrial sectors was multiplied by the growth of total exports index between period 1 and period 2. This result was, in turn, multiplied by the pollution index, which gives an estimate of the amount of pollution that would have been

[11] It was not possible to make this estimate for Canadian exports since BADECEL information for such country is not available in the ISIC classification, which is needed to be able to relate them to emissions in the

emitted if all sectors had expanded at the average rate of growth of aggregate exports. The difference between this hypothetical emission and that of period 1 is the "scale effect".

If we subtract from the scale effect the pollution of period 2, then we obtain the "composition effect". All difference between the "scale effect" and the estimated pollution in year 2 is attributed to a change in composition of exports ("composition effect").

3.2. Scale and Composition Effects: Results.

Total manufacturing Mexican exports expanded by 171% in the period 1992/93 – 1997/98 (Table 3) and the pollution resulting from manufacturing export activity was estimated to have expanded by 86.9% during that same period, that is, an increase of 30.4 million tons of pollutants (see Table 4). This estimated figure was a result of the export dynamism ("scale effect") which would have, by itself, been responsible for an increase of 59.8 million tons of pollution if it had not been offset partially by the contraction of 29.4 million tons resulting from a change in the composition of exports ("composition effect") in favor of less polluting export sectors. In other words, if there had not been an expansion of manufacturing exports, pollution would have diminished in absolute terms, given the lesser weight of the most polluting sectors in total exports in the last period.

More specifically, most of the highly polluting export sectors contributed to the former results. At a disaggregated level, in fact, with the exception of Iron and Steel, the most important polluting sectors, namely, the chemical industry, oil refinery and non-ferrous metals, had a negative "composition effect". Also, other industries close to the highest polluting such as Paper and Cellulose and Plastic Products, experienced a negative "composition effect" (Table 4).

IPPS.

The technologically more sophisticated manufactured exports, whose weight in total exports increased the most - non-electric machinery, electric machinery and transport equipment – undoubtedly generated greater pollution as a result of the change in composition in their favor, but the pollution resulting from such “composition effect” was much lower than it would have been if the structure of exports had changed in favor of the sectors with the greatest emissions per unit of output. In fact, as mentioned before, the negative composition effect of the high pollution sectors outweighed by far the positive composition effect of the winning sectors.

Table 3
Manufacturing Exports Excluding Maquila
US$ Millions

ISIC Rev. 2	Classification	x1 1992-1993a/	x2 1997-1998a/
311	Food products	483,560	1,405,494
313	Beverages	201,596	601,813
314	Tobacco	172,509	63,380
321	Textiles	297,831	1,182,304
322	Apparel	156,073	1,011,853
323	Leather products	111,731	280,208
324	Footwear	108,580	193,436
331	Wood products	280,268	469,469
332	Furniture	120,740	480,148
341	Paper and cellulose	327,507	433,977
342	Printed materials	133,084	303,652
351	Chemical industry	2,063,420	3,112,337
352	Other chemicals	585,162	1,662,112
353	Oil Refinery	567,188	582,655
354	Oil and coal products	10,132	88,561
355	Rubber Products	42,012	296,565
356	Plastic products	163,352	337,312
361	Ceramic	118,950	267,919
362	Glass	503,428	832,910
369	Other non metal mineral	169,854	443,669
371	Iron and steel	838,864	2,557,085
372	Non ferrous metals	991,071	1,655,353
381	Metal products	530,630	1,708,705
382	Non electric machinery	2,298,567	8,925,053
383	Electric machinery	2,547,612	7,901,354
384	Transport equipment	2,581,857	7,585,859
385	Scientific and professional instruments	889,660	2,595,957
390	Other manufactured products	335,521	807,914
	Total	17,630,755	47,787,050

a/ Simple average.

Table 4

Decomposition of Mexican industry pollution increase in the period 1992/93 - 1997/98

Classification ISIC Rev. 2	ti tons per million dollars of 1987	xi1*ti tons 1992-1993	xi2*ti tons 1997-1998	**Scale Effect a/** tons	**Composition Effect a/** tons
311 Food products	0.11	53,551	155,649	91,596	10,502
313 Beverages	0.07	14,883	44,430	25,457	4,090
314 Tobacco	0.14	23,520	8,641	40,230	-55,109
321 Textiles	0.41	123,016	488,337	210,410	154,911
322 Apparel	0.01	1,238	8,029	2,118	4,672
323 Leather products	2.33	260,765	653,968	446,022	-52,819
324 Footwear	0.22	23,956	42,678	40,976	-22,254
331 Wood products	0.18	49,838	83,482	85,245	-51,601
332 Furniture	0.69	83,077	330,371	142,097	105,197
341 Paper and cellulose	1.66	543,180	719,764	929,075	-752,491
342 Printed materials	0.21	28,308	64,589	48,419	-12,138
351 Chemical industry	9.95	20,532,098	30,969,365	35,118,858	-24,681,590
352 Other chemicals	1.37	799,611	2,271,239	1,367,684	103,944
353 Oil Refinery	1.46	830,423	853,068	1,420,386	-1,397,741
354 Oil and coal products	0.24	2,422	21,167	4,142	14,603
355 Rubber products	0.53	22,419	158,259	38,347	97,493
356 Plastic products	1.12	182,452	376,752	312,073	-117,773
361 Ceramic	0.55	64,952	146,297	111,097	-29,752
362 Glass	0.17	83,299	137,816	142,477	-87,960
369 Other non metal mineral	0.46	78,173	204,192	133,710	-7,691
371 Iron and steel	3.17	2,656,835	8,098,758	4,544,348	897,575
372 Non ferrous metals	5.00	4,956,405	8,278,523	8,477,618	-5,155,500
381 Metal products	0.81	430,825	1,387,318	736,899	219,594
382 Non electric machinery	0.23	529,514	2,056,038	905,700	620,824
383 Electric machinery	0.54	1,384,941	4,295,358	2,368,854	541,564
384 Transport equipment	0.36	928,692	2,728,628	1,588,469	211,467
385 Scientific and professional instruments	0.22	199,385	581,790	341,036	41,369
390 Other manufactured products	0.27	89,179	214,736	152,534	-26,976
Total		34,976,956	65,379,243	59,825,877	-29,423,590

a/ The addition of the scale and the composition effect is equal to the estimated variation of pollution between period 1 and period 2, i.e., xi2*ti – xi1*ti.

4. Competitiveness of polluting sectors.

In the previous two sections it was possible to appreciate that, with some exceptions, Mexico's export drive has concentrated in technologically sophisticated sectors in recent years, which, at the same time, is comparatively less polluting. Nevertheless, this does not give a complete picture of the position of polluting sectors in the international market, particularly the NAFTA market, of main interest here. In this section the competitiveness of 25 Mexican manufacturing most polluting export sectors in the U.S. market is examined, and the same is done for Canada as a point of reference for the Mexican experience within NAFTA.

For the competitiveness analysis, the Module to Analyse the Growth of International Commerce (MAGIC) of ECLAC was used. This is a computational program that was designed as a tool to study the changes in the trade flows that have occurred between Latin American countries and the United States since 1990. The information is classified according to the Harmonized System (HS). Although the IPPS, which is in ISIC Rev. 2 classification, could not be applied to the HS, since the former information is not sufficiently disaggregated, a categorization was done at the 2 digit HS level, from higher to lower pollution levels, based on the IPPS classification (Table A-1).

Table 5 shows the value of the most polluting exports from Mexico and Canada to the United States during the period 1990-1998 at the aggregate level.

Table 5
Most Polluting Exports as percentage in total Exports from Mexico and Canada to the United States

	98	97	96	95	94	93	92	91	90
Mexico									
Most Polluting Manuf. Exports (% of Total Mexican Manuf. Exports to US)	11.6	16.0	15.8	16.9	16.7	18.2	19.8	21.4	24.8
Most Polluting Manuf. Exports Minus Oil exports (% of Total Mexican Manuf. Exports to US)	6.03	6.20	6.50	7.40	6.34	5.95	6.31	6.32	7.21
Canada									
Most Polluting Manuf. Exports (% of Total Canadian Manuf. Exports to US)	27.5	30.4	30.8	30.7	29.3	30.4	31.3	32.0	31.3
Most Polluting Manuf. Exports Minus Oil exports (% of Total Canadian Manuf. Exports to US)	19.1	19.7	20.0	21.3	19.5	19.8	20.5	20.7	20.5

Source: MAGIC.

Table 6

USA Imports from Mexico, Most Polluting Sectors
(Thousands of Dollars)

Harmonized System Clas. a/		1998	1997	1996	1995	1994	1993	1992	1991	1990
28	INORGANIC CHEMICALS;	223,413	279,583	246,735	240,299	243,923	181,014	195,494	182,385	236,398
29	ORGANIC CHEMICALS	358,580	406,324	351,901	370,732	285,916	223,233	300,656	256,821	164,442
32	TANNING OR DYEING EXTRACTS;	63,846	54,464	41,461	31,252	29,521	30,988	30,102	28,742	38,669
71	PRECIOUS STONES AND METALS;	577,725	445,015	498,630	394,894	294,242	260,882	275,638	230,217	283,248
75	NICKEL AND ARTICLES	1,004	636	692	383	286	452	773	596	249
76	ALUMINUM AND ARTICLES	319,818	300,452	259,471	280,047	172,891	121,806	122,563	104,992	107,791
78	LEAD AND ARTICLES	35,289	45,188	46,526	36,301	18,552	17,930	32,788	15,575	25,249
79	ZINC AND ARTICLES	126,422	143,718	108,719	109,835	96,159	100,278	50,875	65,728	119,377
80	TIN AND ARTICLES	2,955	2,316	1,966	998	1,010	4,150	2,735	5,984	21,977
74	COPPER AND ARTICLES	660,264	499,193	450,726	628,875	303,822	256,695	211,495	168,275	201,018
81	BASE METALS	10,435	10,547	10,508	9,163	9,970	10,423	9,688	11,946	12,183
27	MINERAL FUELS AND OILS AND PRODUCTS	5,308,913	8,419,663	6,798,428	5,836,865	5,106,514	4,874,777	4,736,831	4,684,933	5,288,108
39	PLASTICS AND ARTICLES	940,102	820,491	715,645	660,129	500,349	377,513	342,944	300,919	241,695
72	IRON AND STEEL	1,055,984	1,136,646	990,254	849,110	578,310	334,478	231,742	227,713	278,900
56	WADDING, FELT AND NONWOVEN; SPECIAL YARNS	93,167	96,563	69,814	41,751	34,266	29,063	22,880	20,088	23,187
59	IMPREG., COATED, COVERED OR LAM. TEXTILE FABRICS;	38,651	29,859	29,699	26,463	24,788	20,629	12,348	12,677	8,919
48	PAPER AND PAPERBOARD AND ARTICLES	432,742	367,305	304,506	351,150	161,562	124,823	135,457	120,485	193,168
31	FERTILIZERS	25,048	31,800	86,352	86,358	40,952	14,212	13,018	14,942	14,692
30	PHARMACEUTICALS	24,581	22,072	19,358	12,657	9,072	10,806	8,154	6,258	3,053
33	ESSENTIAL OILS AND RESINOIDS;	87,015	63,095	51,661	45,085	26,154	20,814	18,742	13,651	16,116
35	ALBUMINOIDAL SUBSTANCES	9,836	7,418	11,375	12,149	6,279	3,322	2,667	1,961	2,682
36	EXPLOSIVES; PYROTECHNIC PRODUCTS	13,642	11,676	9,915	7,393	5,270	5,666	2,386	547	803
38	MISCELLANEOUS CHEMICAL PRODUCTS	159,975	164,435	90,775	59,879	60,478	54,251	50,745	50,321	49,477
15	ANIMAL OR VEGETABLE FATS AND OILS	46,054	29,955	56,778	53,013	40,765	31,706	27,396	33,204	18,416
40	RUBBER AND ART.	399,641	346,054	282,932	253,558	187,640	136,440	116,377	95,887	112,735
Total Most Polluting		11,015,102	13,734,468	11,534,827	10,398,339	8,238,691	7,246,351	6,954,494	6,654,847	7,462,552

a/ See Table 1-A for classification of industrial sectors from greater to lower level of pollution.

Source: MAGIC, ECLAC

From the data processed above it is clear that Mexico is not specialized in highly polluting exports to the United States, as seen in Table 5. The most polluting exports have

been decreasing as a percentage of total manufacturing exports. In fact, while 24.8% of these belonged to that category in 1990, in 1998 this share had fallen to 11.6%. If oil exports are excluded, then this reduction in the participation of the highest polluting sectors is much less pronounced, from 7.2 to 6.0%.

Mexico's exports are much less specialized in pollution sectors than Canada. In the latter case, 31.3% of total manufacturing exports were highly polluting in 1990 and this figure had fallen to 27.5% in 1998. If oil is excluded, then these percentages are 20.5 and 19.1 respectively.

At a more disaggregated level, in the Mexican case, besides mineral fuels and oils, the other most polluting sectors with the greatest weight in total value of manufacturing exports to the US in 1998 were in order of importance, iron and steel, plastics and articles, copper and articles and precious stones and metals (Table 6). Following the same criteria, in the Canadian case, those non-oil polluting sectors with the greatest presence were paper and paperboard, plastic and articles, aluminum and articles and precious stones and metals, also in order of value of exports (not shown in table).

This picture, however, does not provide a precise idea on how competitive the Mexican and the Canadian highly polluting exports are in the US market. In this sense, Table 7 shows additional interesting information. Exports from Mexico and Canada are categorized according to whether they are experiencing (i) "retreats", i. e., those exports which lose participation in that particular US goods market and, additionally, that US market grows at a lower rate than total US imports; (ii) "missed opportunities", exports to the US which lose its market participation in the US, while at the same time such market is dynamic as compared to the total US imports; (iii) "declining stars" are those exports which gain a greater presence in that good's market in the US, but such market is relatively

stagnant as compared to total US import market; and (iv) “rising stars”, exports which gain a greater participation in that particular U.S. goods market, and at the same time that market is winning a greater weight in total US imports.

Mexico and Canada seem to have considerably different performances. While more than half of Canada’s exports (53%) of the most polluting goods were either retreating or missing opportunities in the US markets in 1998, almost all Mexican exports of this sort were gaining greater presence in these US markets at the end of the nineties. In this way, 93% of Mexican most polluting exports were either “declining stars” or “rising stars”. Of these, most belonged to the category of “declining stars”, i.e., though these markets were declining in the United States, Mexico was maintaining a competitive stance in them (see Table 7).

In short, Canadian export specialization was much more pollution prone than the Mexican exports in the nineties and both countries’ most polluting sectors were losing weight in total exports to the U.S., hence they were not becoming more specialized in these kind of exports. In neither case did NAFTA seem to have promoted a greater specialization in pollution intensive exports. Nevertheless, there was a qualitative difference in their competitive position by which Mexico, in contrast with Canada, seemed to have been increasing its comparative advantage in several of those highly polluting markets, while Canada was leaving most of them. In other words, although in Mexico these sectors were less dynamic than the average rate of export growth, they still were considerably more dynamic than the U.S. markets to which they were being exported, and hence, were gaining a greater share of them.

Table 7

Mexico and Canada Export Structure according to Competitiveness
(%)

Exports from most polluting sectors % of Total Mexico-USA Exports									
Competitiveness of Products a/	**98**	**97**	**96**	**95**	**94**	**93**	**92**	**91**	**90**
Retreats	3.8	3.5	4.3	4.7	5.1	4.5	4.1	4.5	5.2
Missed Opportunities	3.6	3.2	3.3	3.8	3.7	3.4	4.6	4.1	2.4
Declining Stars	71.5	78.8	77.1	76.3	77.8	79.9	78.9	80.2	81.4
Rising Stars	21.1	14.5	15.3	15.2	13.4	12.3	12.3	11.2	10.9
Exports from most polluting sectors % of Total Canada-USA Exports									
Competitiveness of Products a/	**98**	**97**	**96**	**95**	**94**	**93**	**92**	**91**	**90**
Retreats	25.1	25.0	25.0	26.8	26.9	25.3	26.3	25.1	26.8
Missed Opportunities	28.0	25.4	26.7	29.0	26.4	28.1	28.5	29.6	28.6
Declining Stars	34.9	38.9	38.5	34.4	37.6	38.7	38.2	38.9	38.1
Rising Stars	12.0	10.7	9.8	9.9	9.1	7.8	7.1	6.4	6.5

Source: MAGIC.
a/ Refers to the competitive position of products in the post NAFTA period: 1994-1998.

5. Investment, export specialization and pollution in Mexico.

Contrary to what could be thought, the change in the Mexican manufacturing sector, excluding the maquila industry, was not too deep in the period that followed the economic reform of the eighties. NAFTA started off with a relatively stagnated manufacturing sector, which had an investment /production coefficient considerably lower than that prevailing in the seventies and the beginning of the eighties (under 6% as compared to near 10% in the former period). In fact, the net stock of fixed capital in 1994 was the same as that of 1984,

though modernized to a certain extent[12] (Moreno, 1999). Although not enough information exists for the second half of the nineties, the capital stock probably increased somewhat, driven by the very significant FDI that has entered Mexico since. In fact, in the period 1995-1999, FDI flowing annually to Mexico (about 10.5 billion dollars) almost doubled that of the period 1990-1994 (around 5.4 billion dollars) (CEPAL, 2000a). This expansion has nurtured mainly the export industry which, in turn, has been the main catalyst of the manufacturing sector's transformation in the recent period. Not too many changes were done to the capital stock directly linked to environment upgrading, since the specific investment on environment protection by enterprises seems to be quite limited still. In 1997 the environmental market was about 2 billion dollars worth in Mexico, i.e., about 0.6% of GDP, which is considered too limited, but the prospects are good, since such market has been growing at a 10 to 14% rate annually (CESPEDES, 1999).

FDI generated to a great extent the Mexican export thrust, but both FDI and export growth concentrated mostly in a few sectors. Basically, of the 61% of the total FDI that went to manufacturing industry between 1994 and 1998, one third was absorbed by the automobile industry and electronic equipment including computers; one sixth went to chemical industry activities (especially pharmaceutical and other chemicals); another sixth was directed toward beverages and the tobacco industries (see Table 8) (Dussel Peters and Mortimore, 2000; Mortimore, Buitelaar and Bonifaz, 2000).

As to the environmental impact of this investment and export profile, the first appreciation is mixed. The most substantial part of FDI does not seem to promote particularly polluting activities, which is encouraging. Instead, it searches local advantages that may reduce costs other than lower environmental standards. This is consistent with

[12] An annual 5% depreciation of fixed capital is considered in that study (Moreno, 1999).

other studies according to which environmental costs are too small - approximately 2% of total value added in 85% of U.S. industry - to determine the location of industry (Esty and Gentry, 1997; Low and Yeats, 1992). Among the elements that determine the location of these industries are the availability of natural resources, low salaries, access to local markets, among others. Even most of the chemical industry, the most polluting of all, does not seem to be attracted by lower environmental standards. In fact, since much of it is integrated to transnational corporations, or large national capital which normally counts with important technological partners abroad, it usually uses technology which is close to the best available internationally (Mattar, 1994; Péres, 1998).

The former situation, nevertheless, does not support the prospect of a country shifting its export activities toward technologically sophisticated, high value added sectors. A special characteristic of the export boom, as was mentioned in section 2, is that an important part has occurred in the maquila industry. In fact, the most dynamic segment of FDI went to the maquila industry. Between 1994 and 1998 the FDI flowing to that industry grew 24% annually and reached almost 25% of total FDI in Mexico in September of 1999 (Dussel Peters, 2000). Hence, technologically, much of this industry has developed only a small segment of this high technology process in Mexico and usually, but not always, that which is intensive in labor. Although there are some references to a second generation of the maquila industry, which in theory incorporates more advanced processes of production than the first generation, even electronic and the automobile maquila industry continue carrying out mostly assembly operations, in a traditional way (Gerber, 1999). Therefore, the industrial technological upgrade spurred by exports is definitely superficial and the change in the manufacturing export structure toward high technology products can be misleading if considered a sign of the level of technological development. Consequently,

the transference of technology and the possibility of building an industry which may produce greater value added per unit of output and increase workers income is still an unaccomplished aim. Additionally, the segments of maquila production, that have been located mostly in the Northern border of Mexico, lack the necessary infrastructure to dispose the solid toxic wastes in an environmentally acceptable way besides causing a series of other emissions to the air and water (EcoFrontera, 2000) .

TABLE 8
Foreign Direct Investment
(millions of dollars)

	1994	1995	1996	1997	1998	Acum. 1994-1998 [2/] Value	Part.%
T O T A L	**10,413.7**	**8,061.7**	**7,384.0**	**11,082.6**	**6,619.6**	**43,561.5**	**100.0**
Manufacturing Industry	**6,073.3**	**4,721.8**	**4,585.3**	**6,984.7**	**4,471.5**	**26,836.6**	**61.6**
Food products, beverages and tobacco	**1,764.6**	**604.2**	**496.9**	**2,896.2**	**633.9**	**6,395.8**	**14.7**
Meat industry	10.3	3.1	1.2	2.3	6.8	23.6	0.1
Milk products	3.6	70.9	12.1	27.3	-1.1	112.8	0.3
Canned food	11.3	-27.6	52.1	6.6	24.7	67.1	0.2
Processed cereals and other agricultural products	5.2	12.3	267.5	33.2	20.0	338.1	0.8
Bread products	0.7	154.9	7.8	7.8	1.3	172.5	0.4
Grinded nixtamal and tortillas elaboration	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Edible oils and fats	8.2	8.9	2.3	0.0	0.1	19.5	0.0
Sugar industry	0.9	78.5	25.0	0.0	0.0	104.4	0.2
Cocoa, chocolate and confectionary's products	5.0	43.1	14.2	1.5	1.9	65.7	0.2
Other food prod. for human consumption	861.9	-0.2	1.6	24.8	2.4	890.5	2.0
Prep. food for animals	3.4	2.1	21.8	1.3	0.2	28.9	0.1
Beverages	854.0	257.9	91.2	651.4	577.6	2,432.1	5.6
Tobacco	0.1	0.3	0.0	2,140.1	0.0	2,140.6	4.9
Textiles, apparel and leather industry	**250.4**	**179.2**	**181.3**	**159.7**	**264.0**	**1,034.7**	**2.4**
Textil ind. of hard fibers	2.3	0.2	0.4	0.0	6.4	9.2	0.0
Soft fiber yarn and fabric	97.5	62.2	46.6	12.6	17.3	236.2	0.5
Textiles materials	24.2	17.8	17.9	19.4	60.7	140.0	0.3
Knitted fabric	81.0	53.4	8.1	15.2	27.4	185.1	0.4
Apparel	35.5	41.4	72.4	106.7	133.7	389.7	0.9
Leather, furs and prod.	2.7	2.1	34.2	4.6	8.8	52.5	0.1
Footwear	7.2	2.1	1.7	1.2	9.8	22.0	0.1
Wood and wood products industry	**9.0**	**46.9**	**32.6**	**15.1**	**21.7**	**125.3**	**0.3**
Sawwood and carpentry	0.5	29.5	6.6	1.8	2.1	40.5	0.1
Packaging and other wood and cork products	0.2	4.7	0.8	4.5	10.0	20.2	0.0
Wood furniture	8.2	12.7	25.2	8.8	9.6	64.5	0.1
Paper and paper products, printing and editorial activities	**78.3**	**155.9**	**71.4**	**218.0**	**48.7**	**572.4**	**1.3**
Cellulose, paper and prods .	71.6	98.8	63.1	211.5	12.6	457.6	1.1
Printing and editorial ind.	6.7	57.1	8.3	6.5	36.0	114.7	0.3
Chemical substances and oil, coal, rubber and plastic derived products	**616.0**	**557.7**	**1,123.4**	**663.5**	**1,033.6**	**3,994.2**	**9.2**
Basic petrochemical ind.	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Basic chemical substances	240.0	69.6	123.0	51.0	7.5	491.1	1.1
Artif. or synth. fibers	10.6	23.3	5.8	1.1	414.3	455.2	1.0
Farmaceuticals	157.0	118.6	150.0	165.4	179.0	770.1	1.8

TABLE 8 (continued)

Other chemical prod. and subst.	83.5	84.5	545.3	147.7	205.6	1,066.5	2.4
Oil refinery	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coal	25.3	19.7	38.2	28.6	7.1	118.8	0.3
Rubber industry	9.8	33.1	20.5	26.9	70.5	160.9	0.4
Plastic products	89.7	208.8	240.6	242.7	149.6	931.5	2.1
Non mineral products	**51.2**	**89.2**	**29.5**	**5.8**	**10.6**	**186.3**	**0.4**
Pottery and ceramics	1.7	2.0	0.1	0.1	0.4	4.3	0.0
Clay material for construction	53.9	61.3	19.4	4.3	-0.4	138.5	0.3
Glass and glass products	-5.2	-0.7	-0.7	0.4	9.3	3.0	0.0
Cement, lime, plaster and other non metallic minerales products	0.8	26.7	10.8	1.0	1.3	40.5	0.1
Basic metal industries	**1,342.3**	**141.7**	**324.8**	**102.9**	**47.4**	**1,959.1**	**4.5**
Iron and steel	1,341.4	121.6	316.3	100.1	45.1	1,924.5	4.4
Basic non ferrous metals	0.9	20.1	8.5	2.8	2.3	34.6	0.1
Metallic products, machinery and equipment	**1,862.3**	**2,832.3**	**2,174.6**	**2,664.9**	**2,035.9**	**11,570.0**	**26.6**
Metallic parts	19.2	19.3	25.1	19.0	17.3	99.9	0.2
Metallic structures, tanks and industrial boilers	2.8	26.4	14.8	2.9	84.6	131.6	0.3
Metallic furniture	17.7	3.1	0.7	7.3	11.0	39.8	0.1
Other metallic products	46.5	73.1	77.9	69.1	71.7	338.3	0.8
Mach. and equip. specific uses.	39.1	41.9	21.1	32.1	30.3	164.5	0.4
Mach. and equip. general use.	75.1	149.4	123.4	123.7	144.4	616.0	1.4
Office machines, including information processing	31.2	33.3	137.5	76.7	222.6	501.3	1.2
Electric machines, equip and accessories.	390.4	839.4	567.4	455.8	473.5	2,726.4	6.3
Electronic equip. including radio, T.V., communication and medical use.	214.1	534.4	425.3	578.6	422.6	2,174.9	5.0
Instr. and acces. domestic use	60.6	71.3	113.5	96.9	96.3	438.7	1.0
Automobile industry	917.2	970.0	630.0	1,160.3	412.9	4,090.4	9.4
Transport equipment and parts	26.2	51.7	11.8	11.5	13.5	114.6	0.3
Precision instruments and equipment	22.3	19.0	26.1	31.1	35.1	133.5	0.3
Other manufacturing industry	**99.2**	**114.6**	**150.8**	**258.5**	**375.7**	**998.9**	**2.3**
Other manuf. industry	99.2	114.6	150.8	258.5	375.7	998.9	2.3

Source: Secretaría de Comercio y Fomento Industrial. Dirección General de Inversión Extranjera.

6. Conclusions

NAFTA deepened the Mexican foreign trade tendencies spurred by trade liberalization policies in the second half of the eighties. Of these, the most important were the high rate of growth of exports and imports as well as the reorientation of production activity towards the export markets, which was accompanied by the doubling of FDI received by Mexico, annually.

From an environmental point of view, the Mexican trade trends do not suggest a shift of export specialization toward more polluting sectors after 1994 (nor since the initial trade opening in such country around 1987). A first characteristic of trade worth while mentioning, is that although some very polluting sectors increased considerably their exports in the post NAFTA period, so did imports, particularly in the chemical sector. This indicates an intensification of trade in some very polluting sectors, but not a shift of such production to Mexico.

Second, an estimate of pollution expansion related to manufacturing exports between a pre and a post NAFTA period (1992/93 and 1997/98, respectively) shows that it was the significant dynamism of exports which was responsible for the greater emissions and not a change in the structure of exports toward more polluting sectors. In fact, if exports had not increased during that period, pollution would have diminished because of the greater weight gained by less polluting sectors during that period. It was therefore the "scale effect" and not the "composition effect" which explains the pollution expansion in the period under study.

Third, the very deep change in the Mexican export structure has further implications for the environment if we consider that they tended to move away from primary goods towards high technology export products, being the automobile and the electronics industries particularly predominant in the latter case. If compared to Canadian export structure, the Mexican one changed to a much greater degree in favor of the high technological sectors' exports after NAFTA, while within the Latin American context the Mexican experience was almost unique.

Fifth, the environmental favorable implications of relying less on natural resources and concentrating more in sectors with high technology have to be taken with reserve.

Overall, investment was stagnant until 1994 and since then it has been the FDI which presumably has injected greater capital for innovation purposes. The most dynamic part of FDI has flowed to maquila industry and this activity only is in charge of a small segment of the production process, usually that which is intensive in labor force. In general, the high technology industries are not really integrated nationally, technological transfer from abroad is limited and value added, particularly in the maquila industry, is quite low. Hence, too, the impact of this activity on incomes and standards of living, which is essential to overcome some environmental problems, is also limited. The maquila industry in itself produces a wide range of environmental problems which are far from being solved.

Finally, although the Mexican most polluting industrial sectors in the United States market are responsible for only a small fraction of total exports and grow at a lower rate than average Mexican exports they have kept their competitiveness in many of those high pollution markets in the U.S. and have not lost their comparative advantage. Notwithstanding this, Mexico is far from being a “pollution haven” as normally characterized.

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Annex

TABLE A-1

Highest Pollution Industrial Sectors a/

Order according to Pollution level from higher to lower	Harmonized System Classification
1	28, INORGANIC CHEMICALS; ORGANIC OR INO
2	29, ORGANIC CHEMICALS
3	32, TANNING OR DYEING EXTRACTS; TANNINS
4	71, NATURAL OR CULTURED PEARLS, PRECIOU;
4	75, NICKEL AND ARTICLES THEREOF;
4	76, ALUMINUM AND ARTICLES THEREOF;
4	78, LEAD AND ARTICLES THEREOF
4	79, ZINC AND ARTICLES THEREOF;
4	80, TIN AND ARTICLES THEREOF
5	74, COPPER AND ARTICLES THEREOF;
5	81, BASE METALS NESOI; CERMETS; ARTICLE
6	29, MINERAL FUELS, MINERAL OILS AND PRO
7	39, PLASTICS AND ARTICLES THEREOF
8	72, IRON AND STEEL
9	56, WADDING, FELT AND NONWOVENS; SPECIA;
9	59, IMPREGNATED, COATED, COVERED OR LAM
10	48, PAPER AND PAPERBOARD; ARTICLES OF P
11	31, FERTILIZERS
12	30, PHARMACEUTICAL PRODUCTS
13	33, ESSENTIAL OILS AND RESINOIDS; PERFU;
13	35, ALBUMINOIDAL SUBSTANCES; MODIFIED S
13	36, EXPLOSIVES; PYROTECHNIC PRODUCTS; M;
13	38, MISCELLANEOUS CHEMICAL PRODUCTS
14	15, ANIMAL OR VEGETABLE FATS AND OILS A
15	40, RUBBER AND ARTICLES THEREOF

a/ Own Categorization based on IPPS.