

Cororaton, Caesar B.; Aldaba, Rafaelita M.

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Philippine Institute for Development Studies
Surian sa mga Pag-aaral Pangkaunlaran ng Pilipinas

Trade Liberalization and Pollution: Evidence from the Philippines

Rafaelita A.M. Aldaba and Caesar B. Cororaton

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The Research Information Staff, Philippine Institute for Development Studies
3rd Floor, NEDA sa Makati Building, 106 Amorsolo Street, Legaspi Village, Makati City, Philippines
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Trade Liberalization and Pollution: Evidence from the Philippines



**Rafaelita A. M. Aldaba
Caesar B. Cororaton, Ph. D.**

Philippine Institute for Development Studies

**Final Report
July 2001**

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ABSTRACT

The paper assesses the impact of trade reforms in the Philippines on pollution using CGE model simulations and two industry case studies on sugar milling and refining and cement manufacturing. Generally, trade reform is output augmenting and welfare improving. The overall impact on pollution is very small. Output taxes to reduce pollution are ineffective. They wipe out the potential gain from trade reforms.

The case studies support the simulation results. Trade liberalization leads to more competition, improvements in efficiency, and increased foreign investment. All this increased environmental awareness. It accelerated the promotion and production of good environmental systems and adoption of ISO standards.

Keywords: Trade and Pollution

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Executive Summary

I. Objective

This paper aims to assess the environmental impact of trade liberalization in the Philippines, which was carried out with much vigor in the 1990s. It focuses on the manufacturing industry and its pollution effects and assess whether trade liberalization is compatible with efforts to promote environmental protection.

Two approaches are adopted in the analysis:

- Simulations using a computable general equilibrium model to isolate the impact of trade and environment from other forces
- Case studies on sugar milling and refining and cement manufacturing industries.

II. Results of CGE Simulations

- Simulation results indicate that the impact of the tariff reform program in the 1990s may be favorable both in terms of household welfare and distribution. The removal of tariff distortion leads to an increase in welfare, averaging P8 billion per year in the second period. Interestingly, this is higher by P1 billion per year than the average increase in government deficit as a result of the reduction in government tariff revenue. There is an average net loss in welfare in the period 1991-1994, which can be attributed to the increase in tariff rates in some sectors, like agriculture for example. But the positive effects in the period 1995-1999 offset the negative effects in the earlier period.
- The income distribution effects are favorable as well. The Gini coefficient declines by -0.06 percent per year in the second period, indicating an improvement in income distribution. In terms of specific household groups, the first decile, which is the poorest group, registers the highest increase in income of 2.31 percent per year in the second period. The lowest is the 8th household group. The favorable effects on factor prices observed earlier translate to positive effects on household incomes, especially in the second period relative to the first period.
- Given these results economic and welfare gains and distribution improvement may continue to accumulate as the government embarks on other trade reform programs in the near future such as the uniform tariff rate.
 - Because of changes in relative prices as a result of the tariff reform, resources tend to move towards the manufacturing sector, indicating possibilities of favorable industrialization. However, the impact on pollution is mixed: emission levels of some pollutants increases, while other decline.
 - On the whole, the overall change in the level of emission for all pollutants seems to be very small relative to case where there is no tariff reform program.

- Simulation results which involved additional output taxes to further check emission of pollutive substances indicate that its imposition may not only wipe out all the economic gains from the tariff reform, it may tend to increase the emission of some pollutants. The increase comes from the reallocative effects of additional output tax. Thus additional output tax to address pollution problems is not recommended.
- Simulation results that incorporated a shift in pollution intensities indicate substantial difference in emission level. Furthermore, the difference increases for all pollutants as the tariff reform progresses. This will imply that improvement in production technology may be a major factor that can check the problem of pollution in the process of industrialization.

III. Case Studies

Case 1: Sugar Milling and Refining Industry

- The estimated BOD pollution intensities range from 0.15 kg/ MT to 201 kg/MT. The average BOD pollution intensity seemed to have declined between 1992 and 1998. However, it is still considered high compared with the 1987 WB-IPPS coefficient for sugar refining.
- The BOD pollution intensities indicate wide gaps in the technological state of the sugar mills in the country. While some mills were able to invest in modern equipment and technology and improve their environmental performance, others especially the old mills remain inefficient and have a much worse environmental performance.
- To address the environmental problem, it is necessary to attack the problem at its source: obsolete technology and inefficiency, otherwise it would be difficult for the firms to compete and comply with environmental regulations.

Case 2: Cement Industry

- The industry experienced strong growth between 1993 and 1996. Production grew by about 18% annually in 1994, 1996, and 1997. In anticipation of continuous future growth the industry engaged in an expansion program, which more than doubled its capacity from 282 million (40 kg bags) in 1995 to 641 million (40 kg bags) in 1998.
- Despite the lack of good pollution data from the cement industry, there are indications that more firms are willing to adopt international environmental management standards and accreditation. Three cement plants have already received ISO 14001 certification while three others are in the process of preparing their ISO 14001 accreditation.

IV. Conclusions and Policy Recommendations

- On the whole, the CGE simulations showed that there is no wholesale environmental degradation arising from trade liberalization. The overall change in the level of emission for all pollutants are very small relative to the case where there is no tariff reform program.
- The simulations also indicated the critical role of technology effects in controlling pollution. Changes in technology have large significant impact in improving the environment.
- To the extent that trade liberalization eliminates economic policy distortions, creates effective competition, promotes economic growth and improves the efficiency of resource use, trade reforms are positive agents for the environment. As trade liberalization encourages more competition, firms are compelled to become more efficient.
- The government should continue its trade liberalization policies as well as other economic reforms aimed at promoting competition and efficiency in the economy. In general, environmental policies are still more efficient and appropriate than trade policies in addressing environmental problems.
- There are still many local cement firms and sugar millers that are unable to comply with DENR regulations and standards. Partly, this could be attributed to older technologies in place in many of these firms as well as to their domestic-orientation and failure to appreciate their potential roles in the international market.
- The absence of good quality industrial pollution data collection and management is a stumbling block to a better understanding and comprehensive analysis of the impact of trade liberalization on industrial pollution.
- The regulating body, DENR, must improve its monitoring and effectively enforce environmental regulations and improve its data gathering and management as these are necessary in accurately assessing the effectiveness of regulations and standards.

Trade Liberalization and Pollution: Evidence from the Philippines

Rafaelita A.M. Aldaba and Caesar B. Cororaton, Ph. D.*

I. Introduction

Trade liberalization is an economy-wide policy that narrows the spread of tariffs and lowers average tariffs with its effect depending on the level and structure of effective protection rates. As trade is an important agent of growth and structural change, it can lead to higher incomes and reallocation of production and consumption. Trade liberalization can affect the environment primarily through increased or decreased emissions of harmful substances into the air, water and/or land including disposal of solid wastes. An expansion in industrial sector output affects pollution in two ways: first, it increases the total volume of pollutants in the short and medium terms and second, it changes the pollution intensity of industrial output.

The OECD (1994, 1995) summarizes the environmental effects of trade liberalization into five main effects:

- Scale effects : these are associated with the overall level of economic activity resulting from trade liberalization. Positive scale effects may result from higher economic growth particularly when appropriate environmental policies are present. Negative scale effects may occur when higher economic growth bring increased pollution and faster draw-down of resources due to the absence of appropriate environmental policies.
- Structural effects : these are associated with changes in the patterns of economic activity resulting from trade liberalization. Positive structural effects may result when trade liberalization promotes an efficient allocation of resources and efficient patterns of consumption. Negative structural effects may occur when appropriate environmental policies do not accompany changes in patterns of economic activity.
- Product effects : These are associated with trade in specific products which can enhance or harm the environment. Positive product effects may result from increased trade in goods which are environmentally-beneficial like energy-efficient machinery while negative product effects may result from increased trade in goods which are environmentally-sensitive like hazardous wastes.
- Technology effects : These are associated with changes in the way products are made depending on the technology used. Positive technology effects may result when the output of pollution per unit of economic product is reduced.

* Research Associate and Senior Research Fellow respectively, Philippine Institute for Development Studies.

- Regulatory effects : These are associated with the legal and policy effects of trade liberalization on environmental regulations, standards and other measures.

These effects may have positive or negative impact on the environment. In general, studies have shown that the impact of trade liberalization on the environment is positive, provided it is accompanied by effective environmental policies (OECD,1995). As trade liberalization improves the efficient allocation of resources, promotes economic growth and increases general welfare, it is viewed as a positive agent which could provide resources for environmental improvement.

Industrial production has a number of potential environmental impacts. Water pollution results from wastewater discharges that are high in biochemical oxygen demand (BOD) and total suspended solids (TSP). Food industries and other agriculture-based industries such as processing of coconut, sugar cane, rice corn, pineapple, tobacco, piggeries, beverage and slaughterhouses are the major sources of water pollution. Other major sources include pulp mills, chemical plants, pharmaceuticals, refineries, metal finishing and textile manufacturing which contain varied chemical compositions. Air pollution arises from emissions of gases and particulates. The major sources of air pollution are cement, oil refineries and chemical plants. Toxic and hazardous wastes result from wastewater discharge containing heavy metals, solvents, and acid/alkali wastes. The major sources of toxic and hazardous wastes are the electronics and metal finishing industries.

The Philippine Environment and Natural Resources Accounting Project (ENRAP) estimates indicated that in 1992, the household sector was the major source of air pollutants PM, PM10, VOC, and CO. Households accounted for 59% of PM, 66% of PM10, 85% of VOC, and 86% of CO. Electricity generation and manufacturing industries were the primary sources of Sox, with electricity generation accounting for the bulk of the emissions. In 1992, electricity generation accounted for 53% of total Sox emissions while manufacturing industries accounted for 32%.

The household sector was the largest source of BOD5 with a share of 44% of total BOD5 discharges in 1992. Industries accounted for 29% of BOD5 the bulk of which could be attributed to livestock production and services sector. Manufacturing accounted for about 2% of total BOD. The manufacturing sector was the primary source of TDS with food, beverages, and tobacco contributing around 93% of total TDS discharges in 1992. Manufacturing also accounted for 32% of oil and grease.

This paper aims to assess the environmental impact of trade liberalization in the Philippines which was carried out with much vigor in the 1990s. In particular, the study will focus on the manufacturing industry and its pollution effects. The paper is divided into two parts. Section II discusses the trade policy changes between the 1980s to the 1990s. Section III presents a review of selected literature, section IV assesses the impact of trade liberalization on industrial pollution using a computable general equilibrium model, and section V presents a qualitative analysis of the environmental effects of trade liberalization on sugar milling and refining and cement industries. Apart from food processing and oil refineries and chemical plants, sugar milling and cement manufacturing are among the major industrial sources of water and air pollution in the

Philippines. The final section summarizes the findings and draws the policy recommendations of the paper.

II. Trade Policy Reforms and Structural Changes Philippine Manufacturing

A. Trade Policy Reforms

The first major trade policy reform in the Philippines was implemented in 1981 as part of the conditions associated with a series of World Bank structural adjustment loans. This consisted of a two-pronged trade reform program which combined tariff reform and import liberalization, but without an accompanying exchange rate policy. The program was implemented over a five-year period starting in 1980. The range of nominal tariffs from zero to 100 percent was to be reduced to a range of 10 to 50 percent. However, the program was suspended in 1983 due to the economic crisis that plunged the country into severe balance of payments problems. Deregulated items were put back in the regulated list, and eventually, a strict system of foreign exchange system was adopted.

The second episode was legislated during the Aquino administration through Executive Order 470 in July 1991 and ended in 1995. This narrowed down the tariff range to within a three to 30 percent tariff range by the year 1995. The third most important tariff reform was pursued during the Ramos administration. Executive Order 264 issued in August 1995 further reduced the tariff range mostly to 3 percent and 10 percent levels and reduced the ceiling rate on manufactured goods to 30 percent while the floor remained at 3 percent. The goal was to create a four-tier tariff schedule: 3% for raw materials and capital equipment which are not locally available, 10% for raw materials and capital equipment which are locally available, 20% for intermediate goods, and 30% for finished goods.

The trade reforms did not only narrow the tariff range but also eliminated import restrictions which were mainly in the form of import licenses and outright import bans. Between 1986 and 1989, import restrictions on 1,471 Philippine Standard Commodity Classification (PSCC)¹¹ lines were lifted. This represented a decline in the number of regulated items as a percentage of total number of PSCC lines from around 32 percent in 1985 to only 8.0 percent in 1989. Subsequent years witnessed the liberalization of a few more items which brought down the percentage of regulated items to about 4 percent in 1995. The number of import restrictions fell to only about three percent of the total number of PSCC lines in 1996.²

The tariffication of quantitative restrictions began in 1992 with the legislation of Executive Order (EO) 8 covering 153 commodities whose quantitative restrictions were converted into tariff equivalent rates. EO 8 increased the tariff rates of relevant commodities by 100% of their old levels. With the country's accession to the World Trade Organization in the GATT-Uruguay Round, Executive Order 313 and Republic Act

¹ The Philippine Standard Commodity Classification is a classification scheme used in the distribution of various commodities that enter foreign and domestic trade and is patterned after the UN Standard International Trade Classification (SITC).

² De Dios L.

(RA) 8178 (1996) were issued. EO 313 increased the tariff rates on sensitive agricultural products while RA 8178 lifted the quantitative restrictions on these products. Minimum access volume were also defined for these products. The government has expressed its intention to adopt a uniform five percent tariff by the year 2004. This is also in line with the country's commitments in the ASEAN Free Trade Area-Common Effective Preferential Tariff (AFTA-CEPT) agreement where tariffs on most products are expected to be reduced to a range of between 0-5 percent by 2002.

Table 1: Weighted Implicit Tariff Rates by Sector

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Palay and Corn	0.564	0.564	0.597	0.631	0.698	0.661	0.475	0.451	0.451	0.432	0.432
Fruits and Vegetables	0.214	0.216	0.212	0.208	0.205	0.201	0.131	0.106	0.088	0.088	0.064
Coconut & Sugar	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Livestock & Poultry	0.048	0.040	0.036	0.045	0.029	0.026	0.033	0.030	0.027	0.023	0.023
Fishing	0.167	0.172	0.270	0.228	0.192	0.139	0.101	0.100	0.061	0.060	0.060
Other Agriculture	0.113	0.116	0.125	0.119	0.111	0.092	0.226	0.184	0.181	0.144	0.144
Forestry	0.179	0.120	0.119	0.120	0.118	0.108	0.048	0.034	0.034	0.034	0.034
Mining	0.138	0.089	0.086	0.070	0.079	0.075	0.042	0.042	0.033	0.033	0.033
Rice & Corn Milling	0.390	0.426	0.497	0.497	0.497	0.497	0.508	0.474	0.467	0.441	0.441
Milled Sugar	0.443	0.544	0.472	0.448	0.421	0.392	0.337	0.302	0.254	0.228	0.226
Meat Manufacturing	0.107	0.104	0.153	0.130	0.119	0.086	0.096	0.089	0.075	0.062	0.061
Fish Manufacturing	0.172	0.177	0.258	0.236	0.185	0.112	0.105	0.099	0.067	0.067	0.063
Beverage & Tobacco	0.378	0.395	0.392	0.388	0.384	0.380	0.237	0.195	0.158	0.150	0.145
Other Food Manufacturing	0.243	0.233	0.225	0.207	0.195	0.178	0.179	0.155	0.125	0.119	0.104
Textile manufacturing	0.249	0.247	0.230	0.218	0.212	0.120	0.121	0.091	0.079	0.078	0.057
Garments & Leather	0.270	0.269	0.268	0.267	0.266	0.160	0.160	0.153	0.106	0.106	0.100
Wood Manufacturing	0.181	0.204	0.190	0.173	0.158	0.140	0.140	0.140	0.091	0.091	0.091
Paper & Paper Products	0.272	0.268	0.236	0.207	0.199	0.166	0.170	0.170	0.112	0.112	0.112
Chemical Manufacturing	0.304	0.273	0.258	0.252	0.252	0.181	0.157	0.141	0.101	0.100	0.097
Petroleum Refining	0.110	0.096	0.121	0.120	0.129	0.112	0.025	0.023	0.022	0.022	0.022
Non-metal manufacturing	0.283	0.275	0.264	0.248	0.245	0.186	0.170	0.150	0.134	0.134	0.083
Metal Manufacturing	0.272	0.262	0.253	0.244	0.233	0.218	0.209	0.205	0.147	0.133	0.129
Electrical Equipment Mfg	0.229	0.223	0.195	0.177	0.139	0.098	0.087	0.087	0.230	0.230	0.230
Transport & Other Machinery Mfg	0.248	0.243	0.279	0.269	0.223	0.146	0.142	0.132	0.120	0.120	0.090
Other Manufacturing	0.179	0.149	0.143	0.132	0.121	0.086	0.087	0.077	0.056	0.054	0.047

Source: Cororaton, C., 1998.

Table 1 presents estimates of implicit tariff rates using price comparison (ratio of domestic prices to border prices) for the period 1990 to 2000. Average implicit tariffs are expected to decline from 28.6 percent in 1990 to 16.8 percent in 2000.³ It is evident from the table that starting in 1995, average implicit tariff rates for all major sectors would decline. Palay and corn would fall from 0.661 in 1995 to 0.432 in 2000. Fishing would decline from 0.139 to 0.6 between 1995 and 2000 while forestry would decrease from 0.108 to 0.034 during the same years. Under manufacturing, beverage and tobacco would fall from 0.38 to 0.145, chemical manufacturing would decline from 0.181 to 0.097, petroleum refining would decrease from 0.112 to 0.022 while non-metal manufacturing

³ Manasan and Querubin (1997).

would decline from 0.186 to 0.083. An increase in implicit tariffs is evident for some sectors like other agriculture and electrical equipment manufacturing.

The trade policy reforms in the 1990s resulted in a significant reduction in the average effective protection rate⁴ for the whole economy from 29.4 percent in 1990 to 24.9 percent in 1995 and to 19.1 percent in 1998 (see Table 2). Within manufacturing, food processing (including rice, corn, coconut, and sugar milling) had the highest protection at 38% in 1998 while non-metallic mineral products had the lowest protection level at 4%. Agriculture was expected to receive effective protection of 25% in 1998 and 24% by 2000. The effective protection on manufacturing was expected to decline from 20% in 1998 to 15% in 2000.

Table 2: Effective Protection Rates (in percent)

Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1998	2000
Sectoral Weighted Averages	29.4	31.1	34.6	32.2	30.5	24.8	27.3	22.1	19.1	16.8	14.9
Agriculture, Fishery & Forestry	27.1	26.5	29.1	29.3	29.8	28.5	21.6	20.9	18.6	18.1	17.2
Agriculture	32.0	32.2	33.6	35.0	36.6	35.5	28.6	26.8	25.3	24.4	23.6
Fishery	17.1	16.9	23.6	20.8	18.6	16.1	9.5	11.0	6.2	6.2	4.6
Forestry	17.4	10.3	11.2	10.8	10.7	10.2	2.8	4.7	2.9	2.9	2.9
Mining	1.0	0.2	1.5	0.5	0.6	1.1	-1.2	0.8	0.3	0.4	0.3
Manufacturing	31.9	34.6	38.7	35.1	32.5	24.8	31.1	23.9	20.3	17.3	14.9
Food Processing	38.2	44.7	60.3	50.7	44.4	34.2	51.4	41.9	37.6	31.8	28.2
Beverages & Tobacco	51.6	47.1	49.1	48.4	47.9	48.1	25.6	27.6	16.4	13.7	7.9
Textile, Garments, & Footwear	25.0	23.7	24.1	21.8	21.8	13.1	12.7	8.5	11.1	9.3	8.4
Wood & Wood Products	32.8	18.7	20.1	19.2	19.2	15.8	20.6	22.7	17.4	15.7	10.3
Furniture & Fixtures	21.1	26.7	22.7	19.0	14.9	13.1	14.4	15.8	14.2	10.5	11.8
Paper/Rubber/Leather/Plastic	32.0	31.4	28.7	26.1	24.8	20.5	19.6	20.1	13.3	11.0	8.5
Chemicals & Chemical Products	28.0	22.5	21.8	21.3	21.4	14.8	11.5	10.4	7.3	7.0	5.8
Non-metallic Mineral Products	21.9	32.8	19.0	25.8	27.5	18.0	29.4	5.1	4.2	3.8	3.3
Basic Metals & Metal Products	22.6	19.5	20.1	19.2	18.5	15.2	13.1	13.6	9.4	8.2	7.4
Machinery	24.2	24.0	23.2	20.7	17.2	11.3	10.5	10.8	8.1	8.0	6.3
Miscellaneous Manufactures	20.4	18.9	17.8	16.6	14.4	10.2	10.2	10.4	6.0	5.1	3.8

Source: Manasan and Pineda, 1999

⁴ The EPR concept is used to measure protection while the DRC framework is employed to determine economic efficiency. The EPR takes into consideration the protection given to the output and inputs of a specific activity. The net effect of protection on output and inputs is indicated by the protection of the activity's value added. Thus, the EPR is computed as the proportionate increase in domestic value added over free trade value added.

B. Performance and Structure of the Philippine Manufacturing Industry

With the introduction of trade reforms, profound changes are expected in industry structure involving both substantial shifts of resources between economic sectors and restructuring within industries. Trade liberalization is expected to drive the process of restructuring and reallocation of resources within and across sectors of the economy such that unprofitable activities contract while profitable ones expand.

Table 3 reveals that over the last two decades, there has been very little systematic movement of resources in industry and manufacturing. It is the services sector which has been experiencing a major increase in size. Since 1980, the share of services has been increasing from about 36 percent to 44 percent in 2000. At the outset of the trade reforms, industry had the largest share of 40.5 percent. Its share declined between 1980 and 1985, although some gradual increases could be observed between 1988 to 2000. The share of agriculture and fishery value added slightly dropped from 21% in 1980 to 19% in 2000. During the same period, the share of forestry dropped substantially from 3% to 0.06 % while mining and quarrying declined, albeit minimally, from 1.5% to 1.06%.

Table 3: Structure of Value Added (1985=100)

Year/Sector	1980	1985	1988	1990	1995	1998	1999	2000
Agriculture	23.5	19.4	18.81	18.01	17.55	18.52	19.0	18.98
<i>Agriculture & Fishery</i>	20.5	18.16	17.45	17.19	17.37	18.37	18.92	18.92
<i>Forestry</i>	3.0	1.24	1.36	0.82	0.18	0.15	0.08	0.06
Industry	40.52	27.69	28.11	28.63	28.81	38.6	37.77	37.41
<i>Mining & Quarrying</i>	1.5	1.64	1.42	1.24	1.02	1.14	1.01	1.06
<i>Manufacturing</i>	27.6	19.86	20.51	20.61	20.63	23.65	23.27	23.74
Services	35.98	31.86	32.85	34.11	35.07	42.88	43.23	43.61
Total	100	100	100	100	100	100	100	100

Source: National Statistical Coordination Board, National Income Accounts.

Table 4 presents the distribution of manufacturing value added for the years 1990, 1994, 1996, and 1997. In 1990, consumer goods comprised the bulk of manufacturing value added with a share of 45 percent, although this dropped to 39% in 1994. As the share of consumer goods continued to drop, a shift towards intermediate goods became evident. In 1996, intermediate goods accounted for the largest share of 38%, this slightly declined to 36% in 1997. Capital goods also registered an increasing share from 19 percent in 1990 to almost 30 percent in 1997.

In 1997, food processing/manufacturing and beverages were the most important sub-sectors under consumer goods as they comprised 24 percent of total manufacturing value added. In the intermediate goods sector, other chemicals and petroleum refineries represented 20 percent of total manufacturing value added while in the capital goods sector, electrical machinery together with professional and scientific equipment were the top sub-sectors with their combined shares of about 22 percent of total manufacturing value added.

Table 4: Distribution and Structure of Manufacturing Value Added

Manufacturing Sector	1990	1994	1996	1997
Food Products	23.55	17.86	17.66	18.07
Beverages	9.60	8.87	6.38	6.35
Tobacco	4.95	5.53	4.16	3.76
Wearing apparel	5.57	6.26	3.91	3.91
Furnitures	1.01	0.79	0.67	0.78
Consumer Goods	44.68	39.31	32.78	32.86
Leather & leather products	0.43	0.50	0.62	0.67
Wood & cork products	1.79	1.00	0.89	0.90
Textiles	4.58	3.10	2.01	2.07
Paper & paper products	2.15	2.05	2.24	1.96
Printing & publishing	1.30	1.48	1.18	1.29
Petroleum refineries	5.76	8.07	13.58	11.89
Petroleum & coal products	0.03	0.05	0.05	0.11
Industrial chemicals	3.25	2.63	1.71	1.82
Other chemicals	9.03	10.40	8.66	8.42
Rubber products	1.83	1.38	0.66	0.50
Plastic products	1.29	1.98	1.93	2.05
Glass & glass products	1.01	1.05	0.97	0.76
Cement	1.41	2.16	2.80	2.61
Nonmetallic mineral products	1.64	1.43	1.04	1.17
Intermediate Goods	35.50	37.27	38.35	36.23
Iron & steel	2.76	4.58	2.95	2.79
Nonferrous metal products	1.37	1.07	0.83	0.85
Fabricated metal products	1.52	1.85	1.57	1.97
Machinery except electrical	0.87	1.14	1.22	1.25
Electrical machinery	9.12	9.92	13.46	15.00
Transport equipment	3.00	3.56	0.97	1.01
Professional & scientific eqpt	0.13	0.30	6.86	7.12
Capital Goods	18.79	22.42	27.85	29.99
Miscellaneous manufactures	1.03	1.00	1.01	0.92
Total	100.00	100.00	100.00	100.00

Source: NSO

III. Review of Selected Literature

Studies Conducted Outside the Philippines

Empirical analysis has used computable general equilibrium (CGE) models to evaluate the effects of economic policies on the environment. Lee and Roland-Holst (1997) used a static, two country CGE for Indonesia and Japan. The model included sectoral industrial pollution data to assess the environmental implications of trade liberalization and three alternative tax policies consisting of export tax, sector-specific effluent tax, and uniform effluent tax. The study covered nineteen industrial sectors and used sectoral emission rates for seven air pollutants, two water pollutants and two toxic

pollutants. These sectoral effluent intensities data formed the basis for estimating environmental effects of trade liberalization and effluent taxes. The results showed that trade liberalization in Indonesia could lead to trade expansion and greater economywide efficiency, however, in the absence of new technologies it would also entail an increase in the total emission levels. Their results also indicated that trade liberalization could lead to an increase in the relative output shares of dirty industries. The study concluded that a combination of trade liberalization and uniform effluent tax could improve welfare and reduce pollution. The authors noted that their approach is limited by the lack of scope for technical substitution with sectors and hence, emissions are proportional to output regardless of relative prices and differential effluent taxes.

Beghin, Dessus, Roland-Holst and van der Mensbrugghe (1996) developed a more advanced CGE model to analyze the links between growth and emissions and the links between trade policies and the environment. This model was used to analyze six country case studies (Mexico, Costa Rica, Chile, China, Indonesia, and Vietnam) undertaken at the OECD Development Centre. The Beghin et al Trade and Environment Equilibrium Analysis (TEQUILA) model is characterized by a high level of disaggregation for pollutants, products, sectors, and types of households. Its main environmental features are:

- It links emissions to the consumption of polluting inputs (as opposed to output).
- It includes emissions generated by final demand consumption.
- It includes substitutability between polluting and non-polluting inputs (including capital and labor).

The model has dynamic features such as capital accumulation, population growth, productivity, and technological improvements and vintage capital (through a putty/semi-putty specification). It also includes impact of emission taxes to limit the level of pollution. While rich in structure, the authors pointed out that the model still lacks some elements for a more comprehensive analysis of environmental linkages. To improve the model, there is a need to include the benefits of limiting emissions, the abatement technology embodied in new capital, and other environmental issues like deforestation, soil degradation, and other similar problems.

Using the TEQUILA model, Beghin et al (1997) analyzed the trade and environment linkages in Mexican agriculture which has been affected by the globalization of economic activities. The paper assessed the effects of three policy reforms: environmental tax, trade liberalization, and combined trade and environmental reforms. Their findings indicated that total agricultural output moderately declined with either environmental reforms or free trade. No evidence of wholesale environmental degradation in agriculture induced by free trade was found. The joint trade and environmental reforms resulted in efficiency gains from free trade and environmental protection from taxes.

In a more recent paper which looked at Chile, Beghin, Bowland, Dessus, Roland-Holst and van der Mensbrugghe (1999) expanded the links between trade and environment to include health effects. The pollution emissions estimated from a CGE model were mapped into a health effects model which transformed emissions data into corresponding changes in health status. The paper assessed the impact of three trade scenarios which included accession to NAFTA, accession to MERCOSUR, and unilateral

opening to world markets on pollution and public health. The results showed that NAFTA integration was relatively benign. Except for increased emissions of bio-accumulative pollutants and small increases in mortality and morbidity linked to lead pollution, MERCOSUR integration indicated no substantial changes in income, pollution, and public health. Unilateral trade liberalization without pollution abatement policy would lead to higher growth and substantial worsening of pollution and expansion of resource-based sectors resulting in detrimental impacts on public health.

Studies Conducted in the Philippines

In the Philippines, there are currently very few empirical studies linking trade policy and the environment. The Intal et al (1994)⁵ study applied a simple multi-industry partial equilibrium simulation model (Chung Lee model) to assess the effects of trade liberalization on the economic structure and on the environment. The model linked changes in industry outputs to changes in effective protection rates and in the real exchange rate. It was static and assumed fixed input-output ratios and constant factor prices. Data were taken from the 1983 input-output table while the pollution intensities were based on the estimates of the Environmental and Natural Resources Accounting Project (ENRAP). The ENRAP calculated the pollution intensities on the basis of emission/effluent factors reported by the World Health Organization and the US Environmental Protection Agency. The study assumed that the pollution intensities remained the same before and after trade liberalization.

The simulations were based on a 50 percent across-the-board reduction in the effective protection rates with or without induced changes in the real exchange rate. The results indicated a tradeoff between trade liberalization and currency depreciation and environmental protection. They showed that while trade liberalization with currency depreciation increased overall output, it also raised the national average pollution and environment damages/intensity of production. This was due to the reallocation of output towards logging, mining, and agriculture that had large offsite environmental damages. Within manufacturing, there was a reallocation of output towards industries with higher pollution/environment damage intensities (food processing, wood products, beverages). These results seem to be different from the findings of Beghin et al (forthcoming in *Environment and Development Economics*) where trade liberalization and other market reforms in the formerly Centrally Planned Economies resulted in a cleaner composition of manufacturing output and shifts towards less polluting allocation of resources.

Intal et al highlighted the need for internalization of environmental damages and the encouragement of environment-friendly technologies as critical complements to trade liberalization and currency depreciation. However, given the partial equilibrium nature of the model, it was not possible to systematically assess the effects of combined environmental policy (say, taxes) and trade liberalization to address environmental degradation.

⁵ Intal, Pineda, Tan, and Quintos, 1994, "Chapter 2: Trade, Industrial Protection, and the Environment", in Trade and Environment Linkages, an UNCTAD-PIDS Study.

Using the same partial equilibrium framework (Chung Lee model as modified by Medalla and Tan⁶), Inocencio et al (1999) assessed the effects of substantial trade liberalization policies implemented in the 1990s on water pollution. The study relied on the pollution intensities estimated by the ENRAP. The results indicated that trade liberalization decreased the national average pollution intensity of production as output was reallocated towards less pollutive industries.

Cruz and Repetto (1992) applied a CGE model to assess the impact of trade reforms but did not quantify their environmental effects as these were not modelled explicitly. The model did not include the environmental consequences of production activities. Cruz and Repetto identified the sectors that were known to have significant environmental effects and indirectly, they then implied the direction (positive or negative) of the environmental effects of trade liberalization. Their findings showed that tariff reforms had adverse environmental implications in sectors such as erosion-prone farming, logging, fishing, and mining. Tariff reform cum devaluation also had adverse environmental consequences due to sectoral shifts in production. Mining, logging, erosion-prone agriculture, and energy use expanded and induced resource degradation.

Orbeta (1999) estimated the effects of tariff changes on the environment using the ENRAP input-output model. The model assumed fixed input ratio in each industry and constant returns to scale in production. Like the Intal et al study, Orbeta assumed constant pollution intensities prior to and after the implementation of tariff changes. The study used the output changes derived from Cororaton's CGE model (1998) as exogenous variables. The findings indicated that with changes in implicit tariff rates, air and water pollution levels would slightly increase during the period 1991 to 2000. The average annual increase in air pollution would range from 0.01 to 3.0 percent and in water pollution, from 0.04 to 0.36 percent. Except for phosphates, water pollution resulted mainly from production activities while air pollution was attributed primarily to household consumption activities.

IV. Tariff Reforms and Pollution: A CGE Analysis

In this section, the impact of tariff reforms in the 1990s on pollution is analyzed through simulation exercises using a computable general equilibrium (CGE) model calibrated to Philippine data and to ENRAP-based and WB-IPPS-based pollution intensities. The impact of the reforms on industry output, resource allocation, income distribution, and household welfare are also examined. Results of simulation experiments involving additional indirect industry output taxes are analyzed to determine whether they tend to reduce emission. Lastly, the impact of an improvement in production technology on emission is examined through simulation experiments involving ENRAP-based intensities and WB-IPPS-based intensities, the former representing an older production technology while the latter a newer one.

⁶ Tan, E., "Effects of the Five Percent Uniform Tariff", PIDS Working Paper 97-17, 1997.

Model Structure

The core equations of the PCGEM model used in the simulation are presented in the Appendix. It is a standard, non-linear CGE model. It has 34 production sectors, 3 factor inputs (labor, variable capital, and capital), and 10 households groups. The model was calibrated to the 1990 social accounting matrix and 1990 sectoral tariff revenue and was coded in General Algebraic Modeling System (GAMS).⁷

The equilibrium conditions in the model include: (a) Total factor demand is equal to total supply; (b) zero profit condition; (c) sectoral supply is equal to sectoral demand for commodities; (d) total savings is equal to total investment. Total investment is fixed. Government expenditure is fixed as well, but foreign savings is endogenous. This model closure implies that the tariff reform program is financed by foreign capital inflow, which is not totally unrealistic considering the fact that when the implementation of the program intensified in the mid-1990s capital inflows from abroad surged. (e) Nominal exchange rate is the numeraire.

The parameters used in the model are presented in Table ---. These parameters are the coefficients in the Cobb-Douglas value added equations, the Armington and the CET elasticities.

Few modifications were introduced into the core equations of PCGEM in order to capture (i) time lagged effects of tariff reform, (ii) emission factors, and (iii) additional indirect tax based on emission.

Dynamic Bloc. Labor supply in t is specified as

$$(1) \quad l_t = l_{t-1} * (1 + lgr_t)$$

where l_{t-1} is labor supply of the previous period and lgr_t is growth of labor in the current period. Similar specification is used for the supply of variable capital

$$(2) \quad v_t = v_{t-1} * (1 + vgr_t)$$

Table 5: Key Parameters in PCGEM

		Production			Armington	CET
Sectors		alpha	beta	gamma	sigma_m	tau_e
1	Palay & Corn	0.051	0.935	0.014	3.70	0.30
2	Fruits & Vegetables	0.178	0.751	0.071	0.85	1.50
3	Coconut & Sugar	0.377	0.214	0.409	1.30	2.00
4	Livestock & poultry	0.140	0.811	0.049	1.40	0.30
5	Fishing	0.117	0.676	0.207	1.10	1.50

⁷For a detailed discussion of the model see CB Cororaton, 2000. "Philippine Computable General Equilibrium Model". PIDS Discussion Paper No. 2000-23.

6	Other Agriculture	0.373	0.308	0.320	0.90	0.30
7	Forestry	0.212	0.087	0.701	0.80	0.30
8	Mining	0.407	0.069	0.524	1.10	1.50
9	Rice & Corn milling	0.115	0.266	0.619	3.70	0.30
10	Milled Sugar	0.218	0.000	0.782	4.10	0.80
11	Meat Manufacturing	0.209	0.181	0.610	1.50	0.80
12	Fish Manufacturing	0.153	0.458	0.389	1.10	2.00
13	Beverage & Tobacco	0.190	0.053	0.757	0.30	1.50
14	Other Food Manufacturing	0.189	0.184	0.627	0.20	0.70
15	Textile Manufacturing	0.484	0.229	0.286	0.70	0.70
16	Garments & Leather	0.319	0.438	0.243	0.20	2.50
17	Wood Manufacturing	0.254	0.344	0.402	0.50	1.50
18	Paper & Paper products	0.326	0.191	0.483	0.60	0.90
19	Chemicals Manufacturing	0.247	0.079	0.674	0.60	1.30
20	Petroleum Refining	0.081	0.000	0.919	0.60	0.30
21	Non-Metal Manufacturing	0.308	0.247	0.446	0.60	1.50
22	Metal Manufacturing	0.346	0.189	0.465	1.80	1.50
23	Electrical Equipment Manufacturing	0.552	0.000	0.448	1.80	3.00
24	Transport & other machinery manufacturing	0.528	0.000	0.472	1.90	1.30
25	Other Manufacturing	0.183	0.268	0.549	1.10	0.60
26	Construction	0.536	0.108	0.356	0.20	0.30
27	Electricity gas and water	0.228	0.000	0.772	0.20	0.30
28	Financial Sector	0.357	0.018	0.625	0.20	0.30
29	Private Education	0.619	0.209	0.172	0.20	0.30
30	Private Health	0.253	0.616	0.132	0.20	0.30
31	Public Education	0.974	0.000	0.026		
32	Public Health	0.951	0.000	0.049		
33	General Government	0.960	0.000	0.040		
34	Other Services	0.164	0.498	0.338	0.20	0.30

where k_{t-1} is supply of variable capital in the previous period and vgr_t is growth of variable capital in the current period.

Supply of industry capital stock is specified as

$$(3) \quad k_{it} = k_{it-1} * (1 - depr_i) + inv_{it}$$

where k_{it} is industry i capital stock in period t , $depr_i$ is depreciation rate and inv_{it} is investment.

Emission. Industry emission levels are calculated through the following equation

$$(5) \quad EMIS_k = \sum_{i=1}^n \hat{a}_{ik} * XD_i$$

where $k = (PM, SO_x, NO_x, VOC, CO, BOD_5, SS)$, \hat{a}_{ik} are industry effluent intensities of pollutant k , XD_i domestic production. Note that output of domestic production is either consumed domestically or exported.

Additional Indirect Output Taxes. Simulation experiments were conducted involving additional indirect output tax to see whether industry emission is reduced. This output tax is added to the existing indirect tax. That is,

$$(6) \quad \text{INDTX}_i = \text{ITAX}_i + \text{EMTX}_i$$

where INDTX_i is total indirect taxes imposed on domestic output of industry i , ITAX_i indirect taxes on i , EMTX_i is the additional tax on output, which is not uniform across industries but scaled according to the level of industry emission, which is given by

$$(7) \quad \text{EMTX}_i = \hat{\sigma} * [\text{pol}_i^0 / \bar{\text{pol}}^0 + (\text{pol}_i^1 / \text{pol}_i^0 - 1) * \text{pol}_i^0 / \bar{\text{pol}}^0]$$

$\hat{\sigma}$ is an across-the-board tax, but the scaling factor in the bracket differentiates the effect of the tax across industries. With the scaling factor, industries with higher emission are imposed with higher tax rates than sectors with lower emission. The term in the bracket accounts for the differences in pollution intensities across industries. pol_i^0 is the pollution intensity of i in the base year. pol_i^1 is pollution intensity during the simulated year (1991 to 1999). Therefore $\text{pol}_i^0 / \bar{\text{pol}}^0$ captures the pollution intensity of i relative to the rest of the industries. The term $(\text{pol}_i^1 / \text{pol}_i^0 - 1)$ accounts for the change in pollution intensity of i during the simulation. Equation (7) equation can be simplified as

$$(8) \quad \text{EMTX}_i = \hat{\sigma} * (\text{pol}_i^1 / \bar{\text{pol}}^0)$$

Welfare Index. Welfare indicator is limited to measuring changes in consumption and income. It does not incorporate the pollution effects on overall consumer welfare. The welfare measure used is the Hicksian equivalent variation (EV). This measure takes the old equilibrium incomes and prices and computes the change needed to achieve new equilibrium utilities.⁸ Computationally, this is given by the following formula:

$$(9) \quad \text{EV} = [(U^n - U^0) / U^0] * I^0$$

where U^n , U^0 , I^n , I^0 denote the new and old levels of utility and income, respectively. The model also generates Gini coefficient as the indicator of income inequality.

Simulations

Tariffs

Figure 1 shows how tariff rates changed over the 1990s. These are implicit tariff rates computed using price comparison by Manasan and Querubin (1997). Based on the movements of the rates over time the entire period may be divided into 2 sub-periods for purposes of analysis: 1990-1994 and 1995-2000. One can observe that the program intensified in the second period with implicit tariffs of major sectors declining until the turn of the century. Also, another important feature that needs to be highlighted is the increase in implicit tariffs for agriculture until 1994. This was the effect of “tariffication”

⁸Shoven and Whalley, 1984. "Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey" Journal of Economic Literature.

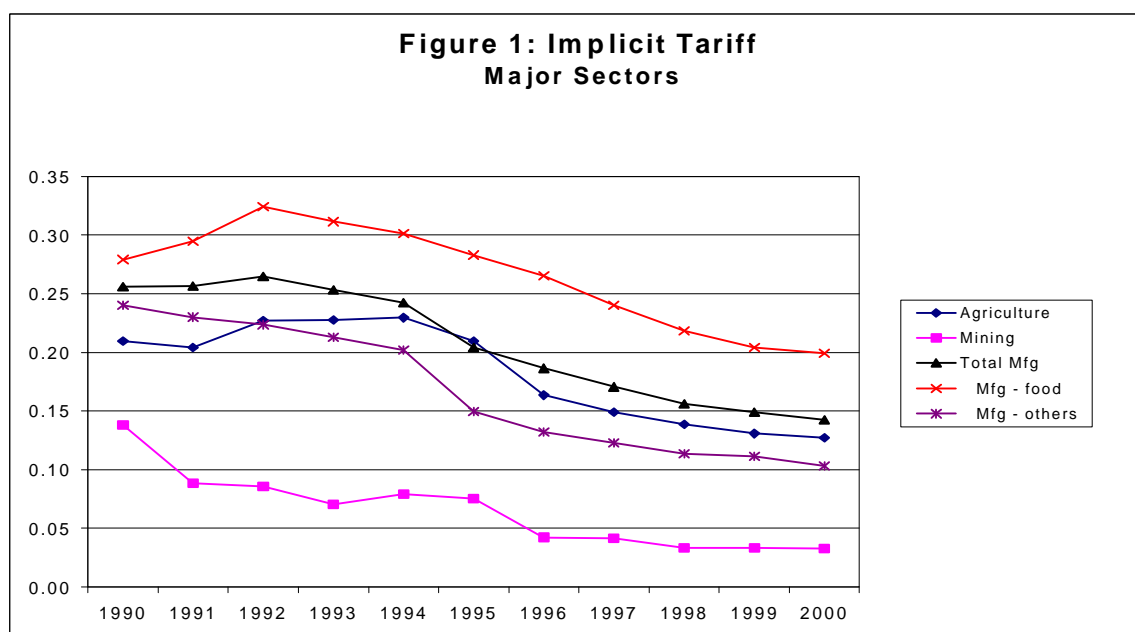
of quantitative restrictions (QR) on several agricultural crops. To date, only QR on rice is retained.

Pollution Intensities

There are no comprehensive data on either total pollution load or pollution intensities in the Philippines. Data on industrial air and water pollution are sparse and often unreliable. The Environmental Sector Units in DENR's Regional Offices are responsible for monitoring environmental quality in their respective Regions while the Environmental Management Bureau (EMB) is responsible for the maintenance of environmental quality data bases⁹.

Pollution intensity is expressed as a ratio of pollution per unit of manufacturing activity.

$$\text{Pollution Intensity} = \text{Pollution Load} / \text{Total Manufacturing Activity}$$



The model uses two different sources of pollution intensity estimates:

- Philippine Environment and Natural Resources Accounting Project (ENRAP)
- World Bank Industrial Pollution Projection System (IPPS).

The ENRAP estimated air and water pollution by industry using emission factors and rapid assessment methodologies devised by the World Health Organization (WHO)

⁹ Despite the intention of the EMB to monitor emissions and effluents of industrial firms with more than ten employees, its efforts have failed because of the agency's staff and resource constraints. In interviews with the EMB and DENR's Regional Offices, the following reasons were cited: lack of necessary equipment to monitor pollution, lack of technically capable staff, lack of funds for the maintenance and repair of pollution equipment, and lack of support from management people who, sometimes, are more concerned with other environmental issues like conservation of natural resources.

and the US Environmental Protection Agency (EPA). It applied the WHO rapid assessment method mainly in estimating water pollution loads as well as in estimating process emissions and the EPA emission factors to generate emissions from fuel combustion. The ENRAP pollution estimates covered all sectors: agriculture, fishing, forestry, mining, manufacturing, and services. The ENRAP pollution coefficients were derived by matching the ENRAP pollution estimates with output data from the National Statistics Office.

Table 6a: ENRAP Pollution Intensity: All Sectors (pounds/current 1990 Philippine peso million output)

	sox	nox	co	voc	pm	bod5	ss
Palay and Corn	0.4	1.1	10.9	1.7	1.3	19,427.9	3,855,547.1
Fruits and Vegetables	4.1	10.6	57.7	9.7	8.6	442.0	87,711.9
Coconut & Sugar	5.5	14.3	77.9	13.2	11.6	14,441.9	2,866,049.6
Livestock & Poultry	4.1	10.7	58.6	9.9	8.7	18,452.1	132,848.6
Fishing	139.5	271.5	236.4	91.8	-	-	-
Other Agriculture	10.1	26.3	143.4	24.4	21.4	901.7	178,942.9
Forestry	134.6	321.9	1,747.7	293.6	262.7	186,804.7	37,072,095.1
Mining	1,829.7	1,463.7	7,193.7	1,221.4	6,219.7	-	3,697,488.1
Rice & Corn Milling	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Milled Sugar	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Meat Manufacturing	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Fish Manufacturing	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Beverage & Tobacco	424.0	265.2	1,095.8	184.8	222.6	2,698.3	2,816.3
Other Food Manufacturing	215.3	196.2	947.2	159.9	933.0	408.7	428.1
Textile manufacturing	727.9	269.8	1,097.4	184.6	219.6	1,446.5	679.1
Garments & Leather	41.0	73.0	389.6	66.2	59.5	101.5	157.4
Wood Manufacturing	467.4	1,147.1	6,226.6	1,055.1	1,113.9	36.5	33.7
Paper & Paper Products	1,366.6	504.2	2,817.4	328.8	3,403.7	1,235.1	1,806.0
Chemical Manufacturing	426.1	218.8	1,057.1	208.8	764.2	213.0	88.9
Petroleum Refining	65.3	120.8	1,465.2	51.9	46.8	75.3	22.2
Non-metal manufacturing	1,354.3	990.0	1,898.2	321.0	649.6	-	143.1
Metal Manufacturing	688.9	306.0	1,162.3	206.6	4,723.2	25.7	101.3
Electrical Equipment Manufacturing	43.8	90.1	484.8	82.2	73.6	-	604.2
Transport & Other Machinery Mfg.	143.1	282.9	1,475.6	771.6	227.7	611.1	262.8
Other Manufacturing	17.3	46.3	251.7	42.9	37.9	-	-
Construction	69.0	162.8	882.0	160.0	1,495.9	-	-
Electricity, Gas and Water	11,961.7	2,070.7	130.7	58.9	825.5	0.8	9,825.0
Financial Sector	6.9	18.2	102.7	17.3	15.0	-	-
Private Education	2.3	5.9	31.9	5.4	4.8	-	-
Private Health	6.5	16.8	92.1	1,032.5	13.7	847.1	383.5
Public Education	2.3	5.9	31.9	5.4	4.8	-	-
Public Health	6.5	16.8	92.1	1,032.5	13.7	847.1	383.5
General Government	56.8	142.7	874.1	185.7	155.5	-	27,912.5
Other Services	43.6	81.6	416.7	164.7	158.8	4,770.6	573.6

Table 6b: WB-IPPS Pollution Intensity: Manufacturing (pounds/current 1990 Philippine peso million output)

	sox	nox	co	voc	pm	bod5	ss
Rice & Corn Milling	10.6	8.4	1.6	8.9	17.4	-	-
Milled Sugar	206.9	198.6	106.4	35.2	4.3	68.6	98.3
Meat Manufacturing	6.3	64.3	16.1	0.3	0.2	1.0	1.3
Fish Manufacturing	5.6	2.4	0.2	0.1	0.1	18.5	31.5
Beverage & Tobacco	49.6	30.7	3.1	48.5	0.7	18.1	32.7
Other Food Manufacturing	76.2	55.8	23.3	17.3	23.4	42.5	25.1
Textile manufacturing	66.2	86.3	13.1	27.4	1.7	2.5	3.9
Garments & Leather	1.1	0.4	0.1	1.4	-	0.2	0.3
Wood Manufacturing	72.2	108.9	268.2	159.7	23.5	3.8	17.6

Paper & Paper Products	271.6	151.8	311.0	56.1	15.3	145.7	492.7
Chemical Manufacturing	179.1	196.3	91.7	151.2	5.1	47.6	175.4
Petroleum Refining	397.5	228.9	206.3	208.7	4.1	4.9	24.6
Non-metal manufacturing	679.1	346.6	47.7	21.1	550.6	3.0	15.9
Metal Manufacturing	687.9	161.6	698.8	58.8	98.9	26.4	4,154.9
Electrical Equipment Manufacturing	5.0	2.4	2.1	10.5	0.1	0.8	1.2
Transport & Other Machinery Manufacturing	6.8	5.9	13.3	40.9	0.5	0.2	4.1
Other Manufacturing	38.1	18.0	167.0	39.4	6.5	1.6	150.9

The World Bank's IPPS coefficients were estimated based on the US EPA data on air, water, and solid emissions and the 1987 US Manufacturing Census. The IPPS pollution coefficients were estimated only for the manufacturing sector and are given in Table 6b. The IPPS coefficients were derived by mapping the IPPS output based pollution intensities with the four-digit Philippine Standard Industrial Classification codes.

As expected, the ENRAP coefficients were found to be substantially higher than IPPS pollution coefficients, except for a few pollutants in certain sectors like suspended solids (SS) in chemical manufacturing, petroleum, non-metal and metal manufacturing. ENRAP intensities for sulfur dioxide (SOX), nitrogen oxides (NOX), and volatile organic compounds (VOC) intensities in petroleum manufacturing were higher than IPPS. ENRAP intensities for Sox in other manufacturing turned out to be higher than IPPS. In these cases, only the IPPS will be used. ENRAP SOX intensities in metal manufacturing and milled sugar were almost the same as IPPS. Both ENRAP and IPPS Nox intensities in milled sugar and SS intensities in petroleum were also found to be approximately equal.

On the basis of the above estimates, the model used three sets of pollution intensities in the analysis: (1) complete ENRAP intensities with pollution coefficients covering all sectors in the model (Table 6a); (2) ENRAP manufacturing intensities with pollution coefficients for manufacturing industries only; and (3) WB-IPPS-manufacturing intensities with pollution coefficients for manufacturing industries only (Table 6b). The first set of intensities was used in the analysis of tariff reforms, while the second and the third sets were used in the analysis of technology change in production.

Simulation Results

1. Macroeconomic Effects

Table 7 presents the macro effects of the tariff reform program. For purposes of the analysis, the entire period is divided into 2 sub-periods: 1991-94 and 1995-99. The results are presented in period annual averages.

Over the entire period the average impact of the program on real GDP growth is 0.32 percent per year. However, broken down into the sub-periods, the 1995-99 period shows higher real GDP growth effect per year (0.51 percent) than in the first period (0.08 percent).

The same pattern is observed in the rest of the macroeconomic results. With larger tariff reduction in the second period, imports increase by 2.7 percent per year. This effect is bigger than the 0.30 percent increase per year in the first period. This bigger drop in tariff rates in the second period however results in a substantial drop in government tariff revenue by -43.7 percent per year, as compared to only -0.60 percent drop per year in the first period. The positive effects on real GDP growth in the second period though translate to slightly higher direct and indirect tax revenue of the government. In spite of the increase, in net terms, the impact of the tariff reform program on government deficit is substantial, averaging -P7 billion per year in the second period, as compared to only -P1.9 billion per year in the first period.¹⁰

Table 7. Macroeconomic Effects

	Average		
	1991-99	1991-94	1995-99
Real GDP growth /1/	0.32%	0.08%	0.51%
Imports /2/	1.63%	0.30%	2.70%
Exports /2/	1.51%	0.52%	2.31%
Government Budget Balance /3/ % of GDP	-3,976 -0.39%	-1.9 0.00%	-7,155.5 -0.71%
Government Revenue /2/ of which:	-1.91%	0.16%	-3.56%
Tariff Revenue /2/	-24.55%	-0.60%	-43.70%
Direct Tax Revenue /2/	1.29%	0.17%	2.19%
Indirect Tax Revenue /2/	0.80%	0.44%	1.09%
Price Changes /4/			
General Import Prices in Local Currency	-2.22%	-0.14%	-3.89%
Composite Prices /5/	0.04%	0.27%	-0.15%
Average Wage Rate /2/	1.06%	0.14%	1.79%
Average Rent to Variable Capital /2/	1.49%	-0.10%	2.76%

/1/ Annual average growth difference from base run

/2/ Annual average% difference from base run

/3/ Annual average absolute difference from base run (P million)

/4/ Agriculture, Mining and Manufacturing

/5/ Prices of locally produced and imported goods

The impact of tariff reduction on prices is generally favorable. General import prices in local currency decline by -3.89 percent per year in the second period, substantially higher drop than the first period of -0.14 percent per year. However, the composite price, which is the combined price of locally produced and imported goods, declines marginally by -0.15 percent per year in the second period, as opposed to a slight increase in the first period of 0.27 percent per year. Annual results, which are available but not presented in the table, indicate that the decline in the composite price is higher towards the end of the second period when the reduction in tariff rates is substantial.

¹⁰Note that investment is shielded from the negative effects on government savings during the simulation with the closure assumption of fixed investment. In the analysis, with endogenous foreign savings the tariff reform program in effect is being financed by foreign inflows.

The effects on factor prices are favorable as well. As we shall see shortly, these have favorable impact on household incomes. Average wage rate increases by 1.79 percent per year in the second period, which is higher than in the first period increase of 0.14 percent per year. Average price of variable capital also increases by a higher rate of 2.76 percent per year in the second period, as compared to a decline in the first of -0.1 percent per year. Since prices are declining, especially in the second period, this implies higher increase in real price of factors.

Table 8 presents the simulation results on output and factor inputs of major sectors, while Table 20 shows the effects on industry output. The tariff reform program results in noticeable resource allocation effects. Resources tend to move out of the primary sector towards manufacturing, in particular other manufacturing sector. These resource allocation effects, which translate into higher output growth for other manufacturing, are evident in the second period than in the first period. On the average, other manufacturing grows by 2.32 percent per year in the second period as compared to 0.33 percent per year in the first period. In terms of specific industries in other manufacturing, electrical equipment manufacturing and garments and textile benefit the most in terms of output growth.

Table 8. Sectoral Output and Factor Inputs : Major Sectors /1/

Average: 1991-99	Output	Factor Inputs		
		Labor	Variable Capital	Capital
Agriculture	-0.19%	0.15%	-0.25%	-0.29%
Mining	-0.54%	-1.06%	-1.44%	0.00%
Manufacturing	0.86%	1.08%	0.79%	0.58%
Food Manufacturing	0.09%	0.64%	0.00%	0.00%
Other Manufacturing	1.44%	1.38%	1.74%	1.44%
Construction	-0.50%	-0.15%	-0.54%	-1.02%
Utilities	0.30%	1.39%		-0.01%
Services	-0.15%	-0.36%	0.08%	-0.24%
Average: 1991-94				
Agriculture	-0.04%	-0.16%	-0.02%	0.02%
Mining	0.15%	0.30%	0.54%	-0.02%
Manufacturing	0.18%	0.57%	0.30%	-0.02%
Food Manufacturing	-0.02%	-0.24%	0.03%	0.00%
Other Manufacturing	0.33%	1.15%	0.62%	-0.05%
Construction	-0.36%	-0.18%	0.06%	-0.75%
Utilities	-0.21%	-0.83%		-0.02%
Services	-0.07%	-0.09%	-0.05%	-0.06%
Average: 1995-99				
Agriculture	-0.32%	0.40%	-0.42%	-0.54%
Mining	-1.08%	-2.15%	-3.02%	0.01%
Manufacturing	1.40%	1.48%	1.19%	1.06%
Food Manufacturing	0.17%	1.35%	-0.02%	0.00%
Other Manufacturing	2.32%	1.57%	2.63%	2.63%
Construction	-0.62%	-0.13%	-1.03%	-1.24%
Utilities	0.71%	3.17%		-0.01%
Services	-0.22%	-0.57%	0.19%	-0.38%

/1/ Annual average % difference from base run

Table 9. Output: Specific Industries

Sectors	Average		
	1991-99	1991-94	1995-99
Palay and Corn	-0.03%	0.03%	-0.07%
Fruits and Vegetables	-0.39%	0.04%	-0.74%
Coconut & Sugar	0.22%	0.33%	0.13%
Livestock & Poultry	-0.34%	-0.05%	-0.56%
Fishing	-0.27%	-0.34%	-0.22%
Other Agriculture	0.04%	-0.01%	0.07%
Forestry	-0.21%	-0.28%	-0.15%
Mining	-0.54%	0.15%	-1.08%
Rice & Corn Milling	0.00%	0.04%	-0.04%
Milled Sugar	0.13%	-0.14%	0.35%
Meat Manufacturing	0.07%	0.08%	0.05%
Fish Manufacturing	-0.24%	-0.15%	-0.31%
Beverage & Tobacco	0.43%	-0.06%	0.81%
Other Food Manufacturing	0.14%	-0.10%	0.33%
Textile manufacturing	1.49%	0.63%	2.19%
Garments & Leather	4.81%	2.13%	6.96%
Wood Manufacturing	-0.15%	-0.37%	0.02%
Paper & Paper Products	-0.37%	-0.19%	-0.52%
Chemical Manufacturing	0.06%	-0.16%	0.23%
Petroleum Refining	-0.16%	0.93%	-1.03%
Non-metal manufacturing	0.03%	-0.42%	0.39%
Metal Manufacturing	-0.75%	-0.96%	-0.59%
Electrical Equipment Manufacturing	7.77%	2.79%	11.75%
Transport & Other Machinery Manufacturing	1.84%	-1.85%	4.79%
Other Manufacturing	-0.35%	-0.41%	-0.30%
Construction	-0.50%	-0.36%	-0.62%
Electricity, Gas and Water	0.30%	-0.21%	0.71%
Financial Sector	-0.01%	-0.09%	0.06%
Private Education	0.24%	-0.12%	0.54%
Private Health	0.31%	0.02%	0.54%
Public Education	0.00%	0.00%	0.01%
Public Health	0.02%	-0.01%	0.05%
General Government	-1.68%	0.14%	-3.14%
Other Services	0.01%	-0.11%	0.11%

/1/ Annual average % difference from base run

2. Welfare and Distribution Effects

Table 10 presents the effects of the program on household welfare and on income distribution. Welfare effects are measured in terms of equivalent variation, while the distribution effects are measured by the income growth of households and the Gini coefficient.

Table 10. Welfare and Distribution

Equivalent Variation (P million)	Average		
	1991-99	1991-94	1995-99
hh1	83	(24)	169
hh2	146	(35)	291
hh3	195	(39)	382
hh4	240	(46)	470
hh5	281	(47)	543
hh6	331	(53)	639
hh7	367	(46)	698
hh8	427	(46)	805
hh9	619	(46)	1,151
hh10	1,643	(96)	3,034
Household Total	4,333	(477)	8,182
Disposable Income /1/			
hh1	1.29%	0.01%	2.31%
hh2	1.28%	0.02%	2.29%
hh3	1.28%	0.03%	2.28%
hh4	1.27%	0.03%	2.26%
hh5	1.26%	0.04%	2.23%
hh6	1.23%	0.05%	2.18%
hh7	1.18%	0.07%	2.08%
hh8	1.14%	0.08%	1.99%
hh9	1.16%	0.09%	2.01%
hh10	1.24%	0.08%	2.16%
Gini Coefficient*	-0.02%	0.03%	-0.06%
Ratio: EV/Disposable Income			
hh1	0.449%	-0.130%	0.913%
hh2	0.470%	-0.115%	0.938%
hh3	0.493%	-0.100%	0.968%
hh4	0.493%	-0.098%	0.965%
hh5	0.488%	-0.085%	0.947%
hh6	0.474%	-0.077%	0.915%
hh7	0.440%	-0.057%	0.837%
hh8	0.406%	-0.045%	0.767%
hh9	0.436%	-0.033%	0.810%
hh10	0.535%	-0.032%	0.989%
Household Total	0.480%	-0.054%	0.907%

/1/ Annual average % difference from base run

Generally, the effects are favorable both in terms of household welfare and distribution. The removal of tariff distortion leads to an increase in welfare, averaging P8 billion per year in the second period. Interestingly, this is higher by P1 billion per year than the average increase in government deficit, as we have seen earlier. There is an average net loss in welfare in the first half, which can be attributed to the increase in tariff rates in some sectors, like agriculture for example.

The income distribution effects are favorable as well. The Gini coefficient declines by –0.06 percent per year in the second period. This implies an improvement in income distribution. In terms of specific household groups, the first decile, which is the poorest group, registers the highest increase in income of 2.31 percent per year in the second period. The lowest is the 8th household group. The favorable effects on factor prices observed earlier translate to positive effects on household incomes, especially in the second period relative to the first period.

Table 10 also shows the ratio of welfare over household income. The increase in welfare on the average in the second period is less than 1 percent of income, in particular 0.907 percent. Of the household groups, it is the 10th decile, the richest group, which benefits the most, with a ratio of 0.989 percent. One factor behind this is that this group benefits greatly from higher consumption when tariff distortion is reduced. The group has highest consumption of imported goods relative to the rest of the household groups.

3. Emission Effects

Table 11. Emission: Major Sectors

	Tons, annual average change, 1991-1999						
	SOX	NOX	CO	VOC	PM	BOD5	SS
Total Economy	298	97	167	100	-124	-191	-99,026
Agriculture	-1	-2	-5	-1	-2	-636	-31,045
Mining	-32	-25	-124	-21	-108	0	-64,065
Manufacturing	89	106	446	141	40	199	342
Food Manufacturing	16	13	56	9	41	62	66
Other Manufacturing	73	93	390	132	-1	136	276
Construction	-3	-6	-33	-6	-56	0	0
Utilities	251	43	3	1	18	0	207
Services	-7	-19	-118	-15	-17	246	-4,464
	Annual average % difference from base run, 1991-1999						
Total	0.19%	0.11%	0.05%	0.14%	-0.25%	-0.09%	-0.03%
Agriculture	-0.27%	-0.28%	-0.20%	-0.19%	-0.37%	-0.17%	-0.40%
Mining	-0.54%	-0.53%	-0.54%	-0.55%	-0.54%	0.00%	0.22%
Manufacturing	0.17%	0.34%	0.37%	0.56%	-0.16%	0.52%	-0.34%
Food Manufacturing	0.10%	0.11%	0.09%	0.09%	0.07%	0.18%	0.00%
Other Manufacturing	0.20%	0.45%	0.51%	0.80%	-0.32%	1.09%	0.05%
Construction	-0.51%	-0.51%	-0.51%	-0.48%	-0.51%	0.00%	-0.21%
Utilities	0.30%	0.30%	0.25%	0.09%	0.31%	0.00%	0.00%
Services	-0.26%	-0.31%	-0.36%	-0.13%	-0.20%	0.02%	0.00%

3a. SOX. Emission of this substance increases by an average of 0.19 percent per year from the base run as a result of the tariff reform program. The biggest contributor is the utilities, with an average increase of 251 tons per year over the period. Other manufacturing comes far second, but in terms of specific industries, the increase comes from textile (31 tons), non-metal manufacturing (20 tons), transport and other machinery (15 tons) and electrical equipment (14 tons).

3b. NOX. There is also an increase in the emission of NOX as a result of the tariff program. The average total increase is 97 tons, or about 0.11 percent from the base run. As a sector the biggest contributor is other manufacturing, but in terms of specific industries, still the largest increase comes from the utilities sector.

3c. CO. The increase in the emission of this pollutant is very small relative to the base run. The annual average increase over the period is 167 tons, representing an average increase of 0.05 percent from the base run. The increase comes from electrical equipment machinery, transport and other machinery, garments and textile.

3d. VOC. Emission of this substance increases by an annual average of 100 tons, representing 0.14 percent increase from the base run values. The biggest contributor is transport and other machinery.

3e. PM. There is a decline in the emission of PM pollutant as a result of the tariff program. The annual average decline over the period is –124 tons, representing about – 0.25 percent of the base run emission. Major reduction comes from the mining sector, metal manufacturing, and construction.

3f. BOD5. Emission from this pollutant declines by an annual average of –191 tons, which is -0.09 percent from the base run. The biggest drop comes from livestock and poultry industry.

3g. SS. Emission from this substance declines by an annual average of –99 thousand tons for the period. This is very small, representing –0.03 percent of the base run emission. Of this the biggest drop comes from mining, palay and corn, and forestry.

On the whole, the results of this experiment indicate some possibility of economic and welfare gains from the tariff reform program. Because of changes in relative prices as a result of tariff reform, resources move towards the manufacturing sector. This indicates some possibilities of favorable industrialization. Furthermore, progressivity in income and household welfare emerges from the results. However, the impact on pollution is mixed: emission levels of some pollutants increases, while other decline. But the overall change in the level of emission for all pollutants seems to be very small relative to case where there is no tariff reform program.

4. Effects of Additional Indirect Output Tax

The main objective of this simulation exercise is to see whether additional indirect tax on industry output will reduce emission. As discussed above, the additional tax is scaled according to the emission level by industry, so that those with higher emission will shoulder higher taxes than those with lower emission. The experiment was conducted using 2 levels of δ in Equation (8) namely, 10 and 50 percent in each of the pollutants. The effects are analyzed with respect to the impact at the macroeconomic level, household welfare and income distribution, and emission of all 7 pollutants. The welfare effects are important to take note because normally indirect tax on industry output is highly distortionary. The results are presented in Table 13.

One can observe from the results that the introduction of higher additional output taxes will significantly reduce GDP growth and economic welfare. The welfare gain from tariff reform is completely wiped out with additional output taxes. In some cases, additional output taxes resulted in welfare losses.

However, the gain in terms of reduction of emission is not significant. In certain cases, emission increases. For example, scenario (b), simulation using NOX emission and scenario (c), using CO emission, results in increase in emission. Under these scenarios the loss in welfare is also significant. The policy implication of these results is that, while trade liberalization results in improved welfare and higher GDP growth and marginal increase in emission, additional output taxes to control emission may be ineffective. The introduction of additional output taxes only creates distortion that wipes out the benefit of tariff reform.

Table 12: Emission: Industries (tons, annual average absolute change, (1991-1999))

	SOX	NOX	CO	VOC	PM	BOD5	SS
Palay and Corn	0	0	0	0	0	-67	-13,236
Fruits and Vegetables	0	-1	-2	0	-1	-12	-2,308
Coconut & Sugar	0	0	0	0	0	8	1,496
Livestock & Poultry	0	-1	-2	0	-1	-497	-3,579
Fishing	-1	-1	-1	-1	0	0	0
Other Agriculture	0	0	-1	0	0	-2	-287
Forestry	0	-1	-1	0	-1	-66	-13,132
Mining	-32	-25	-124	-21	-108	0	-64,065
Rice & Corn Milling	-1	0	-1	-1	-1	-1	-1
Milled Sugar	2	2	6	1	6	3	3
Meat Manufacturing	2	2	6	1	6	3	3
Fish Manufacturing	-1	-1	-2	-1	-2	-1	-1
Beverage & Tobacco	8	5	19	3	4	47	49
Other Food Manufacturing	6	6	29	5	28	12	13
Textile manufacturing	31	12	46	8	10	61	29
Garments & Leather	8	14	77	13	12	20	31
Wood Manufacturing	2	4	20	4	4	0	0
Paper & Paper Products	-8	-3	-17	-2	-20	-8	-11
Chemical Manufacturing	5	2	11	2	8	2	1
Petroleum Refining	-3	-6	-76	-3	-3	-4	-1
Non-metal manufacturing	20	15	29	5	10	0	2
Metal Manufacturing	-10	-5	-17	-3	-70	-1	-2
Electrical Equipment Manufacturing	14	30	160	27	24	0	200
Transport & Other Machinery Manufacturing	15	30	156	82	24	65	28
Other Manufacturing	0	0	1	1	1	0	0
Construction	-3	-6	-33	-6	-56	0	0
Electricity, Gas and Water	251	43	3	1	18	0	207
Financial Sector	0	0	1	0	0	0	0
Private Education	0	0	0	0	0	0	0

Private Health	0	0	1	7	0	6	3
Public Education	0	0	0	0	0	0	0
Public Health	0	0	0	0	0	0	0
General Government	-9	-23	-141	-30	-25	0	-4,495
Other Services	2	4	21	8	8	240	29

In sum, the lessons that may be drawn from the experiments is that the economic cost of additional distortionary output tax is significant than the possible gains through reduced emission. In some cases, additional output taxes do not only wipe out all the economic gains from the tariff reform, they also tend to increase the emission of some pollutants.

5. Technology Effects

The last set of experiments involves changes in pollution intensities in manufacturing. The ENRAP-manufacturing intensities are compared with the WB-IPPS intensities in the simulation runs to see whether they will impact on the level of emission. The ENRAP-manufacturing is supposed to capture an old production technology, while the WB-IPPS a newer one. Both intensities are simulated within the regime of tariff reform.

In terms of levels the difference in emission is substantial, especially for CO and PM (Table 14). The difference increases as the tariff reform progresses for all pollutants. These results imply that improvement in production technology may be a major factor in checking the problem of pollution in the process of industrialization.

However, there is one weakness in the experiments. Production technology should be made endogenous in the model as the country opens up to trade because, normally, trade favorably affects the level of production technology. Inflows of modern technology increases with import and export growth. Thus, the present simulation experiments may have understated the effects on pollution. However, this issue is too complex to be addressed in the present exercise.

Table 13: Addition Indirect Output Tax

a. Using SOX emission					Sox									Annual average emission (tons)						
Scenario	Additional Indirect Output Tax (weights:Sox emission)	GDP growth/1/	Gini/2/	EV/3/	Annual ave. Emission (tons)	Average Emission by Major Sectors (tons)														
						Agricul- ture	Mining	Manufacturing			Construc- tion	Utilities	Services							
								Total	Food	Others				Sox	Nox	CO	VOC	PM	BOD5	SS
1	10%	0.30%	-0.02%	3,839	263.1	-0.5	-30.2	85.7	14.6	71.1	-2.0	217.2	-7.1		91.7	183.5	102.3	-116.4	-207.6	-90,740
2	50%	0.15%	0.01%	1,276	-117.9	0.5	-21.2	74.1	7.6	66.5	1.0	-168.3	-4.0		46.4	296.4	112.9	-60.5	-252.5	-48,002
b. Using NOX emission					Nox									Sox	Nox	CO	VOC	PM	BOD5	SS
1	10%	0.27%	-0.01%	3,109	99.3	-1.5	-22.7	104.8	11.6	93.2	-4.0	40.3	-17.6	283.8		200.1	99.3	-100.3	-338.7	-82,582
2	50%	0.02%	0.04%	(2,356)	106.3	3.5	-11.1	97.8	3.0	94.8	5.0	23.2	-12.1	207.1		344.7	94.2	18.1	-1,056.4	-7,192
c. Using CO emission					CO									Sox	Nox	CO	VOC	PM	BOD5	SS
1	10%	0.25%	-0.01%	2,663	209.7	-2.5	-108.4	440.5	45.9	394.6	-18.1	2.5	-104.3	291.3	100.8		97.8	-88.7	-412.3	-77,976
2	50%	-0.10%	0.07%	(5,050)	413.3	6.6	-29.7	424.4	-4.5	428.9	52.4	1.5	-41.8	258.0	126.0		88.7	85.2	-1,559.4	23,726
d. Using VOC emission					VOC									Sox	Nox	CO	VOC	PM	BOD5	SS
1	10%	0.21%	0.00%	1,679	93.2	0.0	-17.1	134.1	7.1	127.0	-1.0	1.0	-23.7	296.4	108.9	248.0		-46.4	-560.9	-55,208
2	50%	-0.42%	0.11%	(12,164)	61.0	6.6	8.6	97.8	-4.5	102.3	27.2	0.5	-79.6	289.8	180.9	695.5		381.5	-2,883.4	193,437
e. Using PM emission					PM									Sox	Nox	CO	VOC	PM	BOD5	SS
1	10%	0.28%	-0.01%	3,411	-170.4	-1.5	-102.3	-7.6	32.8	-40.3	-58.0	16.6	-17.6	283.8	94.2	165.3	94.8		-325.1	-95,618
2	50%	0.07%	0.03%	(641)	-464.2	-0.5	-79.6	-286.8	-7.1	-279.7	-90.2	12.1	-19.2	193.5	64.5	114.9	61.0		-980.3	-91,578
f. Using BOD5 emission					BOD5									Sox	Nox	CO	VOC	PM	BOD5	SS
1	10%	0.19%	0.01%	992	-758.0	-490.9	0.0	214.7	49.9	164.8	0.0	0.0	-481.8	320.5	126.0	321.0	110.9	12.1		-54,479
2	50%	-0.69%	0.17%	(18,319)	-4,682.1	425.9	0.0	310.0	-34.8	344.7	0.0	0.0	-5,418.0	426.9	296.9	1,246.9	177.4	826.1		227,505
g. Using SS emission					SS									Sox	Nox	CO	VOC	PM	BOD5	SS
1	10%	0.32%	-0.02%	4,243	-130,699	-62,977	-63,886	342.2	64.5	277.7	0.0	206.6	-4,384.3	298.4	97.3	166.8	99.8	-129.5	-344.2	
2	50%	0.29%	0.01%	3,713	-442,377	-376,839	-62,275	342	50.9	291.3	0.0	206.6	-3,811.2	297.4	93.7	145.2	99.3	-157.2	-1,872.9	

/1/ annual average of growth difference from base run

/2/ 1991-1999 annual average of % difference from base run

/3/ 1991-1999 annual average (P million)

Table 14. Emission Difference Between Enrap-Mfg and WB-IPPS-Mfg Pollution Coefficients (metric tons)

Substance	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	Average
Sox	66.9	66.8	66.7	66.7	66.8	67.2	67.5	67.6	67.7	67.8	67.2
Nox	62.9	62.9	62.6	62.7	62.9	63.3	63.5	63.6	63.8	63.9	63.2
Co	405.2	405.3	404.4	404.8	405.6	407.4	408.0	408.2	409.1	409.3	406.7
VOC	59.3	59.3	58.8	58.9	59.2	59.8	60.2	60.3	60.6	60.6	59.7
PM	315.8	315.6	314.4	314.3	314.4	315.0	316.0	315.7	316.2	316.1	315.4
BOD5	140.3	140.4	140.0	140.3	140.5	141.3	141.4	141.8	141.9	142.1	141.0
SS	43.2	43.4	44.5	44.8	45.2	46.0	45.7	46.2	46.6	46.9	45.2

Summing Up

There are possibilities of economic and welfare gains from the tariff reform program. Distribution is also seen to improve. Based on the results, gains may continue to accumulate as the government embarks on other trade reform programs in the near future.

Tariff rates are distortionary taxes. Reducing them results in welfare gain. However, the reduction entails a substantial impact on government revenue, as tariff is a major source of government income. Thus, the implication on the government budget is large. Indeed, the challenge is to replace it with some kind of a “neutral tax”.

Additional output tax to address pollution problems is not recommended. Output tax is similar to tariff rate, which is distortionary. Additional output tax will not only wipe out all the possible gains from the tariff reform, its impact on emission is marginally small. The effects are also mixed: the emission level of some pollutants increase with additional output taxes, while other decline.

The impact of improvement in production technology on the level of emission is significant. Also, the improvement widens as the tariff reform progresses.

However, the experiments may have understated the impact on the level of emission. This is because pollution coefficients were held fixed during the experiments. Production technology should be endogenous in the model as the country opens up to trade because, normally, trade favorably affects the level of production technology. Inflows of modern technology increases with import and export growth. However, this issue is too complex to be addressed in the present exercise. This may well be a good topic for future research.

Industry Case Studies

Case Study 1: The Environmental Impact of Trade Liberalization on the Philippine Sugar Milling and Refining Industry

1. Profile of the Philippine Sugar Milling and Refining Industry

In the Philippines, sugar is extracted from sugarcane. As the sugar content of cane deteriorates rapidly from harvest, sugar mills are located in sugar fields to facilitate cane reception at the mills. In the milling process, raw sugar is produced from canes. Bagasse, filter cake, and molasses are the major by-products of the milling process. Raw sugar is further processed in the refining stage to produce refined sugar.

As one of the country's major traditional exports, the sugar industry has been an important component of the Philippine economy. In 1998, the industry provided direct employment to 675,000 workers and a source of income for about 4.1 million Filipinos (Tolentino, 1999).

Historically, the development of the industry depended heavily on the US sugar market which allowed preferential access to Philippine sugar. Until the early 1980s, the US absorbed a large proportion of Philippine sugar exports. Sugar exports to the US reached over 80% of total Philippine production.

There are 35 sugar mills in the country, the bulk of which are located in Negros and Panay. On the average, these mills accounted for 63% of total raw sugar production for the period 1990 to 2000. Luzon mills had an average share of 21% while Eastern Visayas/Mindanao mills represented an average share of 16% during the same period.

The leading mills in the industry are Victorias (in Negros) which has an average share of 10% of total production closely followed by Busco (Eastern Visayas/Mindanao) and Don Pedro in Luzon with average shares of 8% and 7%. Tarlac in Luzon and Lopez in Negros are next with equal average shares of 6%. La Carlota, Biscom, Hawaiian-Philippines, Bais, and First Farmers which are all located in Negros follow with average shares of between 4% to 5%.

Between the years 1990/91 to 1999/00, the production of raw sugar has not changed much, although a downward trend seemed to be evident. During this period, production reached its peak of about 2 million MT in 1991 and 1992 from a level of about 1.7 million MT in 1990 (see Table 15). Since 1993, there were fluctuations in production; in 1999 and 2000, raw sugar production was registered at only about 1.6 million MT, the lowest level hit by the industry during the 1990s.

Table 15: Raw Sugar Production (in MT), 1990/91 to 1999/00

Sugar Mill	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00
Luzon	425,665	454,624	464,032	393,405	344,778	343,542	390,116	355,920	286,091	317,583
Negros	945,053	1,144,962	1,116,632	1,013,296	953,604	1,023,201	1,026,925	1,003,459	908,094	881,306
Panay	104,666	148,961	159,364	117,446	91,396	103,284	115,379	137,331	125,665	88,664
E. Vis/Mind	244,246	262,294	318,380	285,164	257,244	320,761	296,189	306,034	304,472	331,970
Phils	1,719,630	2,010,841	2,058,408	1,809,311	1,647,022	1,790,788	1,828,609	1,802,744	1,624,322	1,619,523
Percent Change		17	2	(12)	(9)	9	2	(1)	(10)	(0)

2. Government Regulations and Policies Affecting the Industry

The preferential access to the US sugar market provided premium returns among industry participants. Thus, government intervention in the industry has been extensive because of the need to divide the higher than normal returns among millers and planters. The government adopted a market sharing arrangement known as quedan system. The system allocated shares of the US and other markets such that all producers enjoyed equal proportional access to each market. Sugar was classified into different classes by type of market: US, domestic, reserve sugar, and sugar for export to other countries other than the US. Through quedans, planters received between 60 to 70% of the raw sugar while millers received between 40 to 30% of raw sugar depending on the level of production. The quedan is the warehouse receipt issued by the miller certifying to the presence of sugar stored in the warehouse. Quedans are issued on the basis of the sugar classification by destination and on the production sharing arrangement between the miller and the planter.

The Sugar Regulatory Administration (SRA), a quasi-government organization, was set up to control and regulate the sugar market. Its functions are as follows:

- Classification of all sugar produced in the country
- Enforcement of the production sharing system (quedan system) between domestic planters and millers
- Classification of imported sugar

- Imposition and collection of various fees and liens.

Table 16 presents the tariff structure of the Philippine sugar industry since the 1970s. With the implementation of the government's tariff reform program in the early 1980s, tariff rates on raw and refined sugar declined from 70% to 50% between 1973 to 1981. In 1993, tariff adjustments were made which increased refined sugar tariffs to 70%, although these fell to 60% in 1994 and to 50% in 1995.

Table 16: Structure of Tariffs in the Sugar Industry (in %)

Year	Raw Sugar	Refined Sugar
1972	P25/100 kgs Gross Weight	P160/100 kgs Gross Weight
1973	70	70
1981	50	50
1992	75/70	50
1993		70
1994	60/50	60
1995		50
1996	In-Quota: 50%; Out-Quota: 100%	In-Quota: 50%; Out-Quota: 100%
1997	In-Quota: 50%; Out-Quota: 100%	In-Quota: 50%; Out-Quota: 80%
1998	In-Quota: 50%; Out-Quota: 100%	In-Quota: 50%; Out-Quota: 100%
1999	In-Quota: 50%; Out-Quota: 65%	In-Quota: 50%; Out-Quota: 65%
2000	In-Quota: 50%; Out-Quota: 65%	In-Quota: 50%; Out-Quota: 65%

In February 1992, the quantitative restrictions on sugar were lifted under Central Bank Circular Number 850. Republic Act 8178 of May 3, 1996 replaced quantitative restrictions on sugar with tariffs. The Act allowed the importation of raw and refined sugar within the minimum access volume (MAV) at 50% in-quota tariffs. Volumes of imported refined sugar beyond the MAV are levied a higher tariff rate of 100% in 1996. This declined to 80% in 1997 and to 65% in 1999. For imported raw sugar, the out-quota rate was at 100% from 1996 to 1998 and this was reduced to 65% in 1999.

3. Environmental Aspects of the Sugar Industry

A. Sugar Manufacturing Process¹¹

There are five major operations involved in the production of raw sugar.

Milling: Sugar cane is disintegrated into smaller pieces, these shredded cane then passes through a series of heavy mill rollers under high pressure to extract juice. To effect good extraction of juice from the cane, maceration liquid (hot water and light mill juice) is added to the cane/bagasse (fiber residue from cane) bed.

Clarification: The most common way to clarify cane juice is through the defecation process where juice is treated with milk of lime to attain a pH of 7.5 to 8.5 and then heated to a few degrees above 100 degrees Centigrade. The lime-heat treatment results in the formation of a flocculent precipitate which entraps suspended particles/impurities as it settles. Settling is completed in large settling tanks or clarifiers where the juice is drawn off continuously from the top and sent for evaporation.

¹¹ Philippine Sugar Millers Association, Inc.

Evaporation: The clarified juice is fed into the pre-evaporators where initial evaporation of water occurs. Then it goes to the quadruple effect evaporators where a progressive concentration of the thin juice from 12% sugar to a thick sugar is effected. The syrup contains about 55% sucrose, 35% water, and 10% non-sugars.

Crystallization: The heavy syrup is further concentrated in the single-effect vacuum pan evaporators to effect the crystallization of sugar. The massecuite (mixture of sugar crystals and mother liquor) formed in the boiling process contains about 75% sugar, 25% moisture and impurities. The massecuite is dropped to crystallizers (vessels with continuous mixers) where gradual cooling and crystallization of the sugar is effected.

Centrifugation: The massecuite is then dropped into centrifugal machines lined with metal screens. The high spinning action of the centrifugal machines throws off and separates the molasses from the sugar crystals.

Sugar refining involves the following steps:

Affination and melting: Affination refers to the removal of molasses film covering the raw sugar crystal through washing with a syrup in a centrifugal machine. The affined sugar is melted with thin syrup in preparation for clarification.

Clarification: The clarification technology used is carbonation, a process which involves the liming of the melted liquor, the heating of the mixture, and bubbling of CO₂ gas from the boilers into the mixture. The calcium carbonate (CaCO₃) precipitate formed in the process entraps the entrained suspended/insoluble impurities consisting of semi-colloidal matter, ash, and colored substances contained in the melted raw sugar.

Filtration: The mixture from the carbonation process is sent to the pressure filters to separate the clear liquor from the calcium carbonate precipitate.

Decolorization: This involves the removal of dissolved impurities and colorants from the clarified liquor.

Evaporation: The liquor from the decolorization process is evaporated in multiple-effect evaporators to raise concentration to 70 degrees Brix or higher.

Crystallization: The concentrated liquor is sent to the vacuum pans where sugar crystals are precipitated as the liquor is further evaporated. When the optimum crystallization is attained, the resulting magma (crystal-molasses) is dropped to centrifugal machines where it is purged to separate the crystals from the molasses.

As earlier described, sugar manufacturing involves large amounts of sugar cane and cane juices. It also requires voluminous quantities of water and steam and generate by-products such as bagasse, filter cake and ash. The different processes involved in sugar milling and refining generate solid, liquid, and gaseous wastes.

Effluent or waste water generally comes from wash water, laboratory wastes, equipment draining, spills, boiler scrubbers, cooling, and condenser water. Spilled juices, sugars, molasses, and massecuites are sources of high BOD. Condenser water contamination

may result in high BOD. Water used in cleaning equipment, vessels, floors, and spills is high in suspended solids, BOD, and oil and grease. Seepage from bagasse, filter mud and spilled canes is also high in BOD.

Solid wastes include spilled cane, field trash, fly ash from boiler furnaces, and domestic and laboratory wastes generated by the factories. By-products like bagasse and filter cake are potential sources of contamination in factory stream and can cause human discomfort when improperly handled.

Water pollution is a major problem in the industry. Indab (1996) estimated total BOD load of 242,000 MT and suspended solids (SS) of 12,970 MT in 1992. Total emissions for the same year were estimated at 47,670 MT for particulate matter (PM) and 41,620 MT for PM10. SO_x emissions were estimated at around 2,260 MT and NO_x at roughly 3,800 MT. A separate study by Orbeta and Indab (1996) arrived at much lower pollution figures. Estimated BOD load was 5,230 MT, SS was 7,840 MT and PM was around 40,220 MT.

The mills discharge their wastewater in rivers, bays, creeks, and other bodies of water. In the late 1980s, only about 37% of the mills had waste water treatment facilities or end-of-pipe solutions which consisted of physical/biological devices, stabilization ponds/lagoons and aeration and polishing tanks. These end-of-pipe solutions proved to be very costly and unreliable. Despite the installation of these facilities, not all mills are able to comply with DENR pollution standards.

One possible reason was the mills' poor maintenance and management of equipment and operating processes. For instance, equipment capacity imbalances in one mill resulted in costly and unnecessary discharge of process materials still containing valuable sugar. As the existing capacity of the mill's filtration system was not enough to handle the volume of carbonate sludge coming from the carbonatation station, this resulted in the loss of 4590 Lkg of refined sugar annually apart from causing overloading and poor efficiency of the mill's waste treatment plant. Other problems cited were material spills and leaks that find their way to the condenser water stream leading to the receiving river. It was estimated that about 1-2 liters of 57% pol (sucrose) massecuite were spilled every minute which was roughly equivalent to 480 kg sugar losses per day.

Most of the sugar mills are old and inefficient. About 21% of the mills were established between 1908-1920, 31% were founded in the period 1921-1930, 19% between 1960-1970, 12% between 1970-1980, and only 17% between 1981-1998. Inefficiencies in mill operations result in substantial losses in terms of sugar recovery in the manufacturing process and inability to control the release of pollutants in the environment often causing high cost treatment of waste water. The costs shoot up whenever mills violate DENR pollution standards. Penalties are imposed and production losses are incurred particularly when a closure order is issued.

Table 17 : Distribution of Sugar Mills by Year of Establishment

Period	Number of Mills Established
1908 to 1920	9
1921 to 1930	13
1960 to 1970	8
1971 to 1980	5
1981 to 1990	3
1991 to 1998	4
Total	42

Source: SRA

In 1991-92, the average recovery rate of Philippine mills was 78%, in Australia, the average is 92%. Upgrading the country's sugar mills would substantially improve recovery rates. Improving mill tandems, increasing the imbibition percent and improving the evaporation station are some of the specific areas that would increase recovery rates. The physical condition of the rollers, the mill setting and the velocity of the rollers are important factors of extraction efficiency. The use of maceration or imbibition water as well as the proper balancing of stations are also critical (Borrel, D. Quirke et al, 1994).

Note that new plants can readily incorporate up-to-date process technologies using materials and energy more efficiently, minimize emissions, improve product quality and reduce costs. The cost of building environmental controls into new plants are lower than the cost of retrofitting pollution abatement equipment onto old plants.

B. Pollution and Environmental Management in the Sugar Industry

The Philippine sugar industry is well aware of the potential threat that sugar milling poses on the environment. The industry understands that environmental protection has become one of the challenges that they have to face if they are to survive competition brought about by increasing trade liberalization and globalization which require improvements not only in terms of quality and cost but also on the environmental impact of doing business.

With increasing pressures to reduce pollution from government, communities, non-government organizations and even from within the sector, the industry formed an environment committee, the Sugar Industry Environment Committee, with a total membership of 37 sugar mills. The Committee aims to address pollution problems in the industry and lessen the industry's operations impact on the environment and improve their compliance capability. Specifically, the Committee wants to introduce waste reduction measures and efficient water usage as well as to build up the industry's capability to carry out environmental extension services to the mills.

Since the mid-1996, the sugar industry has been taking steps to reduce pollution, waste water generation, and water consumption. Initially, the industry's strategy was focused on measures that were less expensive than end-of-pipe solutions adopted by some mills in the past. These measures consisted of good housekeeping and operational practices aimed at minimizing pollution load, segregation of each major water or waste stream to maintain volume of wastes for treatment at a minimum, and recycling and re-use of water. The economic payback to addressing problems due to poor processing capabilities is large, hence firms have an incentive to reduce leaks, recover materials, recycle water and adopt other

changes which will mitigate environmental damages. Some of the specific low cost measures adopted include the following¹²:

- Reduction of number of service hoses and use of grip-controlled nozzles in the hoses to prevent continuous flow of water
- Practice of dry-cleaning (collection of spilled materials and use of bagasse for cleaning) prior to washing with water
- Provision/installation of spill containment or collection trays/walls underneath pump and tanks
- Regular collection of liquid and solid spills in the spill containment walls and reprocessing of recoverable materials
- Installation of oil separators, regular collection of residual oils from oil-water separators, and recycling/reuse of oils or use of spent oils as boiler fuel
- Repair of leaks, loose fittings of process material lines, tanks/vessels, pumps/casing
- Repair of steam leaks and replacements of defective steam valves/fittings and traps along the stream lines
- Maintenance of proper insulation/cladding of steam lines, hot vessels and boilers
- Segregation of clean cooling water from main factory stream and re-use for other cooling purposes
- Prevention of filter cake and bagasse from getting into canal/drainage systems of factory
- Reduction of volume of samples for analysis in laboratories.

The industry was aware that while these measures could help improve profitability through reduced processing cost, increased productivity and efficiency as well as reduce pollution load and improve the quality of waste water discharge, these were not enough to completely address the problem of pollution. Some firms implemented capital or technically-intensive measures such as:

- Installation of additional filtration capacity to handle excess process sludge in the refinery
- Installation of containment walls and pump to put back spilled process materials into the process Installation of spray/cooling pond and modification of condenser water canal leading to the river
- Elevation of filtrate tank and installation of filtrate juice entrainment separators for rotary vacuum filters
- Expansion of the reverse osmosis plant capacity in order to reduce dependence on fresh groundwater supply.

Table 18: List of BOI Registered Sugar Firms (in thousand pesos)

Sugar Mills	1990	1991	1992	1993	1994	1996	1997	Total
Biscom	269207						332000	601207
Azucarera Bais	29837			145283				175120
Victorias	317004							317004
Batangas		229681		28372				258053
Busco		129487				371100		500587
Azucarera Tarlac		184470						184470

¹² PSMA

Azucarera la Carlota		161564						161564
Azucarera Don Pedro		174490	521118					695608
Davao Sugar Central		150000					357394	507394
Lopez Sugar Corp.		155900	202413					358313
San Carlos Milling		243521						243521
Cagayan Robina		129004						129004
Universal Robina		373603		220706				594309
First Farmers			64268					64268
Herminio Teves				30845				30845
Hideco				240683				240683
New Frontier				106903				106903
Ormoc Sugar				13614				13614
Pampanga Sugar				40495				40495
Passi				145940				145940
Sagay Central				185843				185843
SONEDCO				145226				145226
Seasumco*					58063			58063
South Pacific							255395	255395
Sweet Crystals*							300000	300000
Total	616048	1931720	787799	1303910	58063	371100	1244789	6313429

Source: Board of Investments

Table 18 shows investments in the sugar industry registered with the Board of Investments. The investments amounted to a total of around P 6.3 billion during the years 1990 to 1997. These covered the expansion and modernization of sugar mills and refineries, except for new firms Seasumco and Sweet Crystals which represented new investments. The bulk of the investments were made by eight firms: Central Azucarera Don Pedro, Biscom, Davao Sugar Central, Universal Robina, Busco, Victorias, and Lopez which together accounted for about 57% of total investments registered with BOI.

In terms of environmental expenditures, Lopez, Dacongcogon, First Farmers, and Sagay invested a total of almost P35 million for the acquisition/installation of wastewater treatment and air pollution control facilities from 1996 to 2000. The Lopez Sugar Corporation accounts for 61% of the total while First Farmers Holding Corporation has a share of 27%.

Table 19: Environmental Expenditures

Sugar Mill	1996	1997	1998	1999	2000	Total
Lopez				10993579	10289480	21283059
First Farmers	1901306	2188825	1853392	2134007	1423076	9500606
Dacongcogon	150000	100000	135000	205000	270000	860000
Sagay	550000	150000	2100000	200000	270000	3270000
Total	2601306	2438825	4088392	13532586	12252556	34913665

Source: Philippine Association of Sugar Refiners

C. Pollution In The Sugar Industry: Load and Intensities

Table 20 presents pollution estimates for BOD, TSS, and TSP among 17 sugar firms located in Region VI which is composed of the provinces of Antique, Capiz, Iloilo, and

Negros Occidental. Sugar mills are concentrated in this region and on the average, they account for about 63% of the total raw sugar produced in the country.

The main sources of water pollution in the industry are process, floor washing, scrubber, and condenser. These activities discharge wastes that are high in BOD and TSS. The average BOD load from condenser water is around 199,574 kg and 593,888 kg from process, floor washing, and scrubber.

Air pollution in the sugar industry is primarily derived from energy use from the firing up of boilers. Bagasse, diesel, and bunker oil fuel are used by sugar millers. The critical air pollutants are PM and NO_x. There were no concentration levels reported for NO_x. The only air pollutant whose concentration level was measured and reported by the DENR Regional Office was TSP. On the average, the TSP emission per mill declined from 353 kg in 1998 to 146 kg in 1999. In 2000, the average TSP emission level was only around 53 kg.

Table 21 shows derived pollution intensities for 11 sugar firms. Pollution intensity refers to the amount of pollution generated per unit of output. The average BOD intensity for process, floor washing, and scrubber is 29.50 kg/MT of raw sugar produced and 5.69 kg/MT for condenser water. Process, floor washing, and scrubber BOD intensity is particularly high for Dacongcogon with 200.93 kg/MT followed by SONEDCO with 58.17 kg/MT and San Carlos with 29.50 kg/MT. BOD intensity for process, floor washing, and scrubber is relatively low (less than one) for Danao, First Farmers, and Sagay.

Table 20: Air and Water Pollution in the Philippine Sugar Industry (in Kg)

Name of Sugar Mill	TSP Emissions			Process, Floor Washing, & Scrubber		Condenser Water	
	1998	1999	2000	BOD	TSS	BOD	TSS
Capiz	-	83.29296	-	-	-		
Monomer	-	333.8353	-	622440	505440	224640	280800
New Frontier	-	75.99722	166.478	133763.4	625198.5	-	-
Passi	-	130.2587	-	90061.2	177701.4	242100	21789
South Pacific	-	1.286205	21.30242	-	-	-	-
BISCOM.	9.387503	106.9959	-	-	-	-	-
La Carlota	1135.192	289.1161	-	-	-	-	-
First Farmers	203.9045	-	-	6912	90432		

Hawaiian	-	-	17.36506	295978.5	89199	-	-
Lopez	-	-	5.054386	416116.8	56743.2	126726.48	125307.9
San Carlos	65.27449	-	-	-	1765800	125942742	-
Sunnix	-	247.963	55.70647	-	-	-	-
Victorias	-	45.34496	-	184184.1	445919.4	364490.64	1027553
Sagay	-	-	-	34672.716	40409.928	39911.04	3492.216
SONEDCO	-	-	-	-	-	19870383.6	-
Dacongogon	-	-	-	-	2977172.1	1351928.97	-
Danao	-	-	-	-	5670	2700	-
Average	353.4396	146.01	53.18127	593888.26	12433233.17	199573.60	291788.5

Source of basic data: The TSP, BOD, and TSS loads were estimated from firm level TSP, BOD, and TSS concentration gathered from the DENR Industrial Emission and Effluent Monitoring Reports from the DENR Regional Office -- Region VI.

Comparing these results with the pollution factors estimated by Indab using actual firm level BOD concentration data, we find a noticeable decline in the average BOD pollutant intensity between 1992 and 1998/99. Table 22 shows the BOD factors estimated using information from two sugar mills: Biscom and Hawaiian Philippine. The average BOD pollutant intensity dropped from 176.67 kg/MT in 1992 to 29.5 kg/MT for process, floor washing, and scrubber and 5.69 kg/MT for condenser water in 1998/99. The BOD pollutant intensity of Hawaiian Philippine decreased substantially from 17.55 kg/MT to 3.45 kg/MT during the same years under study.

Table 21: Derived Water Pollution Coefficients (in Kg/MT)

Name of Mill	Process, Floor Washing, & Scrubber		Condenser Water		Type of Wastewater	Receiving Waterbody
	BOD	TSS	BOD	TSS	Treatment Plant	
Monomer	49.89	40.51	18.0	22.51	Biological lagoon & spray pond	Panay River
New Frontier	2.94	13.76	-	-	Biological lagoon	Jalaur River
Passi	2.21	4.37	5.95	0.54	Biological lagoon	Jalaur River
Dacongogon	200.93	91.24	-	-	Biological lagoon	Tablas/Ilog River
Danao	0.33	0.16	-	-	Biological lagoon	Salamanca River
First Farmers	0.15	1.93	-	-	Activated sludge, biological lagoon, & spray pond	Imbang River

Hawaiian Phil	3.45	1.04	-	-	Biological pond & spray pond	Malisbog River
Lopez	4.65	0.63	1.42	1.4	Biological pond & spray pond	Himoga-an River
Sagay	1.1712	2.8355	2.3177	6.5341	Biological pond & spray pond	Himoga-an River
San Carlos	58.17	4148.72	-	-	Biological pond & spray pond	Tanon Creek
SONEDCO	-	403.5	-	-	Biological pond & spray pond	Ilog River
Average	29.50	392.46	5.69	6.20		

Sources of basic data: The environment data were from the DENR Industrial Effluent Monitoring Report from Region VI and production data were from the PSMA.

Table 22: Comparison of BOD Pollutant Intensities

	Prior to Trade Liberalization 1992	After Trade Liberalization 1998/99
Biscom	335.78	No sampling done
Hawaiian Philippine	17.55	3.45
Average	176.67	29.5 process, floor washing, scrubber 5.69 condenser water

It is evident from Table 22 that the decline in the average BOD pollutant intensity from a high level of 176.67 kg/MT before trade liberalization to between 5.69 to 29.5 kg/MT after trade liberalization. This tends to indicate that trade reforms have a positive impact on the environment. As discussed in Section B, sugar millers have been implementing simple housekeeping measures that conserve materials and avoid spoilage or needless contamination that help them reduce wastes at little cost. More industry people are becoming aware of the importance of adopting cleaner processes not only to save on pollution control costs but also to make manufacturing more efficient, thus increasing profits.

Table 23: Derived Air Pollution Coefficients (in Kg/MT)

Name of Sugar Mill	Coefficient (kg/MT)			Pollution Source	Pollution Control Facility
	1998	1999	2000		
1. Capiz	-	0.00232	-	2-Kawasaki boiler diesel engine	Multicyclone oil preheater
2. Monomer	-	0.00267	-	Boilers diesel engine	multicyclone & wet scrubber oil preheater
3. New Frontier	-	0.00200	0.01558	Boilers 1,2,3 Boilers 4,5	multicyclone & water scrubber multicyclone & tangetail inlet cyclonic scrubber
4. Passi	-	0.00331	-	Boilers 1, 2 diesel engine	multicyclone & bottom scrubber oil preheater
5. Binalbagan-Isabela	0.00001	0.00068	-	BW Boiler 6-10 CE Boiler 1,2 BW Boiler 5 Begelow Boiler Keeler Boiler 2 & Takuma Boiler diesel engine	multicyclone & wet scrubber wet scrubber multicyclone & wet scrubber wet scrubber oil preheater

6. La Carlota	0.01085	0.00296	-	Kawasaki boiler 1,2	multicyclone
				JTA boiler	4-clyde vortex scrubber
				Carabi boiler (Kawasaki 3)	multicyclone
				diesel engine	oil preheater
7. First Farmers	0.00318	-	-	Alpha boiler	multicyclone & wet scrubber
				diesel engine	oil preheater
8. Hawaiian Phils	-	-	0.00020	JTA boiler	4-clyde vortex scrubber
				diesel engine	oil preheater
				JTA boiler	multicyclone & microwave type
9. Lopez	-	-	0.00006	diesel engine	gas collector
					oil preheater
10. San Carlos	0.00215	-	-	boiler 7	multicyclone
				boiler 6	multicyclone
				boiler 3,4,5	multicyclone
				diesel engine	oil preheater
11. Sunnix	0.00795	0.00202	-	Takuma boiler 1,2	multicyclone & wet scrubber
				Takuma boiler 3	
				diesel engine	oil preheater
12. Victorias	0.00029	-	-	JTA boiler 2	multicyclone
				JTA boiler 1	wet scrubber
				Yoshemine boiler	multicyclone
				Riley 1,3	multicyclone
				Riley 4	multicyclone
Average	0.00407	0.00228	0.00528		

Sources of basic data: The environment data were from the DENR Industrial Effluent Monitoring Report from Region VI and production data were from the PSMA.

The above evidence tend to indicate that the industry has become more environmentally responsible. Along with this heightened sensitivity to environmental issues has come increasing pressures from both non-government organizations and government regulators for industries to reduce their pollutant emissions and effluents.

Table 23 presents the TSP intensities for 12 sugar firms derived using TSP concentration levels and volumetric rates from the DENR Industrial Emission Monitoring Reports. The estimated TSP coefficients for the sugar firms in Region VI are low. The average TSP intensity dropped from 0.004 kg/MT of raw sugar produced in 1998 to about 0.002 kg/MT in 1999. This increased slightly to 0.005 kg/MT in 2000.

Table 24: BOD, TSS, and TSP Pollutant Intensities
(in pounds per peso million value of output)

Name of Sugar Mill	Water Pollution				Air Pollution		
	Process, Floor Washing, & Scrubber		Condenser Water		Fuel/Bagasse Combustion		
	BOD	TSS	BOD	TSS	1998	1999	2000
Monomer	5057.67	4106.98	1825.32	2281.65		2.71	
New Frontier	296.25	1384.63				0.83	3.35
Passi Sugar	222.77	439.56	598.86	53.90		0.34	

Dacongcong	20370.73	9250.32					
Danao	33.10	15.76					
First Farmers	14.99	196.06			0.32		
Hawaiian Phil	347.42	104.70					0.02
Lopez Sugar	471.14	64.25	143.48	141.88			0.01
Victorias	117.87	285.37	233.26	657.59	0.03		
Sagay	66.43	77.42	76.46	6.69			
San Carlos	5854.03	417529.17			0.22		
SONEDCO		550.44					
Capiz						0.24	
Biscom					0.01	0.10	
La Carlota					1.09	0.30	
Sunnix					0.80	0.20	
Average	2986.58	36167.05	575.48	628.34	0.41	0.67	1.13
IPPS Pollution Intensities	BOD: 103.43		TSS: 148.3		TSP: 206.70		

Table 24 shows the BOD, TSS, and TSP pollutant intensities estimated for the Philippine sugar industry expressed in terms of pounds per million pesos value of output. The conversion was done to be able to compare the results with the IPPS intensities which were based on US 1987 manufacturing and pollution data. Table 24 also presents the corresponding IPPS pollution intensities for sugar factories and refineries in the US. The average BOD and TSS pollutant intensities for the Philippine sugar industry are still way above those prevailing in the US in 1987. For TSP pollutant intensity, the Philippine average is much lower than the US.

Although the average BOD pollutant intensity for the sugar industry is substantially higher than the US, there are some firms with good environmental performance. Compared with the IPPS, BOD pollutant intensities for both process, floor washing, and scrubber and condenser water are lower for Sagay, First Farmers, and Danao. TSS pollutant intensities for process, floor washing, and scrubber and condenser water are also lower for Lopez, Sagay, Danao, and Hawaiian Philippine.

To address their pollution problem, it is necessary for the old and inefficient mills to go beyond good housekeeping measures and attack the source: obsolete technology and inefficiency. Without looking at the fundamental source of their wastewater discharges, it would be difficult for them to compete and comply with environmental regulations and standards. Some of these firms applied expensive end-of-pipe treatment solutions but to no avail. Even after installing wastewater treatment facilities, they still failed to comply with standards. These firms would have to make serious efforts to attack the source of their wastewater discharges by investing in new technologies not only to make their manufacturing process more efficient but also to minimize their pollution control costs.

While trade reforms are necessary, the experience of the sugar industry has shown that trade liberalization alone is not enough to create competitive market conditions. In the absence of effective competition, there is very little incentive for firms to modernize and improve their efficiency. Hence, the expected economic and environmental benefits from trade liberalization fail to materialize. Industry output and productivity have been declining. The industry's costs of production are still higher than Thailand, Australia, Brazil, or South

Africa. Investments in new technology are limited to only a few firms. The same is true for environmental investments.

The present quedan system and the Sugar Regulatory Administration's powers of market classification and control over quedans and warehouses remain as barriers to effective competition in the industry. The sugar sharing system poses a disincentive for producers to make the necessary investments which would lead to the uptake of the best technology and practices to increase productivity and lower costs. Under the quedan system, which provides cane growers and millers equal access to premium markets, producers are penalized for increasing productivity and output. A small increase in production would lower the domestic price for all output and reduce gross revenues.

The continued intervention of the Sugar Regulatory Administration in the market would delay the adoption of proper environmental approach to reduce pollution along with significantly lower growth for the industry. It is only by eliminating the remaining barriers to competition can we realize the expected economic and environmental gains from trade liberalization. The sugar industry is one sector where we have a potential comparative advantage, but we would not be able to compete globally and enjoy the economic and environmental benefits from trade liberalization unless the fundamental reforms are carried out.

Case Study 2: The Environmental Impact of Trade Liberalization on the Philippine Cement Industry

1. A Profile of the Philippine Cement Industry

The cement industry covers the manufacture of hydraulic cements including portland, aluminous slag and superphosphate, whether or not in the form of clinker (1994 Philippine Standard Industrial Classification). Cement is a superior bonding agent used as a raw material in concrete construction. Its main components are limestone, clayey materials, and ferrous materials which are processed into clinker. The latter is ground and mixed with gypsum to produce cement.

Cement manufacturing is basically capital intensive. Capital costs accounted for about 20 percent of total manufacturing costs (SGV Consulting, 1992). The industry is also a heavy user of energy with energy costs ranging from 30 to 43 percent of manufacturing costs depending on the type of manufacturing process applied.

Following the 1997 Asian financial crisis which hit the construction sector badly, an industry reorganization started to unfold as foreign cement companies entered and forged partnerships with local firms. The peso depreciation boosted the debt costs of cement firms with foreign-denominated loans and as the recession caused the construction industry to contract, foreign firms were able to buy into the local cement industry. Most local firms have taken in foreign companies as partners in order to generate fresh capital, strengthen their balance sheet, and improve their technology to bring operations at par with world standards.

2. Government Regulations and Policies Affecting the Industry

The Philippine cement industry developed under heavy government protection and promotion through the imposition of high tariffs and import restrictions and the granting of

incentives under the Board of Investment's (BOI) rehabilitation, modernization and rationalization program. It was also subject to government regulation through the Philippine Cement Industry Authority (PCIA) which was created in 1973 to regulate entry in the industry, allocate supply, and control prices as well as cement exports.

At about the same time, the industry association which is currently known as Philippine Cement Manufacturers Corporation (Philcemcor) was incorporated to help the PCIA in implementing its duties and responsibilities. The PCIA and the Philcemcor worked closely together in regulating the industry with PCIA delegating the setting of production quotas to Philcemcor.

In 1987, the PCIA was abolished, but the price control function was transferred to the Department of Trade and Industry and the Board of Investments. The price control was momentarily lifted in February 1989 and reimposed in July 1989. Prices were finally deregulated in November 1991.

The tariff on cement was reduced from 50 percent in 1979 to 40 percent in 1988 and it was further reduced to 20 percent in 1989. Import restrictions on cement were lifted effective March 1989. From January 1990 to mid-1991, the tariffs on portland cement and clinker were suspended to address the problem of cement shortage following the expansion of construction activities in the country. In July 1991, the 20 percent tariff on cement imports was restored. This was reduced to five percent in 1993-94 and to three percent in 1995-1997. The rate, however, was increased to 10 percent during 1997-1998. In 1999, this was reduced to seven percent and currently, its rate stands at five percent.

Table 25: Tariff Structure of the Philippine Cement Industry

Year	1979	1988	1989	90-91	Jul-91	93-94	95-97	97-98	1999	2000
Tariff	50%	40%	20%	0%	20%	5%	3%	10%	7%	5%

Source: Tariff and Customs Code of the Philippines, various years.

3. Structure and Performance of the Philippine Cement Industry

A. Performance of the Cement Industry (1990-1999)

Table 26 presents a picture of the economic operation of the industry between 1990 up to 1999. Total supply (domestic production+imports+inventory-exports) and total demand (domestic sales+imports) were estimated alongside with excess supply (total supply-total demand). The table also shows average ex-plant prices, capacity utilization rates, and annual percentage changes in sales, production, total demand, and total supply.

The data indicate that after the removal of import restrictions on cement in 1989, tariff reduction from 40% in 1988 to 20% in 1989, and price deregulation in 1991, the industry experienced strong growth between 1993 to 1996. Production grew by about 18% annually in 1994, 1996, and 1997. The capacity utilization rate of the industry was roughly 86% in 1994, 93% in 1995 and 88% in 1996. Exports were not significant with industry production geared almost entirely to the domestic market. Except for the years 1990 and 1992, imports

constituted a small portion of total consumption. In 1990 and 1992, imports represented 13% and 9% of total consumption and less than 5% for the remaining years.

In anticipation of continuous future growth, the industry engaged in an expansion program which more than doubled its capacity from 282 million (40 kg bags) in 1995 to 641 million (40 kg bags) in 1998. To finance their expansion, many of the firms incurred foreign debts. The peso depreciation following the 1997 Asian financial crisis increased the debt costs of these firms. As the recession caused the construction industry to contract, foreign firms were able to buy into the local cement industry. With the presence of the world's largest cement companies in the country such as Holderbank, Lafarge, Blue Circle, and Cemex, the industry is expected to benefit through the infusion of fresh capital and improved technology to bring domestic operations at par with world standards.

Prior to the crisis, average excess supply in the industry stood at about 3 million (40 kg bags). From 1997 to 1999, average excess supply increased to about 9.5 million (40 kg bags). Capacity utilization rate was around 50 percent in 1998 and 1999. With the financial crisis in 1997, the demand for cement dropped by 13 percent in 1998 and by 4 percent in 1999. The slowdown in the construction and property sector resulted in an oversupply of cement in the market forcing cement firms to cut prices.

The cement industry is highly dependent on the construction demand. Between 1998 to 1999, gross value added in construction went down by 8.4 percent and 2.8 percent, respectively. This decline was mostly due to the drop in private construction by around 13.5 percent in 1998 and by 14.5 percent in 1999. Analysts believe that prospects for the sector's recovery in the short term would remain bleak. A Phinma report indicated that the overcapacity of the industry would remain until at least the year 2007¹³.

Table 26 : Economic Indicators in the Cement Industry, 1990-1999(in '000 40 kg bags)

Indicators	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Production	164060	172324	166536	201268	236623	263842	310725	367019	322196	313937
Exports	0	0	0	125	0	0	0	0	2150	17284
Imports	23098	250	17041	0	242	12010	16990	8794	4504	11861
Beginning Inventory		3435	2757	4184	5246	1958	573	4467	8070	10258
Total Domestic Supply	187158	176009	186334	205327	242111	277810	328288	380280	332620	318772
Sales	160625	173002	165109	200081	239911	265227	306831	363416	317858	296733
Imports	23098	250	17041		242	12010	16990	8794	4504	11861
Total Domestic Demand	183723	173252	182150	200081	240153	277237	323821	372210	322362	308594
Excess Supply	3435	2757	4184	5246	1958	573	4467	8070	10258	10178

Source: Estimated using Philcemor data.

¹³ PHINMA; Cement Industry Evolution: Prices and Production Costs as cited in the Philippine Daily Inquirer, Joey G. Alarilla, "Cement Oversupply Expected Until 2007".

4. Environmental Aspects of the Cement Industry

A. Cement Manufacturing Process¹⁴

There are five major steps involved in cement manufacturing:

- Quarrying: entails raw material extraction and hauling, the quarrying of limestone is done by earth-moving equipment and may involve blasting
- Crushing: the limestone goes through crushing to reduce it to an appropriate size for blending, the raw material may undergo drying with heated air
- Milling: involves grinding and blending, the raw material is mixed in controlled quantities with silica, iron and other materials to form the raw feed
- Burning: the raw feed is fed to a rotary kiln where it is calcined by heating to very high temperatures to produce clinker, the clinker is then cooled and may be stored
- Cement handling and packing: the clinker is mixed with gypsum and ground to produce cement which is then bagged or transported in bulk form.

There are two major types of processes employed in cement manufacturing: wet process and dry process. In the wet process, cement plants mix water with the raw materials to form a slurry prior to feeding to the kiln. In the dry process, cement plants use a preheater system where hot gases from the kiln are applied to raise the temperature of the raw feed. Some cement plants have a precalciner which heats the raw feed to a higher temperature prior to introduction to the kiln. Precalcining and preheating increase the fuel efficiency of the process and as such, the dry process is more heat efficient than the wet process. A large part of cement in developed countries is produced by the dry process.

Table 27: Types of Processes Employed by Cement Plants, 1985 and 2000
(in thousand tons)

Process	Number of Kilns		Capacity		Percentage Share	
	1985	2000	1985	2000	1985	2000
Dry	13	25	3968	17725	53	81
Wet	13	12	2645	3168	36	14
Semi-dry	6	6	795	1029	11	5
Total	32	43	7408	21922	100	100

Between 1985 to 2000, the number of kilns using dry process increased by about 90%. The number of firms employing the wet process hardly changed and declined by a very small percentage as only one cement plant (Pacific Cement) upgraded its process and converted to the dry process. In terms of capacity, the dry process increased its share from 53% in 1985 to 81% in 2000 while the capacity of kilns using the dry process declined from 36% to only 14%.

¹⁴ Buenaventura, A., The Portland Cement Industry, Volume II: Sectoral Study 20, ENRAP-Phase III, 1995 and Onada Engineering and Consulting Co., Ltd., Industrial Restructuring Studies:Cement, DBP, 1991.

There was no change in the number of firms using semi-dry process, although in terms of percentage share to total capacity, semi-dry process dropped from 11% to 5% between 1985 to 2000. Rizal Cement, Titan, Solid, Lloyd's Richfield, Apo, Bacnotan (La Union), and Davao Union are still employing wet process. Bacnotan (Bulacan), Lloyd's Richfield, and FR Cement still use semi-dry process (see Table 28).

About 26% of the kilns are relatively new. There are 11 kilns in the industry with ages ranging from one to six years old. Beginning in 1994, the industry started to invest in capital equipment as part of its modernization and expansion program. In 1997, the industry's capital expenditures on new fixed assets reached around P13.1 billion.

Board of Investments data show that total registered investments of 16 cement firms amounted to P24.8 billion in 1997, up from P17.2 billion registered investments in 1994 and P22.4 billion in 1994. For the period 1990 to 1997, total registered investments amounted to approximately P72.2 billion mainly for the modernization and rehabilitation of existing cement plants.

Table 28: Number of Kilns, Type of Process, and Installed Capacity

Company	Kilns		Type of Process	Annual Capacity (in '000 tons)	
	Number	Age		Clinker	Cement
Alsons Cement	1	29	Dry	582	
	1	1	Dry	1200	2138
Apo Cement	1	30	Wet	750	
	1	1	Dry	1650	2880
Bacnotan Cement La Union	1	6	Dry	720	
	1	36	Wet	93	
	1	38	Wet	93	
	1	42	Wet	114	
Bulacan	1	30	Semi-dry	234	1505
Continental	1	26	Dry	480	
	1	1	Dry	990	1764
Davao Union	1	16	Dry	533	
	1	3	Dry	1050	
	1	31	Wet	159	2091
Fortune	1	28	Dry	900	
	1	1	Dry	360	1512
FR Cement	1	2	Dry	990	
	1	35	Semi-dry	87	
	1	35	Semi-dry	93	
	1	34	Semi-dry	360	1836
Grand Cement	1	-	Dry	840	1008
Hi-Cement	1	33	Dry	810	
	1	3	Dry	1650	2952
Lloyd's Richfield	1	40	Semi-dry	127.5	
	1	34	Semi-dry	127.5	
	1	29	Wet	336	709
Mindanao Portland	1	38	Dry	450	540
Northern Cement	1	29	Dry	480	
	1	29	Dry	480	1152
Pacific Cement	1	35	Dry*	180	216
Republic Cement	1	39	Dry	127.5	
	1	36	Dry	127.5	
	1	32	Dry	330	
	1	1	Dry	990	1890

Rizal Cement	1	45	Wet	114	
	1	41	Wet	111	
	1	35	Wet	150	450
Solid Cement	1	6	Dry	990	
	1	30	Wet	435	
	1	33	Wet	435	2232
Iligan Cement	1	29	Dry	465	558
Titan Cement	1	30	Wet	378	454
Limay Grinding	-	-	-	396	475
Goodfound Cement	1	1	Dry	350	420
Total	43			22318	26782

Source: Cement Industry in the Philippines Statistics, Philcemcor.

*Upgraded from wet process in 1999.

Table 29: Registered Investments of Existing Cement Firms (in thousand pesos)

Plant Name	1990	1991	1992	1993	1994	1996	1997	Total
Alsons					7140000			7140000
Apo				7252200	2030000			9282200
Bacnotan	1363000							1363000
Continental			1658990		1080000			2738990
Davao Union				2937000				2937000
Fortune				7035415				7035415
FR					2125286			2125286
Grand							3940000	3940000
Hi Cement					4579000			4579000
Lloyds							10000000	10000000
Mindanao						2660178		2660178
Northern	1047000				2950754			3997754
Republic		95000			2500000			2595000
Rizal							6515000	6515000
Solid	960000							960000
Titan							4372569	4372569
Total	3370000	95000	1658990	17224615	22405040	2660178	24827569	72241392

Source: Board of Investments

B. Analysis of Pollution and Environmental Management in the Cement Industry

Particulate matter (PM) is the major pollutant in the industry. Every stage in the production process is a source of dust. The major source is calcining in the rotary kiln. The kiln emissions come from the burning of coal in a furnace at the lower end of the kiln and particles lifted by the hot gases passing through the kiln. Other PM sources are clinker cooler, raw material dryers, material handling, transport and storage.

Apart from dust, there seems to be no other significant pollutant emissions in the cement plants. While the burning of coal produces sulfur dioxide (SO₂) and nitrogen oxide (Nox), the clinker in the kiln absorbs most of these.

Table 30 shows an inventory of pollution control equipment employed by the industry in 1985. During this time, about 76% of the total number of production sections in the industry had dust collector equipment. A few plants (7) installed dust collectors in the crusher while 16 plants had dust collectors in the raw materials drier sections. All cement plants had bagfilter type dust collectors installed in their packing house section. The grinding section of raw material and clinker as well as the kiln burning section had electrostatic precipitators and/or bagfilters. However, the Onada Engineering and Consulting Co. (1991) noted that there were four plants that had cyclone type dust collectors which were unable to collect fine dust particles from their kiln exhaust gas. The same group also found out that the multicyclone dust collectors installed in the cooler sections were insufficient for clinker dust collection.

By comparison, in 1981, electrostatic precipitators were installed for the kiln section and cooler section of 82% of Japanese cement plants. The remaining plants used bagfilter and gravel bed type collectors. For the other production sections, Japanese cement plants mainly used bagfilter collector.

In the Philippines, while most cement plants had dust collectors in the late 1980s, these were considered too old to be efficient as these were installed about 20 years ago. During this period, dust emission levels from the kilns exceeded the permissible limit of DENR regulations (Onada, 1991).

Table 30: Number of Firms With Dust Collector Equipment, 1985

Production Section	Electrostatic Section	Bagfilter Precipitator	Multicyclone	Singlecyclone	Total Number of Firms
Crusher	1	4	0	2	7
Drier	4	2	0	10	16
Raw Mill	6	5	0	0	11
Kiln	10	2	1	3	16
Cooler	0	0	15	1	16
Cement Mill	2	4	0	1	7
Packing House	0	17	0	0	17
In Percent	19.3	37.0	14.3	14.3	75.6

Source: Onada Engineering and Consulting Co., Cement Industrial Restructuring Studies, 1991.

Table 31 presents TSP concentration reported in 1997 by three firms (Republic, Davao Union, and Hi Cement) to the DENR. The firms had electrostatic precipitators/baghouse, and/or filter bags. TSP concentration ranged from 41.22 mg/Ncm to 300000 mg/Ncm. Phinma firms Bacnotan, Davao Union, and Hi-Cement (under the umbrella company known as Union Cement Corporation), which controls about 24% of total industry capacity, reported low TSP concentrations at levels of about 50 mg/Ncm in 2000. In terms of quarry reforestation activities, Union Cement Corporation, seems to be ahead of the rest of the firms in the industry. All three Union Cement firms are ISO 9002 certified, Davao Union is already ISO 14001 certified while Bacnotan plants in Bulacan and La Union are currently in the process of preparing for ISO 14001 certification.

Table 31 : TSP Concentration in the Cement Industry

Cement Plant	Concentration (mg/normal cubic meter)	Air Pollution Source	Air Pollution Control Facility
Republic	300000	Kiln	Electrostatic precipitator
Northern	No data	Crushers Rotary kiln/dryer Coal grinding Silica ball mill	Electrostatic precipitator/baghouse
Bacnotan	No data	Rotary kiln Coal mill	Dust filter collector
Davao Union	112 41 88	Rotary kiln Dryer Finish mill	Electrostatic precipitator Filter bags
Hi Cement	41.22	Kiln and ballmill	Electrostatic precipitator

Source: DENR Regional Offices

Union Cement is also working on a project to recycle selected wastes as alternative fuels or raw materials in the manufacture of cement. This is being done in its Bulacan plant. The use of selected wastes in cement kilns has been practiced in the last fifteen years in countries like the US, UK, France, Belgium, Switzerland, Australia, and New Zealand.

Recently, two other cement firms were awarded ISO 14001 Environmental Management System rating. Solid Cement received its ISO 14001 accreditation in October 2000 followed by APO Cement in March 2001. Mexican firm CEMEX acquired Solid Cement in late 1997 and APO Cement in 1999. Both companies are quite old with APO Cement Corporation established in 1921 while Solid Cement Corporation was founded in 1964. Upon its entry, CEMEX immediately conducted an environmental assessment of both companies. In 1999, large funds were allocated to the two companies for the improvement of their environmental performance.

The two companies cited the following benefits from the establishment of Environmental Management System:

- The installation of filter capacitors increased the power factor from 0.85 to 0.99 and is now generating savings.
- The use of alternative raw cement manufacture reduced cost per ton by around 3%.
- The modification of coal mill dust collectors to jet-pulse systems increased mill throughput by as much as 27% based on the pre-conversion condition.

VII. Conclusions and Policy Implications

The CGE simulations showed that trade liberalization in the Philippines does not lead to wholesale environmental degradation. The simulations also indicated the critical role of technology effects in controlling pollution. Introducing changes in technology together with trade reforms lead to large significant impact in improving the environment.

The case studies indicated that as trade liberalization leads to more competition, improvements in efficiency, and increased foreign investment, trade reforms are compatible

with efforts to protect the environment. With trade liberalization, industries which used to be protected in the past are exposed to international competition. Competition is what drives businesses to improve their efficiency, develop new products and assists economic growth and create employment. To survive, firms must innovate and improve their product quality and costs.

In the cement industry, trade liberalization and deregulation policies (particularly the abolition of government regulator PCIA) were necessary, though insufficient conditions, to create effective competition in the industry. The entry of foreign investors helped in increasing environmental awareness and accelerating the promotion and introduction of good environmental systems and adoption of ISO standards.

In the case of the sugar milling and refining industry, however, the implementation of trade reforms did not lead to competitive market conditions due to the presence of government regulator SRA. The present *quedan* system and the SRA's powers of market classification and control over *quedans* and warehouses remain as barriers to effective competition in the industry. In the absence of effective competition, there is very little incentive for firms to modernize and improve their efficiency. The continued intervention of SRA in the industry would delay the adoption of proper technologies to improve efficiency and proper environmental approach to reduce pollution. Unless these remaining barriers to competition are eliminated, the industry might not fully realize the expected economic and environmental gains from trade liberalization.

To the extent that trade liberalization eliminates economic policy distortions, creates effective competition, promotes economic growth and improves the efficiency of resource use, trade reforms are positive agents for the environment. As trade liberalization encourages more competition, firms are compelled to become more efficient. Trade liberalization is expected to provide increased foreign investment, access to technology and opportunities for companies to improve efficiency. In general, new plants with up-to-date process technologies using materials and energy more efficiently, minimize emissions, improve product quality and reduce costs. The cost of building environmental controls into new plants is lower than the cost of retrofitting pollution abatement equipment into old plants.

The government should continue its trade liberalization policies as well as other economic reforms aimed at promoting competition and efficiency in the economy. Large and export-oriented firms are the early exponents of sound environmental practices and are the first to adopt environmental management system. There are still many local firms that are unable to comply with DENR regulations and standards. Partly, this could be attributed to older technologies in place in many of these firms as well as to their domestic-orientation and failure to appreciate their potential roles in the international market. Small and medium enterprises (SMEs) may experience difficulties in terms of complying with environmental regulations due to their lack of access to capital and technology. This is one issue requiring proper government attention.

This is not to assert that trade policy should be used to address environmental problems. For as long as environmental regulations are effectively enforced, environmental policies are still more efficient and appropriate than trade policies in addressing environmental problems.

Finally, the absence of good quality industrial pollution data is a stumbling block to a better understanding and comprehensive analysis of the impact of trade liberalization on industrial pollution. The regulating body, DENR, must improve its monitoring and data collection/management functions in order to effectively enforce environmental regulations and accurately assess the effectiveness of regulations and standards.

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APPENDIX 1

	I. Core Equations in PCGEM	II. Description
1	$pm_{it} = pwm_{it} \cdot er \cdot (1 + tm_{it}) \cdot (1 + itxrdom_{it})$	Import price
2	$pe_{it} \cdot (1 + te_{it}) = pwe_{it} \cdot er$	Export price
3	$p_{it} \cdot x_{it} = pd_{it} \cdot xxd_{it} + pm_{it} \cdot imp_{it}$	Composite price, tradable
4	$p_{in} = pd_{in}$	Composite price for nontradable
5	$px_{it} \cdot xd_{it} = pl_{it} \cdot xxd_{it} + pe_{it} \cdot exp_{it}$	Sales price, tradable
6	$px_{in} = pl_{in}$	Sales price, non tradable
7	$pd_i = pl_i \cdot (1 + itxrdom_i)$	Domestic prices
8	$pva_i \cdot va_i = px_i \cdot xd_i - \sum_j id_{ij} \cdot p_j$	Value added price
9	$pk_i = p_i$	Price of capital
20	$pindex = \sum_i pwts_i \cdot pva_i$	Price index
21	$xd_i \cdot vt = va_i$	Supply
22	$ri_i = inp_i \cdot xd_i$	Intermediate input
23	$id_{ij} = aij_{ij} \cdot ri_j$	Matrix of intermediate input
24	$va_{w_vk} = ad_{w_vk} \cdot l_{w_vk}^{a_{w_vk}} \cdot v_{w_vk}^{b_{w_vk}} \cdot k_{w_vk}^{g_{w_vk}}$	Value added, sectors with variable capital
25	$va_{n_vk} = ad_{n_vk} \cdot l_{n_vk}^{a_{n_vk}} \cdot v_{n_vk}^{b_{n_vk}} \cdot k_{n_vk}^{g_{n_vk}}$	Value added, sectors without variable capital
26	$l_i \cdot wage = va_i \cdot pva_i \cdot a_i$	Demand for labor
27	$v_{w_vk} \cdot rvk = va_{w_vk} \cdot pva_{w_vk} \cdot b_{w_vk}$	Demand for variable capital
28	$rkap_{w_vk} \cdot k_{w_vk} = pva_{w_vk} \cdot va_{w_vk} - wage \cdot l_{w_vk} - rvk \cdot v_{w_vk}$	Returns to capital in sectors with variable capital
29	$rkap_{n_vk} \cdot k_{n_vk} = pva_{n_vk} \cdot va_{n_vk} - wage \cdot l_{n_vk} - rvk \cdot v_{n_vk}$	Returns to capital in sectors without variable capital
30	$xd_{it} = at_{it} \cdot (q_{it} \cdot \exp_{it}^{k-e_{it}} + (1-q_{it}) \cdot xxd_{it}^{k-e_{it}})^{(1/k-e_{it})}$	Composite supply, CET, tradable
31	$xd_{in} = xxd_{in}$	Composite supply, nontradable
32	$exp_{it} = xxd_{it} \cdot \left[\left(\frac{pe_{it}}{pl_{it}} \right) \cdot \left(\frac{1-q_{it}}{q_{it}} \right) \right]^{t-e_{it}}$	Export supply
33	$x_{it} = ac_{it} \cdot (d_{it} \cdot imp_{it}^{-r-m_{it}} + (1-d_{it}) \cdot xxd_{it}^{-r-m_{it}})^{(-1/r-m_{it})}$	Composite Good, CES, tradable
34	$x_{in} = xxd_{in}$	Composite Good, nontradable
35	$imp_{it} = xxd_{it} \cdot \left[\left(\frac{pd_{it}}{pm_{it}} \right) \cdot \left(\frac{1-d_{it}}{d_{it}} \right) \right]^{s-m_{it}}$	Import demand
36	$ylbag = wage \cdot \sum_{ag} l_{ag}$	Labor income in agri.
37	$ylbnag = wage \cdot \sum_{nag} l_{nag}$	Labor income in non-agri.
38	$yvkag = rvk \cdot \sum_{ag_vk} v_{ag_vk}$	Variable capital income in agri.

39	$yvknag = rvk \cdot \sum_{nag_vk} v_{nag_vk}$	Variable capital income in agri.
40	$ykap = \sum_i rkap_i \cdot k_i - \sum_i depr_i \cdot k_i \cdot pk_i$	Capital income
41	$pri_inc_{inst1} = dylbag_{inst1} \cdot ylbag + dylbnag_{inst1} \cdot ylbmag + dylbocw_{inst1} \cdot er \cdot ww \cdot ocw +$ $dvykag_{inst1} \cdot yvkag + dyvknag_{inst1} \cdot yvknag + dykap_{inst1} \cdot ykap +$ $\sum_{inst2} secdinc_{inst1,inst2} \cdot pri_inc_{inst2} + gv_tran_{inst1} + er \cdot for_tran_{inst1}$	Income of institution, except government
42	$gv_inc = \sum_{it} tm_{it} \cdot imp_{it} \cdot pwm_{it} \cdot er + \sum_{it} itxrdom_{it} \cdot imp_{it} \cdot pwm_{it} \cdot er \cdot (1 + tm_{it}) +$ $+\sum_{it} te_{it} \cdot exp_{it} \cdot pe_{it} + \sum_i itxrdom_i \cdot pl_i \cdot xxd_i + dykap_{gv} \cdot ykap$ $+\sum_{inst1} dtaxr_{inst1} \cdot pri_inc_{inst1} + gv_dtax + er \cdot for_tran_{gv}$	Government income
43	$dispy_{inst1} = pri_inc_{inst1} \cdot (1 - dtaxr_{inst1})$	Disposable income
44	$pri_save_{inst1} = pri_inc_{inst1} \cdot (1 - dtaxr_{inst1}) -$ $\sum_{inst1} pri_cc_{inst1,i} \cdot p_i - \sum_{inst2} secdinc_{inst2,inst1} \cdot pri_inc_{inst1} - er \cdot for_pay_{inst1}$	Savings of institutions, except govt
45	$int_i = \sum_j id_{i,j}$	Intermediate demand
46	$pri_cc_{inst1,i} = dccmt_{inst1,i} \cdot apc_{inst1} \cdot dispy_{inst1}$	Consumption of institutions except govt
47	$inv_i \cdot p_i = dinv_i \cdot (tin v - \sum_j chstk_j \cdot p_j)$	Sectoral Investment
48	$cab = \sum_{it} (pwm_{it} \cdot imp_{it} - pwe_{it} \cdot exp_{it}) - ww \cdot ocw + \frac{1}{er} \cdot wage \cdot for_lb +$ $\sum_{inst} for_pay_{inst} - \sum_{inst} for_tran_{inst}$	Balance of payments
49	$tin v = \sum_{inst1} pri_save_{inst1} + gv_save + cab \cdot er + \sum_i depr_i \cdot k_i \cdot pk_i$	Total Investment equals total savings
50	$suplbag + suplbmag + for_lb = \sum_i l$	Labor market equilibrium
51	$supvkag + supvknag = \sum_{w_vk} v_{w_vk}$	Variable capital equilibrium
52	$x_{alxgv-se} = int_{alxgv-se} + \sum_{inst1} pri_cc_{alxgv-se,inst1} + gv_cc_{alxgv-se} + inv_{alxgv-se}$ $+ chstk_{alxgv-se}$	Product market equilibrium except in general govt sector
53	$walras = x_{gv-sec} - int_{gv-sec} - \sum_{inst1} pri_cc_{gv-se,inst1} - gv_cc_{gv-se} - inv_{gv-se}$ $+ chstk_{gv-se}$	Walras law

VARIABLES :

* output and input prices

$pm_{(it)}$	domestic price of imports for tradables
$pwm_{(it)}$	world prices of imports for tradables
$pe_{(it)}$	domestic price of exports
$pwe_{(it)}$	world prices of exports
er	exchange rate
$p_{(i)}$	composite prices
$pd_{(i)}$	domestic prices
$p1_{(i)}$	domestic prices without domestic indirect taxes
$px_{(i)}$	sales prices
$pk_{(i)}$	capital good prices
$pva_{(i)}$	value added prices
$pindex$	price index also called GDP deflator
$wage$	average wage rate
rvk	average return to variable capital
$rkap_{(i)}$	sectoral return to capital
ww	international wage rate

* taxes

$tm_{(it)}$	tariff rates
$te_{(it)}$	export tax or subsidies
$itxrdom_{(i)}$	domestic indirect tax rates
$dtaxr_{(inst1)}$	direct income tax rates
gv_dtax	value of direct income tax on govt sector

* output - value added - and trade variables

$x_{(i)}$	composite commodities
$xxd_{(i)}$	xd less exports
$xd_{(i)}$	column sums in the SAM less imports
$va_{(i)}$	value added
$ri_{(i)}$	vector sums of intermediate inputs
$id_{(i,j)}$	matrix of intermediate inputs
$imp_{(it)}$	imports
$exp_{(it)}$	exports

* factor inputs

$l_{(i)}$	demand for labor
$v_{(w_vk)}$	demand for variable capital
$k_{(i)}$	demand for capital
$suplbag$	total supply of agriculture labor
$suplbnag$	total supply of non agriculture labor
ocw	overseas contract workers
$supvkag$	total supply of variable capital in agriculture
$supvknag$	total supply of variable capital in non agriculture

* income and savings

$ylbag$	labor income in agriculture
$ylbnag$	labor income in non agriculture
$yvkag$	variable capital income in agriculture
$yvknag$	variable capital income in agriculture
$ykap$	capital income except govt
$pri_inc_{(inst1)}$	income of institutions
gv_inc	income of govt

$dispy_{(inst1)}$	disposable income of institutions
$pri_save_{(inst1)}$	savings of institutions except govt
gv_save	savings of government
$tinv$	total investible funds equal to total savings
$depr_{(i)}$	depreciation
cab	current account balance

*** demand**

$int_{(i)}$	intermediate demand
$pri_cc_{(inst1,i)}$	consumption demand of institutions except govt
$gv_cc_{(i)}$	consumption of government
$inv_{(i)}$	sectoral investment
$chstk_{(i)}$	sectoral change in stocks

*** transfers**

$for_tran_{(inst)}$	foreign transfers to institutions
$for_pay_{(inst)}$	interest payments to ROW
$gv_tran_{(inst1)}$	government transfers to institutions
for_lb	labor payments to foreign labor

*** walras law**

$walras$	variable to capture walras law
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APPENDIX 2

List of Persons Interviewed:

DENR Environmental Management Office

Environmental Quality Division, National Office
Engineer Cesar Siador, Jr., Chief Air Quality Division
Engineer Nicanor Mendoza, Chief Water Quality Division
Ms. Vilma Elpa, Planning Division

Environmental Quality Division, Davao Regional Office
Engineer Rufino C. Bandialan
Engineer Edgar B. Rubi
Ms. Racquel Villanueva

Philippine Sugar Millers Association
Sugar Industry Environment Committee
Mr. Oscar L. Cortes
Ms. Winnie Claire Odsey-Padong

Philippine Cement Corporation
Mr. Lupo Feliciano, General Manager
Mr. Max Acosta
Ms. Carol Espriritu, Consultant

CEMEX Corporation
Mr. Celestino G. de Leon, Jr.

ALSONS Cement Corporation
Mr. Tom Clough, Chief Operating Officer

UNION Cement Corporation
Mr. Luis Rolando G. Fadrigio, Senior Vice-President -Engineering