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Environmental Impact of Trade Policy Reforms on Pollution Intensity

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ABSTRACT

The paper attempts to provide a theoretical analysis as well as some indicators of the linkage between trade policy and the environment. It looks at what has happened to the share of manufacturing industries by pollution classification over time, and finds that the share of non-pollutive/non-hazardous industries has grown over the years covering the period of trade reforms. It also analyzes the impact of trade policy on the environment using a simulation model, which predicts what happens to pollution intensity with and without trade reforms. The results indicate some positive impact of trade reforms on the environment and that the Philippines should pursue its greater trade liberalization and implement the corresponding environmental measures.

INTRODUCTION

Economic growth has understandably been the major preoccupation of countries around the globe. In the Asia-Pacific region before the Asian currency crisis struck in 1997, greater openness in the trading regime all over the globe was seen to have contributed much to the dynamic growth in the region. Increasingly, however, the pressures on the environment were such that questions about linkages between growth and the environment in general, and linkages between trade policy and the environment in particular, could no longer be ignored.

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While the nature of environmental concerns could require government intervention, it remains open to question whether the use of trade measures would be the best form of intervention to promote environmental objective. Nonetheless, trade policy undoubtedly affects the environment and questions remain whether the adopted trade policy has contributed to environmental degradation. Hence, it is important to determine what has been the impact of Philippine trade policy on the environment, especially in light of the trade reforms that have been undertaken.

This paper attempts to look into this question. Toward this end, the paper first provides a theoretical analysis of the relationships between the trade regime and the environment. Subsequently, it gives a brief overview of the evolution of Philippine trade policy to possibly relate it empirically with what has happened to pollution intensity across sectors. This is done by classifying (four-digit Philippine Standard Industry Classification [PSIC]) manufacturing industries according to how pollutive and hazardous these are, and by looking at what has happened to the share of pollutive industries over the years.

To be sure, pollution is not the only possible environmental impact of policies. However, this paper focuses on the analysis of the impact of trade reforms on pollution, primarily because it is where information and solid data are available. Furthermore, pollution (both air and water) is possibly the most visible and widespread environmental cost of trade reforms. While the trend in the shares of pollutive industries could provide some insights into the environmental impact of trade policy, direct implications could not be conclusively drawn because of numerous other factors that come into play. Hence, the penultimate section seeks to isolate the impact of trade policy using a simulation of the impact of trade reforms on pollution intensity. The last section draws conclusions and recommendations from the results and findings of the previous discussions.

TRADE AND ENVIRONMENT LINKAGES: A THEORETICAL ANALYSIS

Trade theory suggests that for a small country, in the absence of market imperfections (e.g., the case of externalities), the use of trade barriers (whether in the form of tariffs or in the form of quantitative restrictions) creates market distortions that reduce overall welfare. As such, the use of trade measures even for environmental reasons is often considered non-optimal.

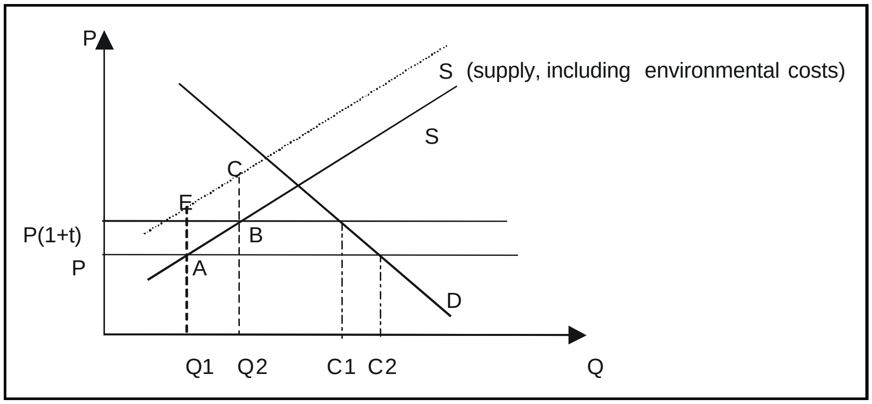
Environmental concerns, on the other hand, almost invariably involve externalities that cannot be captured by market forces alone. Many "environmentalists" would argue that this situation calls for the use of trade control measures to more effectively achieve environmental goal, especially where property rights are not well defined. The question is, would trade barriers improve environmental conditions, and at what costs.

Ideally, distortions should be addressed at the source. For example, if the problem is lack of well-defined property rights, then measures to directly remedy the situation would be more appropriate. Or if externalities are involved, measures to bring about their internalization should be sought. However, these solutions are usually easier said than done, and the use of trade measures for environmental goals is often considered, if not actually resorted to.

While trade measures are often more convenient (politically and otherwise) to implement, their use for the attainment of environmental goals is a roundabout way of addressing the problem, with possible inadvertent costs. Its use may reduce environmental pressures but only at very high costs (or could even aggravate rather than solve an environmental problem). This is further illustrated in two ways.

First, consider a single-commodity case. Suppose that this involves a "dirty" good, whose production entails a pollution cost. A tariff, t, on imports is imposed (or a quantitative restriction on imports) for environmental reasons. See Figure 1.

Figure 1. Impact of a tariff on environmental cost (Area ABCE)



The tariff would raise the domestic market price of the commodity from P_1 to P_2. This would discourage and reduce its consumption from C_1 to C_2. On the other hand, the higher price increases the protection of the local producer and thus encourages more local production of the product from Q_1 to Q_2 while curtailing its importation. On the whole then, the trade barrier, instead of limiting the production of the environmentally undesirable, “dirty” commodity, could increase its local production and thus the pollution cost, the area ABCE. Moreover, production has presumably been transferred from the more globally efficient producer (the exporter) to the less globally efficient one (the importer), indicating a misallocation of resources.

Thus, at best, the use of restrictive trade measures is not enough to promote environmental goals. At worst, it could lead to further degradation of the environment. In any case, what is apparent is that the use of unilateral trade control measures does not seem to offer a viable solution to environmental degradation. The ideal solution is for both the importing and exporting countries to impose a consumption or production tax on the commodity in question (and/or implement some form of command-and-control measure addressing the problem at the source, whichever is more effective and efficient), and refrain from the use of distortionary trade measures.

Now consider a multisectoral economy with a number of exportable and importable sectors. Non-uniform tariffs and/or nontariff barriers (NTBs) create an uneven structure of effective protection rates (EPR)[1] across sectors. Because resources are limited, protection (which is measured by EPR) is relative. Increasing the EPR of one sector is always at the expense of the rest of the economy. It makes the sector relatively more profitable and would accordingly attract a relatively greater flow of resources at the expense of the others.

Suppose the tariff on imports competing with an importable sector associated with high environmental costs relative to the other sectors of the economy is increased. This would lead to a reallocation of resources toward the protected sector from the rest of the economy (which would entail on average lower environmental costs). Thus, on top of the misallocation of resources within the economy resulting from trade distortion, there would be increased environmental costs. On the other hand, if the protected sector has lower environmental costs, then the net effect on the environment would be positive although there would still be a loss in allocative efficiency (arising form tariff distortion).

The discussion indicates some trade-offs between environmental and efficiency objectives. It also strongly suggests another interesting conclusion: that activities associated with high environmental costs, rather than being subjected to trade restrictions, should be liberalized.

In general, if the protected sectors are also associated with higher environmental costs, then protection would clearly be encouraging higher environmental costs, and vice versa. However,

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[1] A tariff on outputs provides nominal protection for the industry while a tariff on inputs imposes a penalty. The effective protection rate (EPR) is a measure of the net effect of tariffs (or NTBs) on both outputs and inputs on the protection an industry receives. It is a measure of protection on value-added, i.e., the percentage difference between protected value-added and "free-trade" value-added (i.e., value-added without protection).

in the latter case (i.e, where protected sectors are associated with lower environmental costs), it is not clear whether the benefits on the environment outweigh the costs in terms of greater allocative inefficiency. In contrast, where environmental measures and/or regulations are enforced to internalize environmental costs instead of using trade measures like tariffs and import controls for environmental reasons, real allocative efficiency is achieved alongside environmental goals with positive impact on overall welfare to boot.

The absence of mechanisms for internalizing environmental costs implies subsidies to the relevant sector. In general, for any given activity, the higher the environmental costs, the greater the implicit subsidy and the higher the implicit EPR. As such, free trade would mean higher EPR for activities associated with higher environmental costs. Thus, in the short to medium term,[2] free trade could lead to environmental degradation if this comes without environmental cost internalization. There is, however, a better allocation of resources (excluding the environment) involved with freer trade, ultimately leading to higher incomes, which should be weighed against the environmental costs. Again, the net effect on welfare is not clear.

What is clear is the near impossibility of designing the tariff scheme such that the resulting EPR structure would exactly but inversely match the environmental costs.[3] It is thus not unrealistic to imagine that a freer trade (with its possible environmental costs) could be better than a more restrictive trade regime, which would likely result in a mismatch of required EPRs (from tariff and trade protection) and environmental costs.[4] In other words, so long as good environmental policy is in place and adequately enforced,

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[2] The dynamic gains from freer trade in the longer run could lead to gains in the environment, arising from cheaper green technology and higher incomes.

[3] This is true even if environmental costs could be adequately measured. In the first place, the output of one sector is usually an input to another so that a tariff on one would have repercussion on the other sectors. In the second place, the tariff should be inversely related to the associated environmental costs. This would not be easy to set.

[4] The latter would have both higher environmental costs and greater allocative inefficiency.

any trade and industrial policy adopted would not impose undue burden on the environment. And, again, the ideal scenario is where environmental measures and/or regulations are enforced to internalize environmental costs, and trade-distorting measures are avoided.

These are basically the same conclusions drawn from the single-commodity case discussed above, but they highlight more fully the impact of trade measures on resource allocation within the economy.

The analysis in both cases, of course, involves a lot of simplifications. Some could argue that the implicit assumptions are far from reality. Markets are imperfect in the real world. The conclusions derived nonetheless remain valid. Whether or not the market is perfect, an increase in protection would generally induce a corresponding flow of resources toward the benefited sectors. Nonetheless, more empirical analysis is needed to support the conclusions. Thus, the next section traces the evolution of Philippine trade policy and attempts to provide some empirical observations on the composition of manufacturing industries with respect to its potential pollution classification.

PHILIPPINE TRADE POLICY ENVIRONMENT AND TRENDS IN THE SHARE OF POLLUTING MANUFACTURING INDUSTRIES

Trade policy has been the major tool that shaped the Philippine industrial policy. It made liberal use of tariffs and import-licensing requirements to protect local industries. Its nature and impact have been well studied. By and large, the Philippines has employed a restrictive trade regime, mainly to promote import-substituting industries, since the early 1950s. There were short periods of decontrol in the 1960s, but on the whole, the trade protection bias has persisted for decades. It was only in the 1980s when major trade reforms began to take shape.

In general, the Philippine trade-policy reform experience could be grouped into five periods. The first is the post-war period up to the 1970s, covering the pre-reform era of highly trade-restrictive and protectionist policy regime and supporting the inward-looking import-substitution strategy at that time. This is followed by the first major trade reforms during the first half of the 1980s—the 1981-85 Tariff Reform Program—which brought down all tariff range to within 50 percent from 100 percent tariff rates. The third period saw the major import-liberalization episodes in 1986-88, soon after the EDSA Revolution and under the Aquino Administration. The fourth period is the second phase of the Tariff Reform Program, narrowing down the tariff range to mostly within 30 percent. This was implemented by the Aquino Administration under Executive Order 470 (EO 470) over a five-year period from 1991 to 1995. Finally, the fifth major period is covered by EO 264, implemented by the Ramos Administration over five years from 1996 to 2000. This further narrowed down the range to within 3 and 10 percent (excluding some agricultural products).

Hence we see a gradual transformation of the Philippine trade regime from a highly restrictive trade policy prior to the adoption of reforms in the mid-1980s to a relatively open trade regime by the end of the 1990s. The reforms were made in recognition of the distortions and adverse effects of the restrictive regime, which led to hidden costs and stunted industrial growth.

Other developments: GATT-WTO, AFTA and APEC

On top of these unilateral trends are multilateral movements toward greater global and regional liberalization, especially in the 1990s. These include, most importantly, the ratification of the General Agreement on Tariffs and Trade-World Trade Organization (GATT-WTO), new initiatives under the ASEAN Free Trade Area (AFTA), and wider regional efforts to accelerate liberalization further under the Asia-Pacific Economic Cooperation (APEC).

In view of the unilateral trade reforms, not much further liberalization is effected by the new WTO. Instead, above anything else for the Philippines, the new WTO represents efforts to strengthen discipline and rules in the global trade and restore global trading order. It thus reinforces the current trend in trade policy. Within their narrower regional context, AFTA and APEC, on the other hand, intend to achieve more in terms of reduction of trade barriers and lowering of tariffs.

Thus, substantial trade reforms have been implemented during the last 15 years or so, marked by a shift from inward policy orientation toward greater openness and more outward orientation. Trade policy affects growth and the pattern of production, and as such has a corresponding impact on the environment. The key question is how has the shift in trade policy affected the environment. As indicated in the theoretical analysis above, so long as good environmental policy is in place and adequately enforced, any trade policy adopted should not impose undue burden on the environment. The problem is that the state of environmental management in the Philippines, as in many other countries, is still far from adequate. Increased production unaccompanied by improvements in environmental management and in the enforcement of environmental laws will only contribute to environmental deterioration, regardless of the prevailing economic policy environment.

Hence, we go back to our question: Have the trade policy reforms imposed undue burden on the environment? Do they have biases that could have contributed to increased environmental degradation?

Trade theory tells us that the inherent bias against exports resulting from the trade protectionist regime of the past made the country heavily dependent on exports—primary products, particularly agricultural crops, and other natural resource-based commodities (mining and forestry), which have huge comparative advantage. These primary industries generally impose greater burden on the environment than the other industries. Thus, the resulting dependence on primary exports has adverse impact on the environment. Secondly, export industries, which have to compete with the world, tend to be more adaptive. Exporters need to stay abreast with the global developments (technological and otherwise), which increasingly demand cleaner and greener environment.

Table 1 presents the EPR trend resulting from trade reforms across sectors, grouped according to pollution classifications. It is interesting to note that with trade reforms, the level of protection for the more pollutive industries went down more substantially relative to the less pollutive sectors. This is indicated by the lower ratio of (1 + EPR) for the more pollutive sectors (average of 0.62 compared to 0.68 for less polluting sectors) between 1983 and 1994.[5] Thus, while trade reforms starting in the 1980s would have mixed effects across sectors with respect to protection, the reforms would likely have, on the whole, a positive impact on the environment. Moreover, the liberalized trade regime would lower the cost of pollution abatement and other similar equipment.

In addition, investments in new machines proceeded slowly under the inward-looking industrial strategy promoted by the highly protectionist regime. This was due to some extent to the limited domestic market it served and to the lack of competition. For example, up to the late 1980s, the textile industry had had to contend with old technology and capital equipment. It was only in the last years of the 1980s when new investments in new machines started to grow. In general, the sluggish re-investment in new machines was likely to have impacted negatively on the environment.

Finally, global trends toward more open trade promote regional and global cooperation, especially in the case of environmental concerns. This is exemplified by such agreements as the International Trade in Timber Agreement (ITTA), the Montreal Protocol, and those on trade in hazardous wastes, biodiversity, climactic change, etc.

[5]The ratio used is 1+EPR rather than EPR. This is more appropriate, since EPR measures a difference, that is, the percentage difference between domestic and free-trade value-added.

Table 1. Pollution classification and effective protection rates (EPR) for manufacturing

PSIC/POLLUTION CLASSIFICATION	1983	1988	1994	Ratio (1+EPR) 94/83
More polluting industries	**80.4**	**32.3**	**12.7**	**0.62**
341 Paper and paper products	65.0	29.2	19.9	0.73
351 Industrial Chemicals	53.2	8.5	3.0	0.67
353 Petroleum refineries	56.6	59.6	20.1	0.77
363 Cement	79.2	42.4	19.5	0.67
369 Other non-metallic mineral prods	280.3	17.4	18.4	0.31
371 Iron and steel	38.3	80.5	9.1	0.79
372 Non-ferrous metal basic products	-9.7	-11.3	-1.2	1.09
Somewhat polluting industries	**61.0**	**42.5**	**22.5**	**0.76**
311 Food	32.9	22.3	14.5	0.86
312 Other food	11.0	21.3	50.3	1.35
313 Beverages	83.7	52.0	44.0	0.78
321 Textiles	92.8	30.6	1.9	0.53
323 Leather and leather products	-13.9	1.7	8.0	1.25
342 Printing and publishing	68.3	72.4	13.6	0.68
352 Other chemical products	37.7	44.8	29.1	0.94
381 Fabricated metal products	82.3	66.3	28.7	0.71
383 Electrical machinery	42.5	30.9	4.7	0.73
384 Transport equipment	50.6	48.8	57.3	1.04
386 Furniture and fixtures of metal	182.7	75.9	-4.5	0.34
Less polluting industries	**60.1**	**13.8**	**8.9**	**0.68**
314 Tobacco	147.0	60.6	53.4	0.62
322 Apparel except footwear	3.1	3.9	4.7	1.02
324 Footwear except rubber	-6.5	-5.3	0.2	1.07
331 Wood and cork products	2.1	4.5	7.5	1.05
332 Furniture and fixtures except metal	-2.6	1.9	-0.1	1.03
354 Prods. of coal and petroleum	74.5	-5.5	10.1	0.52
355 Rubber products	129.3	18.9	17.3	0.51
356 Plastic products, n.e.c.	119.7	20.9	17.9	0.54
361 Pottery and china	224.1	4.7	3.6	0.32
362 Glass and glass products	67.1	37.4	20.2	0.72
382 Machinery except electrical	28.1	11.7	0.4	0.78
385 Professional & scientific eqpt.	-13.2	21.0	1.1	1.16
390 Other manufacturing machinery	8.1	4.6	-0.8	0.92

Sources: Medalla et al. (1996); Medalla (1997).

These insights indicate some positive impact of trade reforms on the environment. The findings on the trend in the share in value-added of the different sectors classified by its pollution potential tend to support these insights.

The Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR) classified manufacturing sectors (at a four-digit level) according to how pollutive and hazardous they could be, ranging from non-pollutive to extremely pollutive and non-hazardous to extremely hazardous, based mainly on their associated effluents. The share in value-added by pollution potential classification of sectors is then computed using the available census data for 1972, 1975, 1983 and 1988, and the annual survey data for 1992. The results are summarized in Table 2. (More details can be found in Appendix A.)

No clear patterns can be established about the share of non-pollutive industries, although some interesting observations can be made. The share of non-pollutive industries is much lower at less than 20 percent than that of pollutive industries. The share of non-pollutive industries was going up and down during the observation points from 1973 to 1992. However, the corresponding levels in the latter period from 1983 were generally higher than those of the earlier, pre-trade reform period. Furthermore, the share of non-hazardous industries steadily rose—from 22 percent in 1972 to almost 37 percent in 1992. Indeed, the share of pollutive and highly pollutive/hazardous industries and extremely hazardous consistently declined from 68.5 percent in 1972 to a little over 50 percent in 1992.

Care should be taken in assessing the resulting trend. Is it an indication of the merits or demerits of industrial and environmental policies? What is the ideal trend in the first place? Furthermore, while industrial policy influences the level and composition of industrial activity, one cannot attribute the trend to industrial policy alone. Equally important is the effectiveness of environmental policy.

Nonetheless, the trend provides a good summary indication of the overall impact of these policies. Furthermore, if there is weak or lax enforcement of environmental laws, it is safe to say that the improving trend most likely implies favorable impact of industrial policies and policy reforms. However, if the trend worsens, it is difficult to tell whether this is the result of the chosen industrial policy or lack of effective environmental measures. Ineffective environmental measures imply non-internalization of environmental costs, which become implicit subsidies to pollutive

Table 2. Share in value-added by pollution classification

Pollution Classification	1972	1975	1983	1988	1992
Extremely hazardous/Highly pollutive	7.06	16.07	16.44	8.61	9.22
Hazardous/Highly pollutive	30.63	28.74	25.40	27.97	24.99
Non-hazardous/Highly pollutive	5.51	3.39	6.03	6.35	6.03
Extremely hazardous/pollutive	3.90	3.39	4.25	5.52	5.09
Hazardous/Pollutive	27.88	22.86	19.34	18.57	18.79
Non-hazardous/Pollutive	9.33	13.49	10.66	11.51	13.35
Hazardous/Non-pollutive	8.90	4.79	5.86	7.14	5.70
Non-hazardous/Non-pollutive	6.78	7.26	12.03	14.33	16.83
ALL INDUSTRIES	100.00	100.00	100.00	100.00	100.00
Non-pollutive	15.68	12.06	17.89	21.47	22.53
Pollutive	41.11	39.74	34.24	35.59	37.23
Highly pollutive	43.21	48.20	47.87	42.94	40.24
TOTAL	100.00	100.00	100.00	100.00	100.00
Non-hazardous	21.62	24.15	28.73	32.19	36.21
Hazardous	67.42	56.39	50.59	53.68	49.48
Extremely hazardous	10.96	19.46	20.68	14.13	14.31
TOTAL	100.00	100.00	100.00	100.00	100.00

industries, hence the relatively higher share of the more pollutive type of industries.

Given the foregoing caveats, the findings seem to support the view that the industrial policy reforms undertaken in the past decade have been beneficial to the environment, or at least have not led to further environmental degradation than would have been in a more protectionist, inward-looking policy regime. Nonetheless, while those findings provide some insights into the impact of trade policy on the environment, direct implications could not be conclusively drawn because of numerous other factors that come into play. Hence, the next section tries to isolate the impact of trade policy using a simulation of the impact of trade reforms on pollution intensity.

IMPACT OF TRADE REFORMS ON POLLUTION INTENSITY: A SIMULATION

The following simulation analysis of the Philippine case illustrates more clearly how trade policy measures affect the environment. Since the 1980s, particularly in 1986 when the Aquino Government took over, the Philippines has been implementing significant trade reforms to push Philippine industries to become globally competitive. It would thus be interesting to determine the impact of trade liberalization on the environment.

The Philippine Institute for Development Studies-Development Incentives Assistance (PIDS-DIA) project has developed a methodology for simulating the impact of trade reforms on output (as well as income and trade balance). The approach is partial equilibrium in nature in that it assumes zero cross-price elasticities and could not incorporate investment behavior. These shortcomings limit the analysis to comparative statistics and short-run impacts. Other comparable approaches have been used in analyzing the impact of trade reforms. Foremost of these are the computable general equilibrium (CGE) models. On the whole, impact results were similar (see Cororaton 1999). The advantage of the model used here, however, is its multisectoral, input-output framework, highlighting best the variation in EPRs across these sectors and incorporating, to some extent, linkages across them. Furthermore, it is the short-run adjustment costs of reforms, which concern policymakers more in the case of policy reforms that are envisioned to have long-term benefits.

Basically, the model works as follows. Changes in nominal tariffs (or tariff equivalents in the case of qualitative restriction removal) effected by trade reforms result in changes in EPRs. Given supply elasticities, EPR changes induce variations in sectoral supply/output. (Refer to equation 1.10 and/or the working equation 1.18 of the Tan (1997) model reproduced in Appendix B.) The resulting changes in sectoral output result in change in income which, in turn, leads to changes in final demand (the magnitude depending upon income demand elasticities). (The change in income is represented in the model by equation 3 while the latter behavior affecting final demand is simulated by equation 5 and/or the working equation 5.6 of the model.) The induced change in supply/output also implies a change in a corresponding modification in intermediate demand according to its input-output coefficient (equation 4.1 of the model). At the same time, the changes in nominal tariffs also affect the output prices, which induce, in addition, changes in final demand, given price elastiticities (equation 5 and/or the working equation 5.6 of the model). Hence, the initial changes in nominal tariffs ultimately affect both supply and demand for each sector. Under the fixed exchange rate assumption, the changes in supply and demand are translated into changes in the trade balance, i.e., exports and imports (equations 6-9). Under the flexible exchange rate assumption, the exchange rate acts as the mechanism used to achieve trade balance (equation 9.15).

Thus, the basic assumption of the model is that protection attracts resources (equation 1). To elaborate, sectors with relatively high effective protection gets a relatively higher share of resources than what would have been under a more even protection structure. Furthermore, resources will flow away from sectors experiencing a relative decline in effective protection, and, conversely, resources will flow to sectors with a relative increase in effective protection.

This study uses the 1985 EPR structure as the pre-reform situation—the base case scenario. Two trade reform scenarios are taken into consideration in the simulation exercise: (1) trade reforms effecting a 50 percent reduction in EPR across the board, and (2) trade reforms levelling tariffs and EPR to a uniform 5 percent. For each case, simulations without exchange rate adjustment (fixed exchange rate) and with exchange rate adjustment (flexible exchange rate) are carried out. These exercises yield five cases: (1) the base case, pre-reform situation; (2) Case A involving simulation of Scenario 1 trade reform without exchange rate adjustment; (3) Case B involving simulation of Scenario 1 trade

Table 3. Pollution abatement cost ratio by sector (in percent)

PSIC	Industry & Process	AC/Q
11-13	AGRICULTURE	1.676
11	Agri crops production	2.340
12	Livestock, poultry, etc.	0.538
13	Agricultural services	0.030
14	FISHERY	0.131
151-159	LOGGING & OTHER FORESTRY ACTIVITIES	28.838
211-212	GOLD & OTHER PRECIOUS METALS	9.117
213	COPPER ORE MINING	7.808
214-219	OTHER METALLIC MINING	34.086
223	STONE, SAND, & CLAY QUARRYING	1.288
221,222,229	OTHER NON-METALLIC MINING & QUARRYING	6.916
311-312	FOOD MANUFACTURING	0.293
313	BEVERAGE MANUFACTURING	0.628
314	TOBACCO MANUFACTURING	0.109
321	TEXTILE MANUFACTURING	0.386
322	WEARING APPAREL	0.125
323-324	MFR. OF LEATHER & LEATHER PRODUCTS	0.480
331	MFR. OF WOOD & WOOD PRODUCTS	1.273
332	MFR. & REPAIR OF FURNITURE	0.298
341	MFR. OF PAPER & ALLIED PRODUCTS	0.660
342	PRINTING, PUBLISHING & ALLIED INDUSTRIES	0.381
351,352 & 356	MFR. OF CHEMICALS & PLASTIC PRODUCTS	0.291
353-354	PRODS. OF PETROLEUM, COKE & COAL	0.045
355	RUBBER PRODUCTS	0.230
356	MFR. OF NON-METALLIC MINING	0.980
371	IRON & STEEL BASIC INDUSTRIES	0.350
372	NON-FERROUS METAL BASIC INDUSTRIES	0.275
381	MFR. OF FABRICATED METAL PRODUCTS	0.228
382	MFR. OF MACHINERY, EXCEPT ELECTRICAL	0.805
383	MFR. OF ELECTRICAL MACHINERY, ETC.	0.110
384	MFR. OF TRANSPORT EQUIPMENT	0.270
385 & 390	OTHER MANUFACTURING INDUSTRIES	0.131
386	MFR. & REPAIR OF METAL FURNITURE & FIXTURES	0.453

Note: AC / Q is the ratio of Abatement Cost (1992 in 1988 prices) and Total Output from the 1988 I-O Table (except for sectors 213-Copper ore mining and 214 to 219-Other metallic mining: Outputs used are from the 1988 Census of Establishments).

reform with exchange rate adjustment; (4) Case C involving simulation of Scenario 2 trade reform without exchange rate adjustment; and (5) Case D involving simulation of Scenario 2 trade reform without exchange rate adjustment.

The pollution intensity ratio (measured by pollution abatement cost per unit of output) for different types of activities using the Environmental and Natural Resources Accounting Project (ENRAP) estimates of pollution abatement costs has been estimated. ENRAP estimated the value of environmental waste disposal services that would reduce pollution to 10 percent of its current level. This includes the annualized costs of investments required to install pollution control equipment (or of shifting to less pollutive technology), and the maintenance and operating costs. The results are presented in Table 3. This, together with the production/output structure, would yield a weighted average pollution intensity. Specifically, using the simulation results of the five cases described above, each, together with the pollution intensity estimates, yields simulation of pollution intensity associated with the different cases of trade reforms.

The results of the exercise are summarized in Table 4. Cases A and C—both trade reform scenarios (50 percent across-the-board reduction in tariffs and a move toward uniform 5 percent tariff rate) under a fixed exchange rate system—represent the worst-case scenario. It appears that trade reforms as such, if implemented without a complementary exchange rate adjustment, would lead to a decline in output and higher overall pollution intensity (pollution intensity rose from the base rate of around 1.90 to 2.09 and 2.27 for Cases A and C, respectively).

This is mainly due to increases in the contribution of agriculture, fishery, forestry activities, mining, and food, beverage and tobacco manufacturing to pollution. (See Tables 5 and 6.) This means that trade reforms increased the relative protection (EPR) in these sectors, inducing a corresponding increase in the share of these sectors in output. (See Tables 3 and 5.) However, because output declined by more than the increase in the pollution intensity, the absolute levels of pollution abatement costs actually went down in these two cases. (See Table 6.)

This result illustrates the trade-off between growth and a cleaner environment. In this case, the cleaner environment is achieved at the risk of lower growth. Moreover, it seems that the cleaner environment is also achieved at a higher pollution abatement cost-per-unit of output.

Table 4. Summary table

	Base	A	B	C	D
Output					
% change with respect to base		-5.17	2.87	-8.96	4.02
Pollution Intensity (in percent)					
All	1.9084	2.0901	1.8934	2.2715	1.9389
Manufacturing	0.3405	0.3401	0.3401	0.3395	0.3394

Notes:
A refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given fixed exchange rate.
B refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given flexible exchange rate.
C refers to post - trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given fixed exchange rate.
D refers to post trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given flexible exchange rate.
Base is 1983.

In Cases B and D (refer back to Table 4)—cases with complementary exchange rate adjustment—the simulation exercise shows increases in the value of output for both types of trade reforms. Case B shows the best result in terms of pollution intensity with the ratio coming down from 1.91 pollution abatement cost-per-unit value of output in the base case 1.89 with trade reforms reducing tariffs and EPRs across the board by 50 percent.

The decline in pollution intensity for Case B (refer back to Table 4) is accompanied by a 2.87 percent increase in the value of output. This, however, does not imply that there has been no trade-off between growth and environmental costs. The total environmental costs also rise with output growth. The trade-off is less costly, however. For Case B, the increase in the value of output is accompanied by a lower increase in abatement costs.

For Case D (refer back to Table 4), pollution intensity increases with trade reforms, reducing the tariffs across sectors to a uniform 5 percent, but only slightly to 1.94. This, however, is accompanied by a higher output growth of 4.02 percent (almost double that of Case B). Is Case D better than case C because of its higher output? Or is Case B better because of its lower pollution intensity? Or is

Table 5. Output simulation under different regime assumptions, tradeable sectors, 1988 (in million pesos)

I-O Sector	Description	Base	A	B	C	D
03-18	Agriculture	29,585	29,025	32,529	29,148	35,602
19-20	Fishery	20,410	20,225	22,693	20,533	25,177
21	Logging	10,682	10,682	10,682	10,682	10,682
22	Other forestry activities	355	355	355	355	355
23	Gold & other precious metals	4,278	4,356	4,902	4,549	5,633
24	Copper ore	2,647	2,730	3,077	2,888	3,592
25	Other metallic mining	589	608	686	644	802
26	Sand, stone, clay	1,246	1,184	1,322	1,146	1,381
27	Other non-metallic mining & quarrying	590	564	630	550	664
28-45	Food manufacturing	90,726	84,305	100,594	80,869	109,074
46-47	Beverage manufacturing	2,598	2,424	2,893	2,336	3,152
49-50	Tobacco manufacturing	5,129	4,570	5,443	4,161	5,571
51-53	Textile manufacturing	9,140	7,278	8,620	5,595	7,288
54-55	Wearing apparel & footwear	11,346	11,346	13,581	11,800	16,085
56-58	Wood & wood products	11,243	10,633	12,698	10,413	14,083
59-60	Paper & paper products	1,614	1,068	1,252	533	627
61	Publishing & printing	1,380	872	1,019	368	409
62	Leather & leather products	385	377	451	384	522
63-65	Rubber products	1,766	1,179	1,382	603	715
66-75	Chemicals and plastic products	13,556	10,398	12,291	7,468	9,608
76	Products of petroleum, coke, & coal	21,462	16,079	18,981	11,018	14,042
77	Cement	1,967	1,679	1,996	1,441	1,913
78	Glass & glass products	1,167	929	1,100	714	930
79	Other non-metallic manufactures	606	517	615	444	589
80	Primary iron and steel prods.	7,643	6,287	7,459	5,102	6,708
81	Non-ferrous basic metals	264	255	304	255	345
82	Fabricated metal products	2,614	1,747	2,049	899	1,067
83	Non-electrical machinery	6,939	3,891	4,507	817	560
84-89	Electrical machinery	8,162	7,291	8,685	6,659	8,920
90-91	Transport equipment	2,142	1,660	1,963	1,215	1,569
92	Wood furniture	1,170	1,171	1,401	1,218	1,660
93	Metal furniture	51	36	42	21	26
94-95	Other manufacturers.	429	565	683	732	1,023
96	Miscellaneous manufacturers	1,663	1,178	1,386	712	882
28-96	Manufacturing	205,161	177,736	211,394	155,776	207,372
[illegible]	ALL	275,544	247,466	288,269	226,271	291,259

Notes:
A refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given fixed exchange rate.
B refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given flexible exchange rate.
C refers to post - trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given fixed exchange rate.
D refers to post trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given flexible exchange rate.
Base is 1983.

Table 6. Abatement cost simulation under different regime cost assumptions, tradeable sectors, 1988 (in million pesos)

I-O Sector	Description	Base	A	B	C	D
03-18	Agriculture	495.8	486.4	545.1	488.5	596.7
19-20	Fishery	26.7	26.4	29.7	26.9	32.9
21	Logging	3,080.6	3,080.6	3,080.6	3,080.6	3,080.6
22	Other forestry activities	102.4	102.4	102.4	102.4	102.4
23	Gold & other precious metals	390.1	397.2	446.9	414.7	513.5
24	Copper ore	206.7	213.2	240.2	225.5	280.4
25	Other metallic mining	200.8	207.4	233.7	219.7	273.3
26	Sand, stone, clay	16.1	15.3	17.0	14.8	17.8
27	Other non-metallic mining & quarrying	40.8	39.0	43.5	38.0	45.9
28-45	Food manufacturing	265.9	247.1	294.8	237.0	319.7
46-47	Beverage manufacturing	16.3	15.2	18.2	14.7	19.8
49-50	Tobacco manufacturing	5.6	5.0	5.9	4.5	6.0
51-53	Textile manufacturing	35.3	28.1	33.3	21.6	28.1
54-55	Wearing apparel & footwear	14.1	14.1	16.9	14.7	20.1
56-58	Wood & wood products	143.1	135.3	161.6	132.5	179.3
59-60	Paper & paper products	10.7	7.1	8.3	3.5	4.1
61	Publishing & printing	5.3	3.3	3.9	1.4	1.6
62	Leather & leather products	1.8	1.8	2.2	1.8	2.5
63-65	Rubber products	4.1	2.7	3.2	1.4	1.6
66-75	Chemicals and plastic products	39.5	30.3	35.8	21.8	28.0
76	Products of petroleum, coke, & coal	9.8	7.3	8.6	5.0	6.4
77	Cement	19.3	16.5	19.6	14.1	18.7
78	Glass & glass products	11.4	9.1	10.8	7.0	9.1
79	Other non-metallic manufactures	5.9	5.1	6.0	4.4	5.8
80	Primary iron and steel prods.	26.8	22.0	26.1	17.9	23.5
81	Non-ferrous basic metals	0.7	0.7	0.8	0.7	1.0
82	Fabricated metal products	6.0	4.0	4.7	2.0	2.4
83	Non-electrical machinery	55.8	31.3	36.3	6.6	4.5
84-89	Electrical machinery	9.0	8.0	9.6	7.3	9.8
90-91	Transport equipment	5.8	4.5	5.3	3.3	4.2
92	Wood furniture	3.5	3.5	4.2	3.6	5.0
93	Metal furniture	0.2	0.2	0.2	0.1	0.1
94-95	Other manufacturers	0.6	0.7	0.9	0.9	1.3
96	Miscellaneous manufacturers	2.2	1.5	1.8	0.9	1.1
28-96	Manufacturing	698.6	604.4	718.9	528.9	703.8
03-96	ALL	5,258.4	5,172.2	5,458.1	5,139.8	5,647.3

Notes:
A refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given fixed exchange rate.
B refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given flexible exchange rate.
C refers to post - trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given fixed exchange rate.
D refers to post trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given flexible exchange rate.
Base is 1983.

Table 7. Net output under different trade regime assumptions, tradeable sectors (in million pesos)

	Base	A	B	C	D
Output					
Level, in million P (tradables)	275,544	247,466	288,269	226,271	291,259
Pollution Abatement					
Cost Level , in milllion P (tradables)					
All	5,258	5,172	5,458	5,140	5,647
Net Output, in milllion P	270,286	242,294	282,811	221,131	285,612

Notes:
A refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given fixed exchange rate.
B refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given flexible exchange rate.
C refers to post - trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given fixed exchange rate.
D refers to post trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given flexible exchange rate.
Base is 1983.

the earlier case, A, the best scenario, which, although associated with lower output and higher pollution intensity ratio, has the lowest total pollution abatement costs?

The results show that trade liberalization could lead to lower overall pollution intensity. However, there is also increased production and a resulting increase in absolute terms in environmental costs (overall pollution). Without a well-defined social welfare function, it is difficult to judge which case is optimal. One possible indicator that could help is the total output value net of total pollution abatement costs. Netting out environmental costs could be loosely interpreted as cost internalization. If goods and resources have been properly shadow-priced, or if costs and benefits as evaluated are close to social prices, then the suggested net value of output would provide a sound (if not perfect) indicator of net welfare, especially for comparison purposes.

The net output for the different cases is presented in Table 7. Using net output as basis, Case D appears to offer the best scenario. This reinforces our earlier conclusion that the ideal scenario is where

Table 8. Sectoral share of pollution abatement cost under different trade regime assumptions: simulation results, 1988 (in percent)

I-O Sector	Description	Base	A	B	C	D
03-18	Agriculture	9.43	9.40	9.99	9.50	10.57
19-20	Fishery	0.51	0.51	0.54	0.52	0.58
21	Logging	58.58	59.56	56.44	59.94	54.55
22	Other forestry activities	1.95	1.98	1.88	1.99	1.81
23	Gold & other precious metals	7.42	7.68	8.19	8.07	9.09
24	Copper ore	3.93	4.12	4.40	4.39	4.97
25	Other metallic mining	3.82	4.01	4.28	4.27	4.84
26	Sand, stone, clay	0.31	0.29	0.31	0.29	0.31
27	Other non-metallic mining & quarrying	0.78	0.75	0.80	0.74	0.81
28-45	Food manufacturing	5.06	4.78	5.40	4.61	5.66
46-47	Beverage manufacturing	0.31	0.29	0.33	0.29	0.35
49-50	Tobacco manufacturing	0.11	0.10	0.11	0.09	0.11
51-53	Textile manufacturing	0.67	0.54	0.61	0.42	0.50
54-55	Wearing apparel & footwear	0.27	0.27	0.31	0.29	0.36
56-58	Wood & wood products	2.72	2.62	2.96	2.58	3.17
59-60	Paper & paper products	0.20	0.14	0.15	0.07	0.07
61	Publishing & printing	0.10	0.06	0.07	0.03	0.03
62	Leather & leather products	0.04	0.04	0.04	0.04	0.04
63-65	Rubber products	0.08	0.05	0.06	0.03	0.03
66-75	Chemicals and plastic products	0.75	0.59	0.66	0.42	0.50
76	Products of petroleum, coke, & coal	0.19	0.14	0.16	0.10	0.11
77	Cement	0.37	0.32	0.36	0.27	0.33
78	Glass & glass products	0.22	0.18	0.20	0.14	0.16
79	Other non-metallic manufactures	0.11	0.10	0.11	0.08	0.10
80	Primary iron and steel prods.	0.51	0.43	0.48	0.35	0.42
81	Non-ferrous basic metals	0.01	0.01	0.02	0.01	0.02
82	Fabricated metal products	0.11	0.08	0.09	0.04	0.04
83	Non-electrical machinery	1.06	0.61	0.66	0.13	0.08
84-89	Electrical machinery	0.17	0.16	0.18	0.14	0.17
90-91	Transport equipment	0.11	0.09	0.10	0.06	0.08
92	Wood furniture	0.07	0.07	0.08	0.07	0.09
93	Metal furniture	0.00	0.00	0.00	0.00	0.00
94-95	Other manufacturers	0.01	0.01	0.02	0.02	0.02
96	Miscellaneous manufacturers	0.04	0.03	0.03	0.02	0.02
28-96	Manufacturing	13.28	11.69	13.17	10.29	12.46
03-96	ALL	100.00	100.00	100.00	100.00	100.00

Notes:
A refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given fixed exchange rate.
B refers to post - trade reform output: changes in output after a 50 percent proportional decrease in EPR from 1985 levels, given flexible exchange rate.
C refers to post - trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given fixed exchange rate.
D refers to post trade reform output: changes in output given a uniform EPR of 5 percent across all sectors from 1985 levels, given flexible exchange rate.
Base is 1983.

environmental measures and/or regulations are enforced to internalize environmental costs, and trade-distorting measures are avoided.

More insights could be gleaned by looking at individual sectors. Table 8 shows the share in pollution intensity by sector. Easily, the forestry and logging sectors account for more than half the pollution intensity in all cases. Manufacturing, on the other hand, accounts for only 13 percent in the base case. Moreover, the share of manufacturing even goes down with trade reforms (in all cases). This results despite the increased share of manufacturing in total output with trade reforms because of the decline in average pollution intensity of the sector.

CONCLUSION AND RECOMMENDATIONS

As stated in the Philippine Medium-Term Plan, the overall strategy of the government is to gear the economy toward export orientation and implement measures that would transform Philippine industries into globally competitive ones. A major part of this strategy is the series of trade reforms implemented and scheduled to be implemented, and the government's active participation in AFTA and APEC.

The findings above complement this thrust. The manufacturing sector accounts for only around 13 percent of abatement costs, and simulation results further indicate that the average pollution intensity (abatement cost) for manufacturing declines with trade reforms (for all cases considered). These strongly suggest that the Philippines should vigorously pursue its current thrust toward greater trade liberalization. It should be emphasized, however, that the findings also highlight the need to implement the necessary environmental measures and to bring about cost internalization. A stronger and more effective enforcement of environmental measures is likewise necessary.

As the foregoing tables indicate, the large majority of environmental problems are found in the natural resources sectors, particularly forestry. This shows that the forestry sector should, in particular, be subject to import liberalization. In relation to the problem of enforcing environmental regulations, the shift toward manufacturing and exporting industries, which would be encouraged by trade reforms, could make the task more manageable. The huge abatement costs in forestry activities could simply frustrate efforts to reverse them and would require more outside assistance, like the Official Development Assistance (ODA), to flow into its environmental management.

A problem that could arise is the environmental management of small- and medium-scale enterprises (SMEs). There is a common perception that compliance with environmental regulations is lower for SMEs. The SMEs' difficulty to comply could be a financing issue, and/or it could arise from economies of scale in waste management. If it is the latter, one solution is for government to encourage the use of common treatment facilities. Such use would be limited, however, since most SMEs are not located close to each other. Another possibility is to encourage the development of firms that would lease out such waste-management services. If it is a financing issue, due, for example, to the huge initial capital requirement, measures to lower interest costs are perhaps called for. Such measures could be in the form of subsidized credit or longer loan maturity.

Finally, and as has been stated earlier, the trade reforms implemented since the mid-1980s toward a more open trade regime appear to have had positive impact on the environment. This is indicated by the lower share in the value-added of pollutive/hazardous industries and the effects of the simulation, which show lower pollution intensity with trade reforms. Since the study has been limited to pollution intensity impacts, the effect on the demands on natural resources could, of course, be different. A more definite, and perhaps more important, insight drawn by the study is the need for good environmental management. Again, so long as good environmental policy is in place and adequately enforced, whatever trade and industrial policy adopted would not impose undue burden on the environment. In other words, trade policy should not be used for environmental objectives. Rather, the problem should be dealt with at its source—environmental regulation for environmental objectives and the best economic policy for economic objectives.

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Appendix A
Share in Value-Added by Pollution Classification (in percent)

PSIC Code/Pollution Classification	1972	1975	1983	1988	1992
Extremely Hazardous/ Highly Pollutive	**7.06**	**16.07**	**16.44**	**8.61**	**9.22**
3511 Mfr. of basic ind'l chemical except fert.	0.84	0.66	1.34	1.21	1.17
3529 Mfr. of chemical products, n.e.c.	1.01	0.90	1.12	1.41	0.78
3530 Petroleum refineries	5.18	14.44	13.92	5.90	7.14
3540 Mfr. of misc. products of petr & coal	0.03	0.06	0.05	0.10	0.12
Hazardous/Highly Pollutive	**30.63**	**28.74**	**25.40**	**27.97**	**24.99**
3123 Sugar milling & refining	11.15	12.99	3.83	3.98	4.60
3131 Distilling, rectifying, & blending spirits	3.06	4.47	2.18	0.57	1.15
3132 Wine manufacturing	0.03	0.07	0.00	0.01	0.00
3133 Malt liquors & malt	0.00	0.00	0.00	7.99	3.93
3211 Spinn'g, weav'g., text'g & finish. textiles	5.52	3.11	4.38	3.18	2.32
3231 Tanneries & leather finishing	0.08	0.07	0.12	0.04	0.08
3232 Mfr. of lthr & lthr. subst. excp. ftwr & wear.app.	0.05	0.06	0.06	0.14	0.17
3411 Mfr. of pulp, paper, & paperboard	2.19	1.83	1.52	2.01	1.70
3419 Mfr. of pulp, paper, & paperbrd. Art. NEC	0.31	0.18	0.05	0.00	0.01
3523 Mfr. of soap & clean'g sol., perfumes, csmtics	3.06	1.16	3.07	2.69	4.97
3630 Mfr. of cement	2.81	1.89	1.64	1.40	1.85
3710 Iron & steel basic industries	2.30	2.57	7.96	3.74	3.53
3720 Non-ferrous metal basic industries	0.08	0.34	0.59	2.22	0.70
Non-hazardous/Highly pollutive	**5.51**	**3.39**	**6.03**	**6.35**	**6.03**
3111 Slaughtering and meat packing	0.25	0.48	0.25	0.86	0.99
3112 Mfr. of dairy products / processed milk	1.32	0.34	0.68	0.15	0.68
3113 Mfr. of dairyproducts except milk	1.13	0.58	0.88	1.70	1.50
3114 Canning & preserving of fruits & veg.	1.77	1.51	1.66	2.33	1.15
3115 Cann'g & presrv'g. fish	0.13	0.14	0.46	1.01	1.23
3117 Mfr. of vegetable & animal oils & fats	0.91	0.35	2.10	0.31	0.48
Extremely hazardous/Pollutive	**3.90**	**3.39**	**4.25**	**5.52**	**5.09**
3512 Mfr. of fertilizers	0.57	0.96	1.26	1.32	1.32
3513 Mfr. of synt.resins, plastic mat'l, exc. glass	0.66	0.51	0.61	0.88	0.59
3514 Mfr. of pesticides, insecticides, oth.	0.08	0.21	0.27	0.57	0.44
3521 Mfr. paints, varnishes, lacquers	0.49	0.28	0.31	0.44	0.38
3551 Tire and tube mfg.	1.55	1.07	0.93	1.49	1.49
3552 Mfr. of rubber footwear	0.32	0.19	0.79	0.61	0.66
3559 Mfr. of rubber products, n.e.c.	0.21	0.17	0.09	0.20	0.20
Hazardous/Pollutive	**27.88**	**22.86**	**19.34**	**18.57**	**18.79**
3140 Tobacco manufactures	6.00	6.12	3.80	6.22	4.88
3212 Knitting mills	0.79	0.93	0.75	0.76	0.53
3214 Mfr. of carpets & rugs	0.19	0.18	0.10	0.03	0.09
3216 Mfr. of artif. leath, oil cloth, oth impreg fabrics	0.03	0.04	0.10	0.01	0.01
3217 Mfr. of fiber batting,pad'ng & uphl. fill'g, + coir	0.02	0.91	0.02	0.02	0.04
3219 Mfr. of textiles, n.e.c.	0.00	0.00	0.00	0.00	0.00
3311 Sawmills & planing mills	3.46	1.76	1.57	1.03	0.38
3312 Mfr. of veneer & plywood	3.37	1.15	2.14	1.07	0.52
3313 Mfr. of hardboard & particleboard	0.00	0.00	0.00	0.00	0.01
3314 Wood drying & preserving plants	0.08	0.12	0.12	0.12	0.07
3315 Millwork plants	0.01	0.01	0.10	0.16	0.13
3560 Mfr. of plastic products, n.e.c.	1.25	1.28	1.66	1.66	1.65
3610 Mfr. of pottery, china, and earthenware	0.13	0.35	0.26	0.35	0.48
3620 Mfr. of glass & glass products	1.29	0.56	0.74	1.30	0.88

Appendix A (continued)

PSIC Code/Pollution Classification	1972	1975	1983	1988	1992
3691 Mfr. of structural clay products	0.26	0.15	0.23	0.18	0.41
3692 Mfr. of structural concrete products	0.45	0.45	0.44	0.24	0.38
3699 Mfr. of non-metallic minl products, n.e.c.	0.27	0.10	0.28	0.37	0.55
3812 Mfr. of structural metal products	1.48	0.87	0.50	0.31	0.53
3813 Mfr. of metal containers	0.44	0.38	0.63	0.47	0.37
3814 Metal stamping, coating & engraving mills	1.25	0.23	0.46	0.42	0.38
3815 Mfr. of fabricated wire products	0.17	0.34	0.18	0.09	0.15
3816 Mfr of non-electric lighting & heating fixtures	0.03	0.05	0.05	0.02	0.05
3821 Mfr. of eng. & turbn, excp. for transport eqpt	0.00	0.02	0.00	0.01	0.01
3822 Mfr. of agrl machy & eqpt	0.23	0.26	0.04	0.04	0.04
3823 Mfr. of metal & woodworkingmachy	0.03	0.08	0.04	0.04	0.08
3824 Mfr. spec'l indl machy excp. metal & woodworking	0.07	0.37	0.06	0.04	0.05
3829 Mfr. of machy & eqpt excp. elecl n.e.c.	1.23	1.03	0.65	0.70	0.99
3831 Mfr. of elecl ind'l machy & apparatus	0.16	0.09	0.17	0.24	0.41
3833 Mfr. of elecl appliances & housewares	0.54	0.94	0.92	0.29	0.42
3834 Mfr. of primary cells & batteries	0.67	0.37	0.27	0.43	0.50
3835 Mfr. of electric accumulators	0.00	0.00	0.16	0.08	0.18
3841 Ship bldg & rprg	0.94	0.33	0.55	0.30	0.37
3842 Mfr. of railroad eqpt.	0.00	0.00	0.00	0.00	0.00
3843 Mfr. & assembly of motor vehicles	2.24	2.41	1.39	0.96	1.22
3844 Rebldg. & major alt. of motor vehicle	0.18	0.19	0.07	0.05	0.06
3845 Mfr. of motor vehicle parts & accessories	0.33	0.50	0.70	0.28	1.60
3846 Mfr. motorcycles & bicycles	0.30	0.30	0.17	0.22	0.34
3847 Mfr. of aircraft	0.00	0.00	0.00	0.05	0.00
3849 Mfr. of transport eqpt., n.e.c.	0.00	0.00	0.00	0.00	0.04
Non-hazardous /Pollutive	**9.33**	**13.49**	**10.66**	**11.51**	**13.35**
3124 Mfr. of cocoa, chococlate & sugar confect.	0.57	0.47	0.32	0.40	0.41
3125 Mfr. of dessicated coconut	0.63	0.42	1.36	0.51	0.23
3126 Mfr. of ice except dry ice	0.14	0.17	0.14	0.15	0.09
3127 Coffee roasting & processing	0.91	0.69	0.41	0.39	0.36
3129 Food manufacturing, n.e.c.	1.41	0.95	1.07	1.91	1.75
3134 Soft drinks & carbonated water mfg.	1.75	8.46	3.26	2.84	3.76
3522 Mfr. of drugs & medicine	3.24	1.79	3.21	4.49	4.94
3836 Mfr. of electric wires & wiring devices	0.26	0.20	0.22	0.40	1.15
3839 Mfr. ofelecl apparatus & supplies, n.e.c.	0.26	0.23	0.41	0.20	0.37
3860 Mfr. & rpr. of furn. & fixt., esp. of metal	0.08	0.05	0.06	0.04	0.08
3902 Mfr. of musical instruments	0.03	0.01	0.03	0.03	0.02
3904 Mfr. of surgical, dental, medical & orthd. supp.	0.01	0.01	0.00	0.04	0.09
3905 Mfr. of opth. . goods (e.g., eyeglasses & spect.)	0.02	0.04	0.00	0.05	0.05
3907 Mfr. of stationers', artists' , & office supplies	0.03	0.02	0.17	0.05	0.05
Hazardous/Non-pollutive	**8.90**	**4.79**	**5.86**	**7.14**	**5.70**
3118 Rice & corn milling	2.69	1.79	0.96	0.90	0.90
3119 Flour milling, excpt. cassava	1.32	0.01	0.42	1.13	0.62
3121 Mfr. of other grain mill products	0.04	0.03	0.00	0.01	0.00
3128 Mfr. of prep. & unprepared feeds	0.83	0.52	0.81	1.31	0.68
3215 Cordage, rope, & twine mfg.	0.27	0.45	0.23	0.23	0.28
3319 Mfr. of wood, cork, & cane products, NEC	0.05	0.11	0.11	0.11	0.07
3320 Mfr. & rpr. of frnture & fixtrs excp. prim.of metal	0.90	0.77	0.92	1.40	0.97
3412 Mfr. of containers & box of paper & paperbrd.	0.80	0.27	0.33	0.49	0.46
3413 Mfr. of articles of paper	0.00	0.00	0.58	0.14	0.20
3414 Mfr. of articles of paperboard	0.00	0.00	0.00	0.00	0.01
3420 Printing, publ., & allied industries	2.01	0.86	1.49	1.43	1.52

Appendix A (continued)

PSIC Code/Pollution Classification	1972	1975	1983	1988	1992
Non-hazardous/Non-Pollutive	**6.78**	**7.26**	**12.03**	**14.33**	**16.83**
3116 Prod'n of crude coconut oil, + cake & meal	1.18	0.81	2.12	1.37	0.72
3122 Mfr. bakery products	1.21	1.45	1.28	1.43	1.87
3213 Mfr. of made-up textile goods, excp. wrng app.	0.24	0.70	0.42	0.24	0.27
3220 Mfr. of wearing app. except footwear	2.19	2.45	3.48	6.03	6.01
3240 Mfr. of ftwr, excp rubbr or plstc. or wood ftwr.	0.29	0.24	0.58	0.31	0.42
3316 Mfr. of wood'n, cane contn. & small cane wares	0.06	0.02	0.03	0.22	0.14
3317 Mfr. of wood carvings	0.19	0.17	0.03	0.09	0.06
3811 Mfr. of cutlery, hand tools, & gen. hardware	0.07	0.07	0.14	0.23	0.30
3819 Mfr. of fabr'd metal prod. excp. machy & eqpt, nec	0.32	0.63	0.07	0.06	0.04
3825 Mfr. of office, computing & acctng machy	0.00	0.01	0.01	0.09	0.11
3832 Mfr. of radio, TV sets, sound recording	0.96	0.63	3.77	3.88	6.34
3851 Mfr. of prof. & scient. & meas'g contr. eqpt	0.00	0.02	0.01	0.05	0.06
3852 Mfr. of photographic & optical instruments	0.00	0.00	0.00	0.00	0.10
3853 Mfr. of watches & clocks	0.00	0.00	0.00	0.00	0.00
3901 Mfr. of jwlry & related articles	0.03	0.04	0.04	0.06	0.15
3903 Mfr. of sporting & athletic goods	0.04	0.00	0.02	0.08	0.11
3906 Mfr. of toys & dolls, excpt. rubr. & plast. toys	0.00	0.00	0.02	0.18	0.13
ALL INDUSTRIES	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Appendix B
Trade Model Using the I-O framework (from Tan 1997)

The model starts with the argument that output of sector j, Q_j, is a function of effective price or value-added V_j only equation (1).

$$Q_j = f(V_j) \qquad (1)$$

V_j in unit prices is defined in equation (1.1) where t_j is the tariff on the output a_{ij} is the amount of input i used to produce one unit of output j, and t_j is the tariff on the input.

$$V_j = (1 + t_j) - \sum a_{it} (1 + t_{it}) \qquad (1.1)$$

Change in output defined in equation (1.2) is equal to the product of supply elasticity, b_j, Q_j^o, the level of output before reform, and a proportionate change in effective price $\hat{V}_j$, which is defined in equation (1.3).

$$dQ_j = b_j Q_j^o \hat{V}_j \qquad (1.2)$$

$$\hat{V}_j = \frac{V_j^1 - V_j^o}{V_j^o} \qquad (1.3)$$

Where is the pre-reform effective price,
is the post-reform effective price.

$$\hat{V}_j = \frac{(V_j^1 - V_j^f) - (V_j^o - V_j^f)}{V_j^f} * \frac{V_j^f}{V_j^o} \qquad (1.4)$$

$$E_j^1 = (V_j^1 - V_j^f) / V_f^f \qquad (1.5)$$

$$E_j^o = (V_j^o - V^f) / V_j^f \qquad (1.6)$$

In equation (1.3) subtract V_j^f from V_j^1, add V_j^f to V_j^o, then multiply by V_j^f/V_j^f to get the equation (1.4). V_j^f is the free-trade effective price. $(V_j^1 - V_j^f)/V_j^f$ is actually the post-trade reform EPR, (E_j^1), while $(V_j^o - V_j^f)/V_j^f$ is the pre-trade reform EPR, (E_j^o), as defined in equations (1.5) and (1.6) respectively. From equation (1.6), equation (1.7) is derived.

$$\frac{1}{1+E_j^o} = \frac{V_j^f}{V_j^o} \qquad (1.7)$$

Substitute equations (1.5), (1.6) and (1.7) into equation (1.4) to get equation (1.8), which shows that the proportionate change in effective price $(\hat{V}_j)$, is the difference between E_j^1 and E_j^o over 1 + E_J^o.

$$\hat{V}_J = \frac{E_J^1 - E_J^O}{1+E_J^O} \qquad (1.8)$$

Given changes in the absolute effective price, equation (1.9) can be used to estimate output effects in the short run.

$$dQ_j = b_j Q_j^o (E_j^1 - E_j^o) / (1+E_j^o) \qquad (1.9)$$

However, in the longer run, the use of relative prices is more appropriate. Therefore, equation (1.2) can be rewritten as equation (1.10).

$$dQ_j = b_j Q_j^o \left(\frac{\hat{V}_j}{\bar{V}} \right) \qquad (1.10)$$

Equation (1.10) states that the change in output is the product of b_j, Q_j^o and $(\frac{\hat{V}_j}{\bar{V}})$ the proportionate change in relative effective price, as defined in equation (1.11).

$$\frac{\hat{V}_j}{\bar{V}} = \frac{\left(\frac{V_j^1}{\bar{V}^1} - \frac{V_j^o}{\bar{V}^o}\right)}{\frac{V_j^0}{\bar{V}^o}} \tag{1.11}$$

where $\frac{V_j^1}{\bar{V}}$ is the post-reform relative effective price of sector j,

$\frac{V_j^o}{\bar{V}^o}$ is the pre-reform effective price of sector j.

V^1 is the post-reform weighted effective price.

V^o is the pre-reform weighted effective price.

Divide equation (1.11) by V_j^f, the free trade effective price, to get equation (1.12).

$$\frac{\hat{V}_j}{\bar{V}} = \frac{\frac{V_j^1}{V_j^f} \Big/ \frac{\bar{V}^1}{V_j^f} - \frac{V_j^o}{V_j^f} \Big/ \frac{\bar{V}^o}{V_j^f}}{\frac{V_j^o}{V_j^f} \Big/ \frac{\bar{V}^o}{V_j^f}} \tag{1.12}$$

From equations (1.5) and (1.6), one can get equations (1.13) and (1.14).

$$1 + E_j^1 = \frac{V_j^1}{V_j^f} \tag{1.13}$$

$$1 + E_j^o = \frac{\bar{V}^o}{V_j^f} \tag{1.14}$$

E^1 and E^o are the weighted pre-and post-reform effective protection rates, respectively as defined in equations (1.15) and (1.16). Substitute equations (1.13), (1.14), (1.15) and (1.16) for equations (1.12) to get equation (1.17).

$$1 + \bar{E}^1 = \frac{\bar{V}_j^1}{V_j^f} \qquad (1.15)$$

$$1 + \bar{E}^o = \frac{\bar{V}^o}{V_j^f} \qquad (1.16)$$

$$\frac{\hat{V}_j}{\bar{V}} = \frac{\dfrac{1 + E_j^1}{1 + \bar{E}^1} - \dfrac{1 + E_j^o}{1 + \bar{E}^o}}{\dfrac{1 + E_j^o}{1 + \bar{E}^o}} \qquad (1.17)$$

Equation (1.18) is used to estimate the change in output of sector j due to changes in relative effective price of sector j.

$$dQ_j = b_j Q_j^o \left[\frac{\dfrac{1 + E_j^1}{1 + \bar{E}^1} - \dfrac{1 + E_j^o}{1 + \bar{E}^o}}{\dfrac{1 + E_j^o}{1 + \bar{E}^o}} \right] \qquad (1.18)$$

Equation (2) states that the level of employment in sector j, (L_j), is the product of an employment ratio (e_j), and Q_j while equation (2.1) shows the change in employment of sector j, (dL_j), to be the product of e_j and the change in output (dQ_j).

$$L_j = e_j Q_j \qquad (2)$$

$$dL_j = e_j dQ_j \qquad (2.1)$$

The third equation is income. Equation (3) shows that income of sector j, (Y_j), is the product of V_j and Q_j. Change in income, dY_j, is equal to V_j times dQ_j, equation (3.1). $\hat{Y}$ is the proportionate income change in which is the ratio of the sum of all changes income over total income, equation (3.2).

$$Y_j = V_j Q_j \qquad (3)$$

$$dY_j = V_j dQ_j \qquad (3.1)$$

$$\hat{Y} = \frac{\sum dY_j}{\sum Y} \qquad (3.2)$$

The fourth equation is intermediate demand. Intermediate demand of sector j, I_j, is the sum of the product of a_{ij}, the amount of input i used in producing a unit of output j, and Q_j, equation (4); the change in intermediate demand of sector j, dI_j, comes from the changes in output only and is the product of a_{ij} and dQ_i, equation (4.1).

$$I_j = \sum a_{ij} * Q_i \qquad (4)$$

$$dI_j = \sum a_{ij} * dQ_i \qquad (4.1)$$

Final demand (F_j) is a function of price and income, equation (5). Assuming that cross-price elasticities are zero, the change in final demand of sector j due to changes in price is estimated as the product of the proportionate change in the domestic price of sector j, ($\hat{P}_j$), own price elasticity of demand, (G_{jj}), and final demand before reform, F_j^o; changes in final demand due to change income is estimated as the product of the income elasticity of demand of sector j, (K_j), the proportionate change in income ($\hat{Y}$) and F_j^o. Therefore, total change in the final demand of sector j, (dF_j), is the sum of the price and income effects, equation (5.1).

$$Fbj = g(P_j, Y) \qquad (5)$$

$$dF_j = \left[G_{jj}(\hat{P_j}) + K_J \hat{Y} \right] F_j \qquad (5.1)$$

The proportionate change in the domestic price of sector j is defined in equation (5.2),.

$$\hat{P}_j = \frac{P_j^1 - P_j^o}{P_j^o} \qquad (5.2)$$

where P_j^o is the pre-reform domestic price of sector j.
P_j^1 is the post-reform domestic price of sector j.

Pre-reform domestic price of sector j in equation (5.3) is assumed to be the product of a world price, Pb, and the implicit tariff of sector j before reform, T_j^o, P_j^1 is also assumed to be the product of Pb and the implicit tariff after reform of sector j, T_j^1.

$$P_j^o = Pb\,(1 + T_j^o \qquad (5.3)$$

$$P_j^1 = Pb\,(1 + T_j^1\,) \qquad (5.4)$$

Substitute equations (5.3) and (5.4) into (5.2) to get equation (5.5).

$$\hat{P}_j = \frac{Pb\,(1+T_j^1 - Pb\,(1+T_j^o\,)}{Pb\,(1+T_j^o\,)}$$

$$\hat{P}_j = \frac{T_j^1 - T_j^o}{1+T_j^o} \qquad (5.5)$$

A final demand estimate that is consistent with the u se of relative prices is shown in equation (5.6)

$$dFj = \left[Gjj * \left(\frac{\hat{P}_j}{\bar{P}} \right) + Kj\hat{Y} \right] F_j^o \qquad (5.6)$$

where $(\hat{P}_j / \bar{P})$ is the proportionate change in relative domestic price j defined in equation (5.7).

$$\left(\frac{\hat{P}_j}{\bar{P}} \right) = \frac{\left(P_J^1 / \bar{P}^1 \right) - \left(P_j^o / \bar{P}^o \right)}{P_j^o / \bar{P}^o} \qquad (5.7)$$

where $\bar{P}^o$ *and* $\bar{P}^1$ are the weighted domestic prices before and after reform as defined in equations (5.8) and (5.9).

$$\bar{P}^O = \bar{P}b\,(1+\bar{T}^o\,) \qquad (5.8)$$

$$\bar{P}^1 = \bar{P}b\,(1+\bar{T}^1\,) \qquad (5.9)$$

where $\bar{P}b$ is a weighted world price and $\bar{T}^o$ and $\bar{T}^1$ are weighted implicit tariff rates before and after reform, respectively. Substitute equations (5.3), (5.4), (5.8) and (5.9) into (5.7) to get (5.10).

$$\left(\frac{\hat{P}_j}{\bar{P}}\right) = \frac{\dfrac{Pb\,(1+T_j^1)}{\bar{P}b\,(1+\bar{T}^1)} - \dfrac{Pb\,(1+T_j^o)}{\bar{P}b(1+\bar{T}^o)}}{\dfrac{Pb\,(1+T_j^o)}{\bar{P}b\,(1+\bar{T}^o)}} \tag{5.10}$$

$$\left(\frac{\hat{P}_j}{\bar{P}}\right) = \frac{\dfrac{1+T_j^1}{1+\bar{T}_j} - \dfrac{1+T_j^o}{1+\bar{T}^o}}{\dfrac{1+T_j^o}{1+\bar{T}^o}}$$

The sixth equation is total demand, (D_j), defined as the sum of intermediate and final demand; change in total demand of sector j, (dD_j), is the sum of the change in intermediate demand and change in final demand, equation (6.1).

$$D_j = F_j + I_j \tag{6}$$

$$dD_j = dF_j + dI_j \tag{6.1}$$

The seventh equation is imports (M_j), which is the difference between the total demand for and output of importable sectors; change in imports of sector j, (dM_j), is the difference between the change in total demand and the change in output of importable sector j, (dQ_j), equation (7.1).

$$M_j = D_j - Q_j \tag{7}$$

$$dM_j = dD_j - dQ_j \tag{7.1}$$

The eighth equation is exports, (X_j), which is the difference between output and total demand of exportable sector j; change in exports of sector j, (dX_j), is taken as the difference between the change in output and the change in total demand of exportable sector j, equation (8.1).

$$X_j = Q_j - D_j \tag{8}$$

$$dX_j = dQ_j - dD_j \tag{8.1}$$

The ninth equation is trade balance, (TB), which is defined as the difference between the sum of exports of exportable sectors, åX_j, and the sum of imports of importables sectors, åM_j; the change in the trade balance, (dTB), is the difference between the sum of changes in exports, ådX_j, and the sum of changes in imports, ådM_j, equation (9.1).B.

$$TB = \sum X_J - \sum M_J \tag{9}$$

$$dTB = \sum dX_j - \sum dM_j \tag{9.1}$$