Environmental Sustainability in Trade: Evaluation of the Potential Industrial Environmental Impacts of the FTAA

BRAZIL CASE STUDY

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Preface

This report arises out of a multiyear program of interdisciplinary and multisectoral research and dialogue undertaken by the World Resources Institute, the University of Miami's North-South Center, and Tulane University's Institute for Environmental Law and Policy, together with the Organization of American States Inter-American Forum on Environmental Law (OAS/FIDA). The program was requested by OAS Member States, through FIDA National Focal Points, who requested technical assistance and capacity building in the area of trade and the environment.

Working with local partners, such as Dr. Ronaldo Seroa Da Motta, Coordinator of Studies on Regulation for the Research Institute for Applied Economics (Instituto de Pesquisa Econômica Aplicada — IPEA) in Brazil, and in coordination with government officials and expert organizations from the region, the project aims to produce ***National Environmental Assessments of the potential impact of proposed multilateral trade agreements, such as the proposed Free Trade Area of the Americas (FTAA).***

The program follows two separate and interrelated paths:

1. ***Research and Analysis***. Assessing potential environmental challenges in the context of increased trade and investment (under Free Trade Agreements (FTAs) and other potential multilateral trade commitments such as an FTAA) through country studies undertaken in collaboration with national environmental officials and experts. The methodology centers on identifying high-change sectors with a high potential impact on the environment as a means to clarify the most significant potential environmental consequences of trade-related and potential FTA-driven growth. The principal focus of the project is on domestic policy alternatives, although some findings may be relevant to the text of the agreements themselves.

2. ***Dialogue and Capacity Building***. Policy options are analyzed in the domestic context through public/private dialogue, as government officials consider alternatives to manage and minimize environmental impacts and to promote environmental benefits. Constructive dialogue and peer review are emphasized in all project elements, so that governments and their counterparts may apply, replicate, and build upon the analytical methodology and manage trade and environment issues in their own domestic circumstances.

Acknowledgments in Brazil

In preparing this report, the author has consulted with a wide range of professionals and decisionmakers from government, private sector, academia, and civil society, with views to obtaining first-hand information, confirming existing data and factual findings, and gaining additional insights and perspectives regarding trade policy and environmental issues.

OAS/FIDA and the author also conducted a peer review co-hosted by the Secretariat of Sustainable Development Policy of the Minister of Environment (Secretaria de Políticas para o Desenvolvimento Sustentável, Ministério do Meio Ambiente) in Brasilia, Brazil, in May 2003. The author and the Series Editors especially wish to acknowledge Dr. Gilney Viana, Secretário, Secretaria de Políticas para o Desenvolvimento Sustentável, and to thank him for his support in preparation of this peer review meeting.

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Executive Summary

As Brazil is expected to be one of the major partners in the Free Trade Area of the Americas (FTAA), Brazilians may question the agreement's resulting environmental impacts. If the FTAA is accepted by the developing countries in the region, it will presumably address the United States' trade barriers for agricultural goods and specific industrial sectors.

This study is an attempt to estimate the industrial environmental impacts of the FTAA in Brazil. The paper starts by explaining the basis of the study's theoretical motivations. Next, it analyzes the growing effectiveness of the Brazilian environmental legal framework and discusses the findings of Mendes (1994) and Young (2002), showing that industrial environmental control costs are, on average, low and do not seem to restrict competitiveness.

Looking specifically at the FTAA's estimated impacts on the Brazilian economy, the results of a recent computable general equilibrium (CGE) study (Tourinho and Kume, 2002) that estimated the direct impacts of trade liberalization are presented. Results indicate that Brazil's production of sugar, shoes and leather goods, steel and iron, and vegetable goods would increase from 3.6 to 13.7 percent. Export increases will also be the highest in these four sectors, plus in the wearing apparel sector, which shows a similar performance. Imports would increase in several industrial sectors, for example, vehicle assembly and wood and furniture.

Based on these CGE model results from Tourinho and Kume (2002), the resulting changes in pollution emission and water and energy use levels in the Brazilian industrial sector due to the FTAA are estimated. This study's results are very interesting, as economy-aggregate direct environmental impacts of the FTAA on the Brazilian economy are expected to be, in general, very minor and in the direction of lower air pollution intensity (particulates and SO_2) and energy uses. However, increasing intensities in water pollution and uses and in CO_2 emissions are expected. These changes will occur in a few sectors where dynamic technological and environmental policies already exist as well as motivation to meet the export market's stricter environmental rules.

The next section of the paper analyzes the determinants of adoption of control practices, estimated in Seroa da Motta (2001) and in Ferraz and Seroa da Motta (2002), indicating that, apart from sanctions and public pressure, the industrial sector is motivated to enhance environmental performance whenever the environmental measures bring about cost savings, are requirements for accessing public credit, and respond to restrictions in expanding export markets.

Based on this analysis, it is recommended that environmental regulators follow strategies that further enhance the industrial sector's current performance, economic efficiency, and competitiveness. To carry out these strategies, this study makes the following recommendations:

1. Stimulate cooperation on and integration of environmental and trade policies at ministerial levels.

2. As water pollution and water uses seem to be the main potential environmental impacts of the FTAA, current initiatives for the application of water charges, which are part of the new water legislation in Brazil, or measures similar to Brazil's should be promoted and included as part of any possible FTAA environmental provisions. With such an instrument, total industrial abatement could be attained at higher levels with lower total social costs. High levels of economic efficiency could also be attained, apart from generating some level of revenue to be channeled to reduce other tax payments (the one on labor, for example) or to increase budgets for environmental monitoring and enforcement.[1]

3. Options for subsidized credits should be made available in ways that link access to this credit to a company's compliance status. It must be noted, however, that subsidies divert resources from other governmental policies and that compliance may be achieved with instruments that are neutral in fiscal terms.

4. Stimulate technological research in the agricultural goods processing sector, which is diversified in output and location and, thus, has not been able to sponsor joint efforts on research and development (R&D) and indicators of environmental policies across its several actors.

5. Interchanges between existing private research centers of the leading industrial sectors should be promoted with international public research centers to increase access to information on cost savings and to reduce transaction costs of implementing procedures aimed at these targets.

6. Mechanisms that facilitate local communities' access to information about firms' environmental performances, which add complementary efforts on enforcement, should be created. This can be done with low-cost initiatives, such as inventories of pollution releases and lists of best or worse firms according to specific parameters on compliance status.

Contents

1. INTRODUCTION

As Brazil is expected to be one of the major partners in the Free Trade Area of the Americas (FTAA), Brazilians may question the agreement's resulting environmental impacts. If the FTAA is accepted by the developing countries in the region, it will presumably address the United States' trade barriers for agricultural goods and specific industrial sectors.

The benefits of pollution control usually affect whole societies. High transaction costs of assigning and securing property rights over most goods and environmental services prevent those suffering from the harmful effects of pollution from seeking full compensation against emitters. This is the typical case of a negative externality, that is, third party damages that the market is not properly pricing.

If the benefits of pollution control accruing to polluters (for example, avoidance of sanctions) are lower than their respective private control costs, emitters will lack incentives to undertake controls. Thus, pollution control represents a typical case of governmental intervention to correct a market failure. The classic paradigm for environmental policies is then based on the regulator (a principal) that controls private agents through regulation. Under this paradigm, noncompliance with norms and rules dictated by regulators results in sanctions or other legal liability for the noncomplying entity. The seminal work of Becker (1968) on general legal compliance stated that profit maximization would make agents equalize noncompliance and compliance costs at the margin. Compliance costs require that firms adjust to regulatory standards by increasing their expenditures and incomes sufficiently to cover compliance costs.

Noncompliance costs can be calculated as sanctions applied to firms that have not made the required adjustments and depend on the level of the sanction weighted by the probability of being caught and punished, that is, the expected sanction value. While sanction values are usually known (penalty value, closure costs, and so on), the probability of being caught and punished is not directly observed by firms. So regulators may use different strategies, from low sanction values with high monitoring levels to high penalties with low inspection rates. Firms determine their own expectations of the probability of being caught and sanctioned and will make compliance decisions in light of the expected value of noncompliance costs. Regulators, for their part, often possess the means of increasing environmental regulatory enforcement.

However, firms that are closely regulated, compared with those subject to lax environmental restrictions, may lose competitiveness. As the argument goes, adoption of stricter environmental regulations in some countries will, theoretically, affect international relative costs, thus altering comparative advantages and trade patterns. Therefore, in response to trade liberalization, polluting-intensive industries will, in principle, tend to move to the countries that have lax environmental regulations, the so-called "pollution haven" hypothesis.[2]

Environmental strategies in each country will balance gains from improvements in environmental quality against costs related to lost income from firms' reallocations, such as losses on exports and increasing import costs. Under noncooperative or nonenforcement circumstances, all countries will tend to adopt lax environment policies, and environmental standards will be weaker in smaller countries, where gains from attraction of new firms are more dominant (see Kanbur, Keen, and Wijnbergen 1995).

The empirical literature on the subject has largely failed to find evidence on the correlation between location decision and the environmental standards of host countries[3] (see reviews in Dean 1992; and Zarsky, 1999). As mentioned in the literature (see, for example, Neumayer 2001), it seems that environmental regulation costs are, on average, not significantly excessive and do not exceed other location decision costs (associated with labor, exchange rate swings, tax differentials, transport, and so on). Repetto (1995) has pointed this out for the U.S. economy.

In fact, as mentioned by Neumayer (2001), the World Bank's *World Development Indicators* (1998) show evidence that "dirty" industries operate in developed countries because they are capital-intensive and not labor saving, as "clean" industries, in general, are.

Although there is no strong evidence support this view, trade is still often seen as bad for the environment. In the context of trade agreements, this fear is apparent and has led to intense debate. It is still a concern within the European Community (EC) and among the North American Free Trade Agreement (NAFTA) countries, as well as in the negotiations toward an FTAA.

The removal of U.S. trade barriers under the proposed FTAA would create opportunities for the economic expansion of the agricultural and industrial sectors in other countries, particularly in Brazil, where there are many modern agricultural and industrial activities. Expansion of these sectors may well create additional pressures on land use and increase pollution emissions.

The land use issues in developing countries of deforestation and land degradation seem to attract more attention in world public opinion than industrial contamination, although pollution can cause as much harm to human well-being in developing countries as it does in developed countries.

This study recognizes the importance of land issues in trade-related problems, but it is only focused on industrial pollution problems, as the scope of the study could not accommodate methodological capacity and data availability on deforestation and land degradation matters.

In this study, how increased trade, as expected from FTAA, will affect the environmental performance of Brazil's industrial sector will be analyzed. The approach will be based on static CGE model results from Tourinho and Kume (2002), applied to Brazil when trade tariffs are removed, according to a hypothetical scenario under the FTAA. By converting output changes, as indicated in the model application, into industrial pollution and water- and energy-use levels, the respective environmental effects can be measured. This methodology measures the direct effects of trade in a static context; dynamic firm behavior is not taken into account. To compensate for this, the analysis will be extended to offer indicators on determinants of environmental performance.

Prior to the quantitative analysis, recent Brazilian environmental legislation and its enforcement procedures will be discussed. The study's third section presents indicators estimated by Mendes (1994) and Young (2002) on the impacts of pollution control costs in the Brazilian industrial value-added and exports sectors.

The fourth section presents the direct FTAA environmental impacts on the Brazilian economy, based on the CGE exercise estimated by Tourinho and Kume (2002), followed by a brief description of the main initiatives on environmental management already occurring in industrial sectors that are expected to benefit the most from the FTAA.

Two studies on the determinants of environmental performance of the Brazilian industrial sector, Seroa da Motta (2001) and Ferraz and Seroa da Motta (2002), are analyzed in section five to provide some dynamic indicators of environmental control in this sector.

The last section presents final conclusions and policy recommendations.

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2. POLLUTION REGULATION AND ENFORCEMENT IN BRAZIL

In Brazil, in addition to the Environmental Protection Agency (EPA), any citizen can act against polluters for noncompliance. Anyone can file a complaint against a an alleged violator with the office of the EPA and/or to the Public Prosecutor (Ministério Público — MP).

Firms face two types of legal sanctions: 1) administrative fines imposed by state EPAs and 2) remediation and clean-up costs imposed by the judiciary. The payment of an EPA fine does not preclude the payment of remedial costs (civil responsibility), nor the potential for criminal charges.[4]

Jurisdiction for environmental pollution control is decentralized and lies with the states,[5] but noncompliance sanctions are usually established by federal law and are classified in three levels: serious, mild, and light. The EPA can, however, in extreme cases, close plants. Categories of fines are defined by law, but their interpretation and pecuniary value are established by states within a range of values. Only very recently have states revised upward these values, which had been depreciated by inflation in the late 1980s and early 1990s.

The application of fines follows some general procedures: 1) warning, 2) proposed fine, 3) a firm's defense of the fine, 4) fine analysis, and 5) fine application. In most states, the fine's value is set by the EPA, and its analysis is conducted, in severe cases, either by the Secretary of the Environment or by a state council linked to the State Secretariat of the Environment, where nongovernmental environmental agencies and civil society (industrial associations, NGOs, and academia) also participate as observers. If a fine is confirmed, a firm can only appeal to the judiciary. EPAs spend a great deal of time and effort on monitoring and sanction-setting and analysis, which means that enforcement costs are not negligible.

When firms are caught and placed on noncompliance status, apart from having to pay the fine, they are forced to remedy the problem and return their facilities and operations to compliance status. However, agreements are usually set between the violator and the EPA and/or the judiciary, called the "term of behavior adjustment" (*termo de ajuste de conduta* — TAC), which grants firms a grace period for achieving compliance. The contents of the TAC often account for economic constraints faced by firms and the need to compromise with regional development goals possibly related to that firm's activities.

Firms undertaking activities with potential environmental impacts are required to have an environmental license granted on environmental criteria.[6] This permit to operate an industrial plant has to be obtained prior to operation and periodically renewed (every four to five years)[7] and is issued according to environmental impact assessment reports (Estudo de Impacto Ambiental-Relatório de Impacto Ambiental — EIA-RIMA). Licensing is analyzed by the state EPA, but its issuance is often authorized by the Environment State Council.

Licensing procedures are supported by a 1981 federal law, which was regulated in 1986 and revised in 1998. These legally binding instruments make the Environment State Council's decisions on licensing compulsory and are not disputable in judicial litigation, although failure to meet licensing requirements can be deferred with the TAC instrument. Just as the installation of a firm is easily spotted, the monitoring of licensing is also easily undertaken. Moreover, licensing is mandatory in order for a firm to be entitled to certain governmental incentives (fiscal and credit). Consequently, firms have learned that licensing is not easily avoided; therefore, only a very low proportion of firms have full noncompliance licensing status.

Public prosecutors do not have a budget for monitoring; their work consists of putting together a judicial case with the collaboration of governmental and nongovernmental organizations. Thus, today they have become the main driving forces of judicial enforcement of environmental regulation.

It is interesting to note that in Brazil, mostly due to acute social problems, violators are sometimes forced by judges to pay for public welfare projects (from building hospitals to food distribution) instead of full remediation or clean-up actions.

A firm's defense cost varies. In the case of sanctions, they can range from just a letter or a simple report contradicting the findings of the reported violations, to a dense report with monitoring data. Judicial litigation is costly and often avoided, unless extreme cases call for imprisonment and closures, which are becoming more frequent. Although most fines applied are confirmed, firms have the incentive to avoid their payment because enforcement for administrative fines is rather weak.

EPA fines are collected by the state treasury and usually funded in the EPA's budget. The value of the fines is not high enough to motivate the treasury to allocate efforts for collection, nor does the treasury receive a share of the resulting revenues. Nevertheless, fines are eventually paid because they will constitute a liability as governmental debt for firms and may jeopardize the firm's status under other governmental licenses, credit, and fiscal benefits. EPAs do not follow-up fine payments that are totally controlled (in a very nonsystematic manner) by the state treasury. In contrast, judicial payments are relatively easier to enforce, although they may take longer to be set against firms due to judiciary procedures.

Each state is responsible for its own territorial monitoring on industrial sources. Systematic and random monitoring is rare. Monitoring is mostly driven by four factors: 1) environmental harm potentiality and past behavior of firms, 2) follow-up of licensing agreements and TAC, 3) demand from public prosecutors, and 4) community complaints on change of media environmental quality. The former two factors are endogenously defined by the EPA, whereas the latter two are defined outside the authority.

Community denouncement is very common in Brazil, and it can usually be made by a telephone call. Once the case gets space in the news media, its priority on EPA strategies increases. NGOs are frequently a main source of pressure to denouncement, particularly those that are locally organized.

As EPA managers can be prosecuted due to mandate failures, and they are always facing a great deal of systematic monitoring inefficiency, they tend to give high emphasis to these community denouncements. And, in fact, EPA performance is measured by its capability to act promptly against these notorious cases. Also, currently, public prosecutors have been imposing a greater monitoring burden on the EPA for its own actions.

A few states have implemented self-monitoring practices, although they have failed to implement efficient random field verifications of firms under this system. Although there is no specific rule for lower fines for self-reported violations, EPAs tend to apply lower fines for self-reported violations. This is also true for violations by firms that are not in the self-reporting system, which, for any reason, report their violations (particularly the accident-related ones with "visible" consequences).

Media environmental monitoring is still weak and partial. In the case of water quality, due to the importance of hydroelectric energy generation in the country, monitoring is systematic in certain basins covering only organic matters and suspended solids. Few major cities with acute air pollution problems have systematic air quality monitoring, and some industrial zones have their own monitoring structure. Because of the lack of consistent and systematic media monitoring, public perception (including visual changes, smells, fish mortality, human health incidences, and so on) is the major indicator for denouncement and the basis for EPA actions.

Moreover, in Brazil, as elsewhere in the world, the integration of environmental concerns into sectoral development and general economic policies is still minimal. Therefore, the insertion of environmental variables in the planning process usually ends up as a matter of ad hoc adjustments at a project level, from the design to the operational phases. Disputes on environmental grounds still confront radical positions, based on the assumption that there is an inherent conflict between growth and preservation.[8]

In sum, environmental legislation and its instruments are fully based on strict mandatory norms and standards, which do not recognize opportunities for balance or compromise. Consequently, environmental licensing and supervision are often informally relaxed to take into account the needs for compromise when political pressure is high. Such a pattern creates uncertainty, litigation, and enforcement failures.

In addition, it must be recognized that trade and environmental issues have been treated separately, but due to Brazil's increasing international insertion and movements toward regional trade agreements, the country cannot afford to separate the issues any longer. Therefore, it is urgent to create opportunities for further integration in both environmental and trade policy-making decisions.

3. Industrial Pollution Costs in Brazil

There are no updated estimates of industrial pollution control costs in Brazil. Mendes (1994) has, however, estimated water pollution control costs (organic and inorganic matter), including investment costs. The costs of emission control were calculated for three different scenarios: removal of 50 percent, 75 percent, or 100 percent, which is equivalent to the best available technology (BAT) for dealing with pollutants above the existing levels.

Data on existing control levels was taken from the 1998 national inventory on industrial pollution control, prepared by the World Bank for the no longer functioning Brazilian National Pollution Control Project, and unitary sectoral costs, based on European references. Table 1 presents the estimation of cost increases per sector as a share of each sector's value added. As can be seen, costs, in general, are not very large, and most of them would not exceed 3 percent of the sectoral value added even at the highest removal rate.

Industries indicating the highest potential control costs are nonferrous metallurgic, other metallurgic, and footwear, which have costs over 3 percent in the three scenarios.

Table 1. Industrial Water Pollution Control Costs in Brazil (% of sectoral value added)

Sectors	Organic Matter			Inorganic Matter		
	50%	75%	100%	50%	75%	100%
Mineral extraction	0.00	0.00	0.00	0.31	0.36	0.55
Oil and natural gas	0.00	0.00	0.00	0.27	0.31	0.47
Non-metallic minerals	0. 00	0.00	0.00	0.28	0.33	0.51
Iron and steel	0.00	0.00	0.00	0.52	0.61	0.92
Non-ferrous metallurgic	5.30	6.18	8.99	7.71	9.00	13.15
Other metallurgic	5.30	6.18	8.99	6.55	7.64	11.15
Machinery and equipment	0.00	0.00	0.00	1.10	1.28	1.89
Electric material	0.00	0.00	0.00	1.54	1.80	2.66
Electronic material	0.00	0.00	0.00	0.47	0.55	0.81
Motor vehicles	0.00	0.00	0.00	0.99	1.15	1.72
Vehicle parts and other vehicles	0.00	0.00	0.00	1.41	1.64	2.42
Wood and furniture	1.00	1. 06	1.37	1.56	1.70	2.34
Pulp, paper and paperboard	0.16	0.18	0.55	0.46	0.54	1.22
Rubber industry	0.00	0. 00	0.00	0.28	0.33	0.53
Chemical industry	0.39	0.57	1.19	0.62	0.84	1.63
Petroleum refineries	0.00	0.00	0.00	0.17	0.20	0.32
Other chemical products	0.39	0.57	1.19	0.72	0.98	1.91
Pharmacy and veterinary products	0.03	0.03	0.06	0.28	0.34	0.59
Plastic products	0.00	0.00	0.00	0.20	0.24	0.39
Textiles	0.48	0.53	0.74	0.92	1.03	1.48
Wearing apparel	0.48	0.53	0.74	0.98	1.09	1.64
Footwear	5.01	5.96	16.01	6.42	7.64	20.24
Coffee industry	0.13	0.14	0.29	0.28	0.33	0.63
Other vegetable products	0.13	0.14	0.29	0.35	0.40	0.71

Table 1. Industrial Water Pollution Control Costs in Brazil (% of sectoral value added) *—continued*

Sectors	Organic Matter			Inorganic Matter		
	50%	75%	100%	50%	75%	100%
Meat industry	0.13	0.14	0.29	0.31	0.36	0.68
Dairy products	0.13	0.14	0.29	0.44	0.50	0.89
Sugar factories and refineries	0.13	0.14	0.29	0.43	0.50	0.87
Vegetable oils	0.13	0.14	0.29	0.48	0.55	0.95
Other food products	0.13	0.14	0.29	0.46	0.53	0.95
Other industries	0.00	0.00	0.00	0.53	0.62	0.95
Public utilities	0.00	0.00	0.00	0.14	0.16	0.25
Civil construction	0.00	0.00	0.00	0.75	0.87	1.28
Commerce	0.00	0.00	0.00	0.07	0.09	0.15
Transportation	0.00	0.00	0.00	0.17	0.20	0.31
Communications	0.00	0.00	0.00	0.13	0.15	0.24
Financial institutions	0.00	0.00	0.00	0.03	0.03	0.06
Services to households	0.00	0.00	0.00	0.25	0.29	0.46
Business services	0.00	0.00	0.00	0.07	0.08	0.16
Renting	0.00	0.00	0.00	0.11	0.12	0.18
Public administration	0.00	0.00	0.00	0.07	0.09	0.15
Non-mercantile private sectors	0.00	0.00	0.00	0.04	0.05	0.08

Source: Mendes (1994).

Young (2002) made some estimates of the impacts on the Brazilian exports if these costs were incurred into each industrial sector.[9] That is, how much these additional control costs for each removal scenario would represent to total export value. The exercise applied input-output techniques by weighting emission control costs through the production chain, according to the relative weight of each input to the overall production costs, according to distinct export price elasticities for Brazilian exports found in the literature.

Results are also summarized in Table 2 for two demand scenarios. The optimistic estimates assume the lower elasticity estimates, and the pessimistic estimates assume the upper-bound ones.

As can be seen in Table 2, total losses, assuming the application of the best available technology, which could reach almost 100 percent removal, would not exceed an estimated 2 percent of the total value of exports. These figures are close to the ones obtained by Repetto (1995) in his analysis of U.S. industry. In sum, costs of pollution abatement may not be a barrier for competitiveness in the Brazilian case.

Table 2. 1996 Estimates of Export Value Losses with Increasing Industrial Water Pollution Control in Brazil -1996

Removal Scenario	Optimistic Estimate	Pessimistic Estimate
50% of total emissions	0.4%	1.0%
75% of total emissions	0.5%	1.2%
100% (BAT) of total emissions	0.9%	2.1%

Source: Young (2002).

4. Industrial Environmental Impacts of the FTAA in Brazil

We will not be able to measure the various dimensions of the FTAA's environmental impacts on the Brazilian economy. As mentioned earlier, we will focus on direct impacts from changes in industrial output levels.

4.1 Economic Impacts of the FTAA

Our estimates are based on the results obtained in Tourinho and Kume (2002) of a static computable general equilibrium (CGE) model that simulates the macroeconomic impacts of the FTAA on the Brazilian economy.[10] This simulation also estimates changes in sectoral output, exports, and imports. By applying pollution coefficients on these sectoral results, we are able to analyze changes on emissions derived from direct trade impacts of the FTAA in Brazil.

Tourinho and Kume (2002) employ a static CGE model to simulate the impacts of the FTAA in the Brazilian economy. This model estimates equilibrium prices and quantities assuming perfect competition, that is, all producers are price takers, and decisions on production, input uses, and trade are made in profit maximization behavior. Aggregate investments equal aggregate savings.

Labor is mobile across sectors, while capital is not and can become idle in a sector where output is reduced. Supply of both factors is given because the model is built in a static context, so increases in the external demand (exports) are only possible with reductions in the domestic market.

Inter-sectoral relationships are based on the Leontief input-output matrix for 42 sectors, represented in fixed technical coefficients and macroeconomic aggregates of the National Accounts.

Domestic demand for goods is met by domestic production or imports, following a constant elasticity of substitution (CES) function type, based on relative prices, taking into account tariffs and exchange rate and assuming that they are imperfect substitutes (Armington elasticities). Production, also following a CES type for the transformation function, allocates between domestic and export sales, according to their respective relative prices, including all taxes and subsidies.

In sum, the Tourinho and Kume (2002) model estimates sectoral responses for reductions on trade barriers due to FTAA, in terms of changes of output and export and import levels. The reference year is 1998.

Tourinho and Kume's results are contrafactual indicators of how the Brazilian economy would be in 1998 — if trade liberalization had taken place in that year with the FTAA. However, as the authors emphasize, these results are not taking into account dynamic impacts, such as technological progress and investment flows that might occur with freer trade, which are often used as arguments in favor of trade agreements, as they would amplify the resulting trade-related benefits.

The scenario with the FTAA is only related to U.S. imports that comprise almost 80 percent of the Brazilian imports from the FTAA region, excluding those from MERCOSUL.

The model simulates FTAA impacts as the following:

1. imports: reducing effective tariffs actually paid that are captured in the National Accounts figures and
2. exports: reducing nominal and *ad-valorem* tariffs over 5 percent rate plus elimination of anti-dumping and quota tariffs.

Table 3 presents the aggregate macroeconomic impacts from FTAA on the Brazilian economy.

As can be seen, the FTAA will, as simulated in this model, generate higher deficits in the Brazilian trade account (12.4 percent increase), when imports go up by 4.4 percent and exports only by 2.4 percent. Private consumption increases by 0.6 percent. The exchange rate is overvalued in 2.7 percent with a small 0.5 percent increase in general prices.

Table 3. FTAA Impacts on Macroeconomic Aggregates of the Brazilian Economy (base year values in 1998 R$ and simulated annual change rates in %)

Indicators	Base Value (in R$billions)	FTAA (%)
GDP growth	899,8	0
Investment	191,5	-2,8
Private consumption	572,4	0,6
Import tariff	6,5	-36,8
Imports	78,1	4,4
Exports	57,5	2,4
Deficit on Goods and Services Account	20,6	10
Deficit on Trade Account	10,7	12,4
Deficit on Service Account	9,9	7,3
Inflation rate	1,07	-0,5
Exchange rate for US dollars	1,16	-2,7

Source: Tourinho and Kume (2002).

As the authors conclude, trade deficits could be mitigated if capital inflows to finance export-driven investments were considered as results of the FTAA's new trade regime, although this feature is not captured in a static model like this one. Thus, these results can be seen as the most conservative ones.

In sectoral terms, there are winners and losers. Table 4 indicates sectoral results in terms of changes in output, exports, and imports.

As can be seen, production of sugar, shoes and leather goods, steel and iron, and vegetable goods (cocoa, rice, tobacco, fruits, etc.) would increase from 3.6 to 13.7 percent. Export increase variations will also be the highest ones in these sectors plus the wearing apparel sector that has a similar performance. Imports would increase in several industrial sectors, for example, vehicle assembly and wood and furniture.

Table 4. Impacts of FTAA on the Brazilian Industrial Sectors

Sectors	Output		Exports		Imports	
	Base Value (1998 10^9R$)	FTAA (%)	Base Value (1998 10^9 R$)	FTAA (%)	Base Value (1998 10^9 R$)	FTAA (%)
Mineral extraction	7,5	-0,5	3,8	-1	0,3	1,2
Oil and natural gas	5,8	0	0	0	2,8	2
Non-metallic minerals	20,5	-1,1	0,8	2,5	0,6	0,7
Iron and steel	24,5	6,5	3,4	27,4	0,9	0,8
Non-ferrous metallurgic	10,9	-2,4	1,7	-3,5	1,1	5,2
Other metallurgic	23,3	-1,3	1	-1,8	1,6	5,4
Machinery and equipment	26,2	-4	3,2	-6,3	7,9	6,7
Electric material	15,4	-0,3	1,4	-2,4	3,6	0,9
Electronic material	12,3	0,6	1,1	-1,1	8,2	2,4
Motor vehicles	20,5	-1,7	3,3	-3	4	6,5
Vehicle parts and other vehicles	19,6	-1,8	4,8	-3,3	5,4	0,6
Wood and furniture	14,1	-0,9	1,4	-3,7	0,4	7,6
Pulp, paper and paperboard	23,8	-0,2	1,8	-2,4	1,3	3,7
Rubber industry	7,1	-1,2	0,7	-3,9	0,8	5,4
Chemical industry	15,2	-1,2	0,9	-3,9	2,1	8
Petroleum refineries	55,6	-0,1	1,6	-2,9	5,4	1,1
Other chemical products	20,7	-0,2	0,8	-2,8	2,5	2,4
Pharmacy and veterinary products	15,7	0,7	0,5	-2,6	2,7	3,4
Plastic products	10,3	-0,9	0,3	-4	0,8	8,5
Textiles	17,3	1,1	1	8,9	1,7	7,7
Wearing apparel	9,5	1,2	0,1	11,5	0,3	5

Table 4. Impacts of FTAA on the Brazilian Industrial Sectors *—continued*

Sectors	Output		Exports		Imports	
	Base Value (1998 10^9R$)	FTAA (%)	Base Value (1998 10^9 R$)	FTAA (%)	Base Value (1998 10^9 R$)	FTAA (%)
Footwear	5,3	12,7	2,1	19,8	0,3	5
Coffee industry	9,9	-1	2,3	-2,1	0	0
Other vegetable products	24,2	3,6	3	11,3	1	2,8
Meat industry	21,4	0,6	1,5	-0,2	0,3	7,4
Dairy products	9,8	0,6	0	0	0,5	5,1
Sugar factories and refineries	7,3	13,7	1,9	30,5	0	0
Vegetable oils	14,7	0,2	2,6	-0,1	0,5	6,4
Other food products	31,8	0,7	1,1	-1,1	1,4	2,9
Other industries	8,2	-4	0,6	-7,1	1,9	17
TOTAL	508,4	0,27%	48,7	2,89%	60,3	4,09%

Source: Tourinho and Kume (2002). Note: 10^9R$ = billions.

4.2 Environmental Impacts of the FTAA

Following the seminal exercise on environmental direct impacts of trade liberalization from NAFTA made by Grossman and Krueger (1993),[11] our measures are given by the product of sectoral changes presented in Table 4 above and the sectoral pollution and resource use coefficients. Based on this simple procedure, we are able to identify the variations of emission levels of each sector and variations throughout the whole economy.

Estimates are carried on using two data sets of pollution coefficients, namely, São Paulo state's and the U.S. Environmental Protection Agency's (EPA) Industrial Pollution Projection System (IPPS).

Only the São Paulo State EPA, the Environmental Sanitation Technology Company (Companhia de Technologia de Saneamento Ambiental — CETESB), is able to offer a user-friendly database. However, the inventory is updated gradually through the years and, consequently, current figures actually refer to previous years. Seroa da Motta (2002) and Young (2002) were able to use this database with sectoral figures for the period 1995-1997, from which they estimated "1996" sectoral emission charges and related them to the respective sectoral production values, presented in the 1996 Instituto Brasileiro de Geografia e Estatística (IBGE) Annual Industrial Survey, to determine sectoral coefficients.[12]

The World Bank organized the Industrial Pollution Projection System, referred to as IPPS, which is based on the USEPA's inventory database. Although they are estimated from a very large sample of industries and products, and thereby are more technologically consistent, the representativeness of these coefficients is biased toward the U.S. industrial profile.[13] We carry our exercise with IPPS just for the sake of allowing future comparisons with other country studies that, lacking domestic data parameters, use the IPPS ones. In this exercise, the IPPS coefficients will be restricted only to those comparable to São Paulo State's, as presented in Table 5.[14]

We have also estimated energy use and CO_2 coefficients, using data from national statistics on energy and greenhouse gases inventory. For these coefficient sets' statistics, we are restricted to only nine sectors, as presented in these databases, and so several coefficients are repeated for more than one sector in our CGE results.

In addition, we use water use coefficients estimated in Guilhoto, Lopes, and Seroa da Motta (2002), which were determined based on water uses surveys for some states in Brazil that, consequently, carry regional biases.

For the cases of CO_2 and energy and water intensities, we do not have IPPS comparable sets because these are uses very much correlated to the supply-side characteristics of each country and not driven mainly by technological availability, as one could suppose for pollution control (see Table 5).

Table 5. Pollution and Use Coefficient Sets

São Paulo's	IPPS
Water-organic	BOD lower bound
Water-inorganic	Toxic Metal lower bound
Air-SO_2	SO_2 lower bound
Air-TSP	TSP lower bound
CO_2	no match
Water use	no match
Energy use	no match

4.2.1. Aggregate Environmental Impacts

Table 6 presents the economy-aggregate environmental results as changes in emission loads and use levels for Brazilian parameters. These changes are due to the difference between the sectoral performance in terms of output, exports, and imports of the Brazilian economy in 1998 and the same performance with FTAA direct impacts.

Because in the applied static CGE results increases in exports are only possible with reductions in domestic production, structural adjustments in sector outputs will dynamically follow, *ceteris paribus*, the export and import sectoral trends estimated in the model. That is, more specialization on leading exporting sectors and reduced comparative advantage in increasing importing sectors should occur.[15] Therefore, the trade trend is measured as the difference between exports' and imports' impacts to offer a dimension of emission patterns of this sectoral adjustment trend.

As can be seen in Table 6, aggregate air emission level changes for particulates and SO_2 are negative, respectively, -0.3 and -0.1 percent. Recalling that the static CGE results assumed no total output change, FTAA sectoral impacts may lead the Brazilian economy to an industrial structure that could be cleaner in air pollution than it is now. Also, for both air pollutants, exports' emission levels are lower than imports' levels, indicating negative trade trends of almost -1 percent for particulates and as much as -5,4 percent in SO_2. Therefore, the CGE result of 0.6 percent increase in private consumption can be achieved with less than current levels of air pollution.

Table 6. Economy-Aggregate Emission and Use Level Changes due to FTAA in the Brazilian Industry (Brazilian Parameters)

Indicators	Pollutants	Particulates (ton)	SO_2 (ton)	Organic Matter (ton)	Inorganic Matter (ton)	CO_2 (ton)	Energy Use (Gwh)	Water Use (10^3m^3)
Product Value	Base Year	36.919.373	506.618	317.578	3.044	191.848.952	443.154	8.044.087
	With FTAA	36.794.954	505.940	326.109	3.078	195.523.372	444.344	8.135.323
	Change	(124.419)	(678)	8.531	34	3.674.420	1.189	91.235
	Variation (%)	-0,3%	-0,1%	2,7%	1,1%	1,9%	0,3%	1,1%
Exports	Base Year	18.242.967	51.816	32.444	546	18.262.055	47.411	797.183
	With FTAA	18.097.459	52.075	36.938	579	20.460.769	48.991	840.674
	Change	(145.507)	259	4.494	33	2.198.714	1.580	43.491
	Variation (%)	-0,8%	0,5%	13,9%	6,0%	12,0%	3,3%	5,5%
Imports	Base Year	1.484.210	36.940	19.139	466	12.514.924	40.416	600.076
	With FTTA	1.505.052	37.996	20.093	480	12.845.360	42.188	621.270
	Change	20.842	1.056	953	14	330.436	1.772	21.194
	Variation (%)	1,4%	2,9%	5,0%	3,0%	2,6%	4,4%	3,5%
Exports less Imports	Base Year	16.758.756	14.876	13.304	80	5.747.131	6.995	197.106
	With FTTA	16.592.407	14.079	16.845	99	7.615.409	6.803	219.403
	Change	(166.349)	(797)	3.541	19	1.868.278	(192)	22.297
	Variation (%)	-1,0%	-5,4%	26,6%	23,6%	32,5%	-2,7%	11,3%

The results are the opposite for water pollution from organic and inorganic matters, where output emissions increase, respectively, as shown in Table 6, by 2.7 and 1.1

percent, indicating that Brazilian industry could produce more intense levels of water pollution with the FTAA. Trade trends (net result of exports and imports) with high positive changes of, respectively, 26.6 and 23.6 percent, are reinforcing this pattern.

Also, high intensity is expected for CO_2 emissions that show a positive output variation of 1.9 percent. In this particular case, the trade trend is extremely high when emission changes from exports are 30 percent higher than those from imports.

Nonetheless, energy use patterns are more environmentally favorable. Although output change is positive, it is very low, around 0.3 percent, and the trade trend is negative, -2.8 percent.

However, water patterns show an output change of 1 percent and a high trade trend of 11.3 percent.

In sum, the FTAA's aggregate direct environmental impacts on the Brazilian economy are expected to be, in general, very minor and in the direction of the following:

1. lower pollution intensity in air pollution of particulates and SO_2 and energy uses and
2. higher pollution intensity in water pollution and uses and CO_2 emissions.

Please note that number estimates with IPPS intensities for industrial pollution are also presented in Table 7. As can be seen, although all impact changes are positive, IPPS applied estimates indicate that output emission changes are quite low; excluding the 2.3 percent in particulates, the others do not exceed 0.5 percent. Setting apart the issue of applicability of U.S. EPA parameters for Brazil, these results confirm that FTAA environmental impacts will not necessarily lead the Brazilian economy to a "dirtier" economy.

As these results are derived from CGE modeling against changes in tariffs in the U.S. economy, it seems that most prospective environmental impacts may be borne in the United States rather than in Brazil because production would shift to the United States. Environmental impacts

Table 7. Economy-Aggregate Emission and Use Level Changes due to FTAA in the Brazilian Industry (IPPS parameters)

Pollutants Indicators		Particulates (ton)	SO_2 (ton)	Organic Matter (ton)	Inorganic Matter (ton)
Product Value	Base Year	293.032	873.060	96.629	397
	With FTTA	294.430	876.339	96.957	406
	Change	1.398	3.279	328	9
	Variation (%)	0,5%	0,4%	0,3%	2,3%
Exports	Base Year	24.454	71.334	6.635	38
	With FTTA	26.285	76.189	6.856	44
	Change	1.831	4.855	221	6
	Variation (%)	7,5%	6,8%	3,3%	16,2%
Imports	Base Year	13.600	58.044	6.961	33
	With FTTA	14.000	59.951	7.343	35
	Change	400	1.908	382	2
	Variation (%)	2,9%	3,3%	5,5%	4,9%
Exports less Imports	Base Year	10.854	13.291	(325)	5
	With FTTA	12.285	16.238	(487)	9
	Change	1.431	2.948	(162)	4
	Variation (%)	13,2%	22,2%	49,6%	94,6%

Table 8. Sectoral Indicators

Industrial Sectors*	Value/%Total	Number of Local Units	Number of Enterprises	Gross Industrial Product (10^3 US$)	Workers on 12 / 31
Iron and Steel	Value	785	466	13.259.669	96.918
	% Total	0,6	0,4	4,3	1,9
Sugar	Value	471	184	5.989.272	121.945
	% Total	0,3	0,1	1,9	2,3
Footwear	Value	3.851	3.574	4.877.998	271.195
	% Total	2,8	2,9	1,6	5,2
Leather[1]	Value	1.772	1.683	2.061.345	61.846
	% Total	1,3	1,3	0,7	1,2
Vegetable Products and Other	Value	15.813	14.565	16.694.175	385.750
Food Products[2]	% Total	11,3	11,7	5,4	7,4

Source: *Pesquisa Industrial Anual - PIA Empresa - IBGE*, 2000.
* The first three sectors follow the International Standard Industrial Classification of All Economic Activities (ISIC); for the other two, the translation of the ISIC is presented below:

1. Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness.
2. Processing and preserving of fruit and vegetables. Manufacture of grain mill products, starches and starch products, and prepared animal feeds. Manufacture of other food products.
3. The designation, 10^3 US$, indicates millions of US$.

may also follow production to the United States; however, enforcement of laws may mitigate these impacts.

If one considers the reasonable possibility that trade liberalization will dynamically allow for higher foreign investment levels and the introduction of advanced technologies, these estimated minor static trends could also be altered through time.

4.2.2. Sectoral Environmental Impacts

As analyzed earlier, Tourinho and Kume’s (2002) CGE results indicated that domestic production and exports of sugar, shoes & leather, steel & iron, and processed vegetable goods (cocoa, rice, tobacco, fruits, etc.) would increase with the FTAA.

Table 8 below offers some indicators of these sectors, showing that they together represent almost 15 percent of the Brazilian Industrial GDP. Note also that the processed vegetable goods sector comprises a great variety of products widespread in almost 16,000 production units over the country.

Together with footwear, it also employs together almost 15 percent of the industrial working force.

As each of these sectors has a different pollution and use pattern, an analysis of how they are dominating aggregate changes follows.

This analysis will be based only on Brazilian parameters and concentrated on output emission levels. All exports and imports emission and use level changes are fully reported in the Annex of this paper.

Table 9 on the next two pages presents these output changes in absolute (load values) and relative (percent of total change) indicators. Analyzing the positive variations, we are able to indicate which sectors are responsible for the major contributions for these changes in emission and use levels in the Brazilian industrial sectors.

Table 9. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sectors (Brazilian parameters)

Sectors	Particulates			SO_2			Organic Matter		
	Base Year Emission	FTAA Change		Base Year Emission	FTAA Change		Base Year Emission	FTAA Change	
	(ton)	(ton)	%	(ton)	(ton)	%	(ton)	(ton)	%
Mineral extraction	35.686.558	(178.433)	95,5%	55.186	(276)	10,3%	453	(2)	0,3%
Oil and natural gas	-	-	0,0%	-	-	0,0%	-	-	0,0%
Non-metallic minerals	371.120	(4.082)	2,2%	119.490	(1.314)	49,2%	183	(2)	0,3%
Iron and steel	8.829	574	0,9%	1.054	69	3,4%	3	0	0,0%
Non-ferrous metallurgic	24.065	(578)	0,3%	8.570	(206)	7,7%	297	(7)	1,1%
Other metallurgic	12.689	(165)	0,1%	5.693	(74)	2,8%	821	(11)	1,6%
Machinery and equipment	2.613	(105)	0,1%	306	(12)	0,5%	245	(10)	1,5%
Electric material	6.327	(19)	0,0%	2.433	(7)	0,3%	219	(1)	0,1%
Electronic material	2	0	0,0%	25	0	0,0%	536	3	0,0%
Motor vehicles	660	(11)	0,0%	1.140	(19)	0,7%	1.863	(32)	4,9%
Vehicle parts and other vehicles	2.930	(53)	0,0%	2.035	(37)	1,4%	463	(8)	1,3%
Wood and furniture	752	(7)	0,0%	3.933	(35)	1,3%	14.947	(135)	20,7%
Pulp, paper and paperboard	57.893	(116)	0,1%	19.056	(38)	1,4%	31.736	(63)	9,8%
Rubber industry	281	(3)	0,0%	3.366	(40)	1,5%	570	(7)	1,1%
Chemical industry	79.857	(958)	0,5%	3.872	(46)	1,7%	25.963	(312)	47,9%
Petroleum refineries	47.404	(47)	0,0%	115.952	(116)	4,3%	3.555	(4)	0,5%
Other chemical products	36.077	(72)	0,0%	81.097	(162)	6,1%	10.787	(22)	3,3%
Pharmacy and veterinary products	2.479	17	0,0%	1.904	13	0,7%	14.682	103	1,1%
Plastic products	56	(0)	0,0%	520	(5)	0,2%	232	(2)	0,3%
Textiles	2.506	28	0,0%	10.989	121	6,1%	16.876	186	2,0%
Wearing apparel	88	1	0,0%	1.176	14	0,7%	116	1	0,0%
Footwear	646	82	0,1%	622	79	4,0%	13.018	1.653	18,0%
Coffee industry	2.864	(29)	0,0%	1.170	(12)	0,4%	124	(1)	0,2%
Other vegetable products	21.550	776	1,2%	34.129	1.229	61,7%	17.486	630	6,9%
Meat industry	6.615	40	0,1%	6.580	39	2,0%	17.011	102	1,1%
Dairy products	1.089	7	0,0%	2.921	18	0,9%	19.302	116	1,3%
Sugar factories and refineries	442.398	60.609	97,2%	2.298	315	15,8%	42.813	5.865	63,9%
Vegetable oils	22.036	44	0,1%	958	2	0,1%	10.990	22	0,2%
Other food products	26.423	185	0,3%	13.394	94	4,7%	71.459	500	5,4%
Other industries	52.569	(2.103)	1,1%	6.748	(270)	10,1%	828	(33)	5,1%
TOTAL	36.919.373	(124.419)		506.618	(678)		317.578	8.531	
Positive Total		62.362			1.992			9.181	
Negative Total		(186.781)			(2.589)			(650)	

Table 9. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sectors *—continued*

Sectors	Inorganic Matter			CO_2		
	Base Year Emission (ton)	FTAA Change (ton)	FTAA Change %	Base Year Emission (ton)	FTAA Change (ton)	FTAA Change %
Mineral extraction	-	-	0,0%	4.388.076	(21.940)	3,7%
Oil and natural gas	-	-	0,0%	3.215.919	-	0,0%
Non-metallic minerals	3	(0)	0,1%	21.731.861	(239.050)	40,3%
Iron and steel	0	0	0,0%	50.850.532	3.305.285	77,4%
Non-ferrous metallurgic	84	(2)	5,5%	1.807.300	(43.375)	7,3%
Other metallurgic	641	(8)	22,8%	3.863.310	(50.223)	8,5%
Machinery and equipment	32	(1)	3,5%	718.078	(28.723)	4,8%
Electric material	10	(0)	0,1%	422.076	(1.266)	0,2%
Electronic material	4	0	0,0%	337.113	2.023	0,0%
Motor vehicles	44	(1)	2,0%	561.855	(9.552)	1,6%
Vehicle parts and other vehicles	957	(17)	47,1%	537.188	(9.669)	1,6%
Wood and furniture	1	(0)	0,0%	386.447	(3.478)	0,6%
Pulp, paper and paperboard	12	(0)	0,1%	7.775.599	(15.551)	2,6%
Rubber industry	4	(0)	0,1%	194.594	(2.335)	0,4%
Chemical industry	551	(7)	18,1%	5.872.167	(70.466)	11,9%
Petroleum refineries	53	(0)	0,1%	30.828.467	(30.828)	5,2%
Other chemical products	12	(0)	0,1%	7.996.965	(15.994)	2,7%
Pharmacy and veterinary products	46	0	0,5%	430.299	3.012	0,1%
Plastic products	7	(0)	0,2%	282.298	(2.541)	0,4%
Textiles	25	0	0,4%	1.808.132	19.889	0,5%
Wearing apparel	0	0	0,0%	260.372	3.124	-0,5%
Footwear	553	70	99,1%	145.260	18.448	-3,1%
Coffee industry	-	-	0,0%	3.924.282	(39.243)	6,6%
Other vegetable products	-	-	0,0%	9.592.690	345.337	8,1%
Meat industry	0	0	0,0%	8.482.792	50.897	1,2%
Dairy products	-	-	0,0%	3.884.643	23.308	0,5%
Sugar factories and refineries	-	-	0,0%	2.893.663	396.432	9,3%
Vegetable oils	-	-	0,0%	5.826.964	11.654	0,3%
Other food products	2	0	0,0%	12.605.270	88.237	2,1%
Other industries	2	(0)	0,2%	224.742	(8.990)	1,5%
TOTAL	3.044	34		191.848.952	3.674.420	
Positive Total		71			4.267.645	
Negative Total		(37)			(593.225)	

Table 9. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sectors *—continued*

Sectors	Energy Use			Water Use		
	Base Year Level (GWh)	FTAA Change GWh	FTAA Change %	Base Year Level (10^3 m^3)	FTAA Change $10^{3*}m^3$	FTAA Change %
Mineral extraction	24.133	(121)	3,6%	96.963	(485)	1,9%
Oil and natural gas	2.242	0	0,0%	74.984	-	0,0%
Non-metallic minerals	5.718	(63)	1,9%	265.031	(2.915)	11,2%
Iron and steel	44.793	2.912	64,1%	321.601	20.904	17,8%
Non-ferrous metallurgic	35.838	(860)	25,7%	143.080	(3.434)	13,2%
Other metallurgic	76.607	(996)	29,7%	305.849	(3.976)	15,3%
Machinery and equipment	8.286	(331)	9,9%	23.485	(939)	3,6%
Electric material	4.870	(15)	0,4%	258.622	(776)	3,0%
Electronic material	3.890	23	0,5%	206.562	1.239	1,1%
Motor vehicles	6.483	(110)	3,3%	45.762	(778)	3,0%
Vehicle parts and other vehicles	6.199	(112)	3,3%	43.753	(788)	3,0%
Wood and furniture	4.459	(40)	1,2%	474.285	(4.269)	16,5%
Pulp, paper and paperboard	39.533	(79)	2,4%	800.565	(1.601)	6,2%
Rubber industry	2.245	(27)	0,8%	24.525	(294)	1,1%
Chemical industry	26.973	(324)	9,7%	52.403	(629)	2,4%
Petroleum refineries	21.492	(21)	0,6%	191.684	(192)	0,7%
Other chemical products	36.733	(73)	2,2%	71.364	(143)	0,6%
Pharmacy and veterinary products	4.965	35	0,8%	54.127	379	0,3%
Plastic products	3.258	(29)	0,9%	35.510	(320)	1,2%
Textiles	20.705	228	5,0%	333.449	3.668	3,1%
Wearing apparel	3.005	36	0,8%	183.108	2.197	1,9%
Footwear	1.676	213	4,7%	102.155	12.974	11,1%
Coffee industry	4.693	(47)	1,4%	324.755	(3.248)	12,5%
Other vegetable products	11.471	413	9,1%	793.845	28.578	24,4%
Meat industry	10.144	61	1,3%	701.995	4.212	3,6%
Dairy products	4.645	28	0,6%	321.474	1.929	1,6%
Sugar factories and refineries	3.460	474	10,4%	239.466	32.807	28,0%
Vegetable oils	6.968	14	0,3%	482.211	964	0,8%
Other food products	15.074	106	2,3%	1.043.151	7.302	6,2%
Other industries	2.593	(104)	3,1%	28.325	(1.133)	4,4%
TOTAL	443.154	1.189		8.044.087	91.235	
Positive Total		4.542			117.154	
Negative Total		(3.352)			(25.918)	

Table 10. Leading Industrial Sectors with Major Contribution in Potential Changes of Environmental Impacts of FTAA in Brazil

Organic	Inorganic	SO_2	Particulates	CO_2	Energy	Water
Sugar	Shoes & leather	Processing of veg. goods	Sugar	Steel & iron	Steel & iron	Sugar
Shoes & leather		Sugar		Sugar	Sugar	Processing of veg. goods
				Processing of veg. goods	Processing of veg. goods	Steel & iron

As can be seen in Table 10, for organic matters, the sugar and shoes and leather sectors dominate with, respectively, 64 and 18 percent of total emission changes, whereas the latter is almost the only sector with increasing inorganic emissions. In SO_2 the leading emitting sector is the processing of vegetable goods, with 62 percent followed by the sugar sector with 16 percent of total change. Full dominance is observed for the sugar sector in particulates.

Emission of CO_2 is led by the iron and steel sector, share of 77 percent; followed by sugar, at 9 percent; and processing of vegetable goods, at 9 percent.

The share of the iron and steel sector in energy use level change is about 64 percent, followed by the sugar sector, at 10 percent; and processing of vegetable goods (9 percent).

Sugar and processing of vegetable goods sectors each has a quarter of water use in output changes followed by the steel and iron sector with 18 percent.

Table 10 sums up these leading sectors by pollutants and uses. As can be seen, sugar, steel and iron, shoes and leather, and processing of vegetable goods dominate the potential increases in emission and use levels resulting from the direct trade liberalization impacts of the FTAA.

As can be seen from their nominal and relative export values in Table 4, these sectors are already export-oriented sectors. According to our analysis in Section 4, exporting sectors have, in general, a high environmental performance.

As will be discussed next, export-oriented sectors are, in fact, already employing solid environmental management policies with several advanced initiatives. Therefore, the enhancement of the already existing environmental control practices in these sectors may further reduce the environmental impacts of FTAA in the Brazilian economy.

4.2.3 Sectoral Environmental Performance

It is very difficult to measure the current environmental performance of each sector for the whole country. However, we have been able to determine pollution abatement efforts (organic, inorganic, particulate, and sulfur dioxide) in each sector, using São Paulo's sectoral database, applied for the estimation of pollution coefficients. This effort indicator is the ratio of the difference between potential and residual emission levels and potential emission level as indicated in the database. That is, it indicates how much pollution was abated in relation to the potential level of the installed capacity.

Results of this indicator, as presented in Table 11, show that the abatement level is already high in most sectors. For the particular cases of our leading sectors, as indicated in Table 14, organic matter control in the sugar and footwear sectors is, respectively, at the impressive levels of 99 and 97 percent. Further reductions in this pollutant intensity will be more difficult to achieve, so technological research is crucial in this case. Inorganic matter control in the footwear sector is already

Table 11. Average Abatement Rates of Industrial Processing in São Paulo – 1996

Sectors	(Pot-Rem) / Pot (%)			
	Organic Matter	Inorganic Matter	Particulates	SO_2
Mineral extraction	90	-	36	16
Oil and natural gas	-	-	-	-
Non-metallic minerals	83	92	86	37
Iron and steel	58	76	61	**65**
Non-ferrous metallurgic	51	88	93	77
Other metallurgic	80	85	70	42
Machinery and equipment	86	82	63	47
Electric material	61	94	43	28
Electronic material	28	96	95	74
Motor vehicles	66	86	46	75
Vehicle parts and other vehicles	67	73	80	49
Wood and furniture	53	90	26	34
Pulp, paper and paperboard	83	74	75	68
Rubber industry	97	82	77	66
Chemical industry	97	1	52	76
Petroleum refineries	89	23	80	19
Other chemical products	90	98	83	48
Pharmacy and veterinary products	58	52	42	81
Plastic products	60	63	13	81
Textiles	66	77	72	74
Wearing apparel	81	94	1	3
Footwear	**97**	**69**	18	34
Coffee industry	98	-	56	48
Other vegetable products	87	-	69	**8**
Meat industry	89	0	17	54
Dairy products	81	-	12	55
Sugar factories and refineries	**99**	-	**27**	59
Vegetable oils	75	-	47	95
Other food products	84	0	23	62
Other industries	44	97	58	6

Source: Based on the CETESB Sectoral Emission Inventory.

about 70 percent, but it can be increased when compared to other sectors. Recall that in Section 1, we showed (see Table 1) that the footwear sector is the one facing the highest pollution cost level in terms of value added share, so renewal of capital stock will be crucial to incorporate embodied clean processes, and the FTAA may offer this opportunity.

Although we have shown that the estimated direct environmental impact of the FTAA is negative in particulate and SO_2, control levels in the steel and iron and sugar sectors are also high but with possibilities of greater improvements. However, control of SO_2 is quite low for processing of vegetable goods and, perhaps, the introduction of advanced abatement devices may greatly enhance this performance. The same can be said for particulate control in the sugar sector.

In fact, these sectors have taken specific care to make sure that their environmental and technological policies will make feasible, continuing improvements in environmental performance.

The sugar and footwear sectors have their own Technological Centers. In the sugar sector, COPERSUCAR, a major producers' cooperative located in São Paulo state, where 70 percent of sugar production takes place, houses the world renowned Copersucar Technology Center (CTC) that has been responsible for technological advancements that have placed Brazil's sugar production at the most efficient level in the world (see Carvalho and Szwarc 2001).

The footwear sector sponsors the Technological Center of Leather, Footwear, and Allied Industries (Centro Technologío Couro, Calçados e Afins — CTCCA), in the south of Brazil, where most of the country's footwear production is located. This Center has an aggressive environmental research program and, in addition to that, they offer extensive technical assistance on practices related to pollution control and avoidance for leather producers, who usually run medium-sized firms.[16]

In the steel sector, we have been able to access specific data on its environmental performance.[17] After privatization of the steel industry, environmental investments during the period 1994-2001 reached R$1.12 billion (about US$400 million). Recycling of scrap steel and iron has already reached the rate of 26 percent, and other residuals of steel production (mud and other aggregates) are processed and sold for several purposes (for example, road paving and concrete structures). The steel industry's water re-circulation rate is at about 80 percent. All steel companies have implemented environmental management systems, and 70 percent areare ISO 14001 certified. (The International Organization for Standardization's (ISO) designation "ISO 14001" is granted by the ISO to companies having in place a basic environmental management system, including commitments to training, reporting, and maintaining required licensure.)

Because the processing of vegetable products is diversified in output and location, there is no common effort in this sector on research and development or on indicators of environmental policies.

5. Determinants of Industrial Environmental Performance in Brazil

It must also be taken into account that firms themselves may find other reasons, rather than regulators' sanctions, to comply with high environmental standards. Literature in the field also analyses how firms comply when they face public scrutiny. Wheeler and Afsah's (1996) study explains how a 1995 program on information release about firms' environmental performances has largely contributed to high compliance rates in Indonesia, where there is a weak formal enforcement regime.

However, Konar and Cohen (1997), applying an econometric model, undertake a similar analysis for the Toxic Release Inventory (TRI), started in 1988 in the United States, in which they found that negative media attention to firms' emission levels, after controlling for firms' characteristics, particularly size, has not affected firms' decisions on environmental compliance. That is, ability to comply dominates market incentives. Hamilton (1995), instead, found correlation between intense media exposure of high emitters and declining stock prices, analyzing the same program although controlling for exposure intensity.

Quantitative studies in developing countries have mostly addressed the effects of informal regulation or how communities and NGOs may affect environmental performance of firms. The first approach was to regard informal procedures as a complement of weak formal enforcement. Local community members can act negatively against bad compliers in different forms, from political sanctions to boycotts. Pargal and Wheeler (1996) test this hypothesis for Indonesia, using data on industrial wastewater. Apart from the importance of firms' characteristics, they found that there is high elasticity between emission and community income and education levels. Hettige, Huq, Pargal, and Wheeler (1996) reviewed studies on determinants of pollution abatement in South and Southeast Asia and found some similarities with the results in Indonesia regarding informal regulation. Panayotou, Schatzki and Limvorapitak (1997) analyzed environmental investments in Thailand and found that formal and informal pressures were influential on firm's decisions, and Blackman and Bannister (1998) did the same for propane substitution in Mexico.

Recently, Dasgupta, Hettige, and Wheeler (2000), based on a detailed field survey, analyzed how abatement control was determined in the Mexican industrial sector. They used indicators of self-evaluated performance, with endogeneity for several environmental management variables, and again found evidence on firms' characteristics but little on market incentives and none on informal regulation measured from responses of the survey.

Thus, it appears that firms' environmental performance can be affected by their own characteristics (ability aspects) to cope with regulatory procedures (formal sanctions and/or community pressure). Market-related constraints have been captured as a major determinant only where stock markets are dynamic, as in the United States. If so, multinational firms located in developing economies may be affected in exactly the same ways by the host country's regulations as local firms are. In addition to the performance of local stock markets, there are production and demand-driven determinants affecting firms' environmental performances in developing countries.

As conventional wisdom states that enforcement of environmental management is positively highly correlated with the degree of economic development, imports from high-income economies may impose demand-driven restrictions on exports from firms in developing countries, based on their environmental performance.

If that international competitiveness cost exists, one also has to account for costs related to foregone income due to lax domestic environmental controls.

It is also possible that production-side factors play important roles. Access to governmentally subsidized credit, conditioned by an environmental compliance status, may induce firms to improve their performances as well as take advantage of cost savings granted by pollution control practices.

As mentioned earlier in this paper, a polluting firm will minimize production costs by equalizing compliance to noncompliance costs. Compliance costs can be measured by the efforts of the firm to comply with mandatory regulation and avoid sanctions but also to take advantage of market premiums associated with high environmental performance. Noncompliance faces costs due to penalties applied by regulators, payments resulting from judicial litigation from accidents and damages to third parties, compensations to community members, and foregone market premiums. So in a simplified form, determinants of environmental performance can be related to the following factors:

1. Firm's marginal pollution control cost that reflects its ability to comply in terms of firm's characteristics (size, sector, origin of capital, etc.) given by a vector **X**.

2. And firm's noncompliance marginal costs related to sanctions applied by regulators, whether resulting from regulator's inspection or pressure from community members and NGOs, given by vector **E**.

3. The market incentives to increase environmental performance due to their effects on competitiveness (on sales or costs), given by a vector **M**.

If so, environmental performance indicators (EPI) can be presented in a reduced form expressed as this equation:

$$\mathbf{EPI} = f\,(\mathbf{X}, \mathbf{E}, \mathbf{M}) \qquad \mathbf{(1)}$$

(Note: f stands for function.)

To analyze how the interaction of these variables does affect environmental performance and how the effect of each one is conditional to the existence of the others, we can apply econometric techniques that will be discussed next.

Two recent studies, Seroa da Motta (2001) and Ferraz and Seroa da Motta (2002), test this model related to data for the Brazilian case, as will be shown in the next section.

5.1 Determinants of the Adoption of Industrial Pollution Control Practices in Brazil

In 1998, the Brazilian National Confederation of Industries undertook the "Survey on Environmental Management in Brazil" (CNI, 1998). This inquiry was carried out in the period August-September 1998 to determine respondent firms' characteristics and motivations in year 1997 and some financial variables for year 1996. Its main aim was to generate insights that would allow governmental and development agencies as well as the industries themselves and their institutions to evaluate strategies, policies, and instruments to enhance environmental management.

Apart from information on firms' characteristics (such as, size, revenue, origin of their capital, etc.), the survey inquired about the motivations of firms for adopting environmental control practices that were already in place and properly functioning. Results are described in Table 12.

Table 12. Frequency of Adopted Environmental Control Practices

Environmental Control Practices	Percentage
Reduction in the use of raw material	33
Reduction in the use of energy	35
Reduction in the use of water	36
Change in packing	13
Liquid effluent control	50
Air emission control	27
Noise and vibration control	43
Disposition of solid waste	51
Recycling of solid waste	61
Substitution of raw material	21
Training of employees	31
Requirements of suppliers	20
Others	4
No adoption of environmental management practices	4

Firms were also asked to indicate their most important motivations, up to three, that led them to the adoption of the environmental control practices already in place. Table 13 presents frequencies for these motivations. As can be seen, categories of formal regulation and market orientation show much higher frequencies than community-related aspects. The dominance of meeting the firm's own social policy, with a 20 percent rate, is understood as one choice that overlaps with the others.

Table 13. Motivations to Adopt Environmental Control Practices

Motivations to Adopt Environmental Control Practices	Percentage
To comply with licensing	18
To comply with norms and standards under inspection	18
To reduce production costs	13
To improve quality of the produced goods	6
To increase competitiveness of exports	2
To meet customers' demands	5
To meet financial institutions' demands	1
To meet community pressure	6
To meet NGOs' pressures	1
To meet firm's social policy	20
Image	7
Other	2
No adoption	2

Seroa da Motta (2001) has analyzed the environmental performance of the Brazilian industrial sector, using this database related to 325 medium and large firms covering all regions and several industrial sectors.

To carry this on, Seroa da Motta (2001) adopted the level of environmental control practices that firms have in place in the year 1997. This is a constructed index vector that gives log values of a continuous variable that reflects a number of practices adopted by each firm summed up by the respective value of $(1-p_i)$, where p is the sample average frequency of practice i; that is: $\ln \sum (1-p_i)$. This variable then reflects the level of environmental management practices (EMP) of the firm that assigns high values for practices that are less frequent and thereby differentiates firms by the adoption of less standard practices, which may reflect a higher environmental performance.

As can be seen, the continuous variable on the environmental practice index represents the current level of environmental management procedures built up over the years and reflects the total current effort of the firm on environmental management. It has the feature of a stock, although measured in no monetary dimension, and we cannot assume a possible relation between the variable levels and the costs of implementation of such practices.

It is then assumed that the 1997 level of adoption of EMP is correlated to a firm's characteristics, such as size given by number of employees;[18] origin of capital if it is international (CAPI); and sectors (classified according to their pollution intensity level in green, brown, and red).

Due to restrictions in degree of freedom in regressions,[19] only five categories of dummy variables, based on possible motivations, were used, aggregating motivations related to compliance with those associated with licensing and norms and standards, and for community-driven aspects, the ones related to community and NGOs pressure. The dummy variables were the following:

MotEPA — to collaborate with regulators

MotCOST — to reduce production costs

MotEXP — to increase competitiveness of exports

MotDEM — to improve quality of the produced goods

MotFIN — to meet environmental requirements from governmental financing agencies

MotCOM — to meet demands from community and NGOs

The equation model was then given by:

EMPm = f ([SIZE, CAPI, GREEN, BROWN] (X), [motEPA, motCOM] (E), [motFIN, motCOST, motEXP, motDEM] (M),)

The motivation to meet a firm's social policy was not considered in the above variables because it overlaps with the other choices that are also items of a firm's policy.

The OLS model provides a higher robust fitting to the data with adjusted $R^2 = 0.25$ in the final form. The discrete variables show shifts in the function of the relationship between EMP and the continuous variables (only size in this case) over the medium values, that is, how EMP would change if the dummies took the value of 1. Note that the dummy variables in the regression are the ones in which coefficients are related to the absent one.

Results of Seroa da Motta (2001) are presented in Table 14. As can be seen, size and origin of capital (CAPI) are significant and show the expected sign, confirming that larger firms with foreign capital tend to adopt a greater number of environmental control procedures. Sector's characteristics are also relevant, as the coefficients of green and brown sectors are # in negative to the absent red sector. That is, as expected, less pollution-intense sectors require a lesser number of control practices than more pollution-intense ones. On the other hand, perhaps due to sector misclassification (#), green sectors' coefficients are, in both models, slightly higher than the brown ones.

Table 14. Determinants of the Adoption of Industrial Pollution Control Practices in Brazil

Independent Variable	Coefficient	(Statistic t)
SIZE	0.17	(4.33)*
CAPI	0.21	(1.91)***
GREEN	-0,24	(-1.89)***
BROWN	-0,29	(-3.16)*
motFIN	0.33	(1.92)***
motCOST	0.44	(5.40)*
motEPA	0.20	(1.86)***
motCOM	0.27	(2.71)*
motEXP	0.25	(1.83)***
motDEM	-0,01	(-0.13)
Constant	4.03	(14.82)*
R^2	0.25	

Source: Seroa da Motta (2001).
Note: OLS Model, White standard error with significance at *1%, ** 5%, and *** .10%.

Also as expected, motivations to avoid EPA sanctions (motEPA) and to attend to demands from the community (motCOM) are also positive and significant. Coefficients of motivations to save production costs (motCOST) and to access subsidized credit (motFIN) are also positive and significant. And finally, motivation to increase export competitiveness, a typical demand-driven determinant, is equally positive and significant.

Although the variable related to quality of produced goods (motDEM) is not significant, the other motivation results are closer to what one could expect on market influences on environmental performance.[20]

5.2 Determinants of Environmental Industrial Investments in São Paulo State

In the state of São Paulo, more than 60 percent of Brazil's total industrial output is concentrated. It also has the most effective EPA (CETESB) in the country. In 1998, São Paulo state's Statistical Office (Sistema Estadual de Análise de Dados — SEADE) undertook a comprehensive survey on the economic activities in the state to analyze its investment decisions. Ferraz e Seroa da Motta (2002) used part of this data set to analyze the determinants of industrial performance in São Paulo's industrial sector. Although the environment-related questions of this survey were limited, regression counted almost 11,000 observations.

The indicator of environmental performance was given by firms' responses to their actual adoption of any investment related to environmental practices (input substitution, waste management, and clean processes) in the year 1996 (INV96). If a firm's response was "yes," then the indicator was given value 1; otherwise, it was 0.

Firms' characteristics were again related to size, given by number of employees (size); origin of capital, saying whether it was international or mixed with domestic capital (CAPI and CAPM); and sector (classified according to their pollution intensity levels in green, brown, and red). It was also possible to include two other characteristics: 1) age of the plant, which should indicate a positive correlation as old firms need more updating of technologies and 2) the level of formal education required for recruitment that would be expected to be positively correlated to a firm's performance, because high technological investments are associated with a staff's expertise.

EPA pressure (sanction) was not measured in this survey, so authors used a probability sanction indicator, measured by the ratio of municipal number of non-compliance warnings issued by the state EPA and municipal number of industrial plants.

Market incentives were measured by the proportion of export sales to total sales (exports). As the dependent variable is a flow variable associated only with the year 1996, two variable controls (PREVINV1 and PREINV2) were introduced from firms' responses indicating whether they had adopted technological innovation and process improvement led by environmental concerns prior to 1996.

The model applied by Ferraz and Seroa da Motta (2002) was identified as follows:

INV96 = f ([SIZE, CAPI, CAPM, AGE, GREEN, BROWN] (X), [SANCTION] (E), [EXPORTS] (M), [PREINV1, PREINV2) (C))

Because the dependent investment variable was a dummy (0 or 1), a Probit model was applied, in which each determinant affected the probability of the firm adopting environment-related investments. As illustrated in Table 15, showing results for São Paulo State, Ferraz and Seroa da Motta (2002) confirm the ones already presented for the whole country in Seroa da Motta (2001).

As can be seen, larger and international or mixed firms tend to have more environment-related investments. The same applies to older firms with high educational requirements for training. Sanctions again are a major determinant as well as export sales share.

Table 15. Determinants of the Industrial Environmental Investment in São Paulo State

Independent Variables	Coefficient	Standard Error
SANCTION	1,8974	0,3637**
SIZE	0,0005	0,0001**
CAP1	0,3503	0,0830**
CAPM	0,3241	0,1130**
AGE	0,0070	0,0011**
EDREC	0,0685	0,0317*
GREEN	-0,1721	0,0404**
BROWN	-0,2114	0,0369**
PREINV1	0,1748	0,0090**
PREINV2	0,6337	0,0325**
EXPORTS	0,0063	0,0017**
CONSTANT	-1,3546	0,0466**

Source: Ferraz e Seroa da Motta (2002).
Note: Probit Model, White standard error with significance at *1% and **5%.

An instrumental variable for sanction, that is, given by the ratio of municipal number of non-compliance warnings and municipal number of industrial plants, was estimated in relation to several municipal variables, such as industrial GDP share, urban rate, urban educational level, votes for green candidates, and number of NGOs to capture the impact of public pressure on EPA enforcement level. The results, not shown here, indicated that community pressure is determinant in EPA enforcement level and location. This indirect result was expected, because in the state the EPA has a great deal of influence on and contact with the general public, including a free hotline for people's complaints.[21]

In sum, recent studies on determinants of industrial environmental performance in Brazil are unambiguously suggesting that enforcement of environmental legislation through sanctions and pressure from the community are very highly influential in determining firms' compliance. They also show that cost saving opportunities derived from pollution control provide one of the main motivations to increase the adoption of control practices. The role of the access to subsidized credit was also pointed out as important for financing investments in these practices.

Moreover, the study emphasizes, as we had hoped it would, that large firms and international firms competing in the international markets are the ones most capable and motivated to enhance their environmental performance.

6. Conclusions

Our study started by showing indicators (Mendes 1994; and Young 2002) that industrial abatement control costs in Brazil are not high enough to be seen as barriers to competitiveness, nor are they low enough to become incentives for Brazil to be seen as a pollution haven.

We also described environmental legislation and enforcement in Brazil, showing that while monitoring is still weak in some states, licensing and public prosecutors' judicial actions are effective tools of enforcement.

Looking specifically at the FTAA's probable impacts on the Brazilian economy, we presented the results of a recent CGE study (Tourinho and Kume, 2002) that estimated the direct impacts of trade liberalization. Results indicate that production of sugar, shoes and leather goods, steel and iron, and vegetable goods would increase from 3.6 to 13.7 percent. Export increase variation will also be the highest in these sectors plus in the wearing apparel sector, which shows a similar performance. Imports would increase in several industrial sectors, for example, in vehicle assembly and wood and furniture.

Based on these CGE results, following the seminal exercise on the direct environmental impacts of trade liberalization from NAFTA, made by Grossman and Krueger (1993), we estimated environmental impacts of the FTAA on the Brazilian economy by relating these sectoral CGE results on output, exports, and imports to the sectoral pollution and resource use coefficients. Based on this simple procedure, we were able to identify the variations of emission levels for each sector and the whole economy for four pollutants (organic and inorganic matters, particulates, and sulfur dioxide), using two data sets of pollution coefficients, namely, São Paulo state's and the U.S. EPA's Industrial Pollution Projection System, IPPS. Our results are very interesting because economy-aggregate direct environmental impacts of the FTAA on the Brazilian economy are expected to be, in general, very minor and in the direction of

- lower pollution intensity in air pollution of particulates and SO_2 and energy uses and
- higher pollution intensity in water pollution and uses and CO_2 emissions.

In the CGE modeling exercise, production of sugar, steel and iron, shoes and leather, and processing of vegetable goods (cocoa, rice, tobacco, fruits, etc.) dominate the potential increases in emission and use levels resulting from the direct trade liberalization impacts of the FTAA. Because they are export-oriented sectors, as our analysis of environmental performance suggested, they would tend to adopt improved systems of environmental control. In fact, we briefly indicate that these sectors are already sponsoring technological research centers and employing solid environmental management policies with several advanced initiatives. Therefore, the enhancement of the existing environmental control practices in these sectors may further reduce the environmental impacts of the FTAA in the Brazilian economy.

Next, we presented econometric results of recent studies (Seroa da Motta 2002; and Ferraz and Seroa da Motta 2002), analyzing determinants of environmental investments.

Results of these studies indicated that industrial environmental management in Brazil is highly affected by the level of sanctions and that firms have a clear motivation to avoid sanctions. They also showed that cost saving opportunities derived from pollution control provide one of the main motivations for increasing the adoption of control practices. The role of access to subsidized credit was also pointed out as important for financing investments in these practices. Also, large and international firms competing in the international markets are the ones most capable and motivated to enhance their environmental performances. Based on all of this evidence, regulators may follow strategies that would further enhance firms' current performances together with improved economic efficiency and increased competitiveness. To carry out these goals, we recommend the following:

1. Stimulate the cooperation and integration of environmental and trade policies at ministerial levels.
2. As water pollution and water use seem to form the main potential environmental impact of the FTAA, current initiatives for the application of water charges (which are part of the new water legislation in Brazil) should be promoted. With this instrument, total industrial abatement could be attained at higher levels with lower total social costs and, therefore, at higher economic efficiency, apart from generating some level of revenue to be channeled either to reduce other tax payments (as the one on labor, for example) or even increasing budgets for environmental monitoring and enforcement.[22]
3. Options for subsidized credits should be made available in ways that link access to this credit to a company's compliance status. It must be noted that subsidies divert resources from other governmental policies and that compliance may be achieved with instruments that are neutral in fiscal terms.
4. Technological research for the processing of vegetable goods sector should be promoted. Due to its diversification of output and location, this sector has been unable to coordinate joint efforts on R&D and indicators of environmental policies across its several actors.
5. Interchanges between existing private research centers of the leading industrial sectors should be promoted with international public research centers to increase access to information on cost savings and to reduce transaction costs of implementing procedures aimed at these targets.
6. Mechanisms that facilitate local communities' access to information about firms' environmental performances, which add complementary efforts on enforcement, should be created. This can be done with low-cost initiatives, such as inventories of pollution releases and lists of best or worse firms according to specific parameters on compliance status.

NOTES

1. See Seroa da Motta, Huber, and Ruitenbeek (1999) for a detailed analysis of these market-based instruments in environmental management in Latin America and the Caribbean.

2. See, for example, Copeland and Taylor (1994).

3. Weak evidence is also found in firms shifting production across states in the same country. See, for example, Gray and Deily (1996) and Gray and Shadbegian (2002) for the U.S. case.

4. A new environmental criminal law has recently been approved with very stiff sanctions, including imprisonment.

5. Problems with transboundary pollution and rivers and ecosystems crossing more than one state are dealt with by the engaged states and led by the federal EPA.

6. Of course, political pressure, particularly on the state governor, can force a high degree of discretion in some cases. This is, however, more common for infrastructure projects with diffuse sources of degradation than for specific industrial plants with an easily spotted source of emission.

7. Licensing is granted preliminarily during a plant's project design phase and later for operation, which is, in fact, the ultimate licensing status.

8. The high expectation for environmental performance indicators, EPI, in place in the European Community since 2000 will offer useful insights.

9. Young (2002) also analyzes pollution intensity of final demand components using an input-output matrix.

10. They also make estimations for possible trade agreement with the EC.

11. A similar study was later carried out by Reinert and Roland-Holst (2000).

12. No firm data is available, only aggregation by sectors, so a certain level of aggregation of products is inevitable.

13. A simple exercise calculating total Brazilian pollution by multiplying residual CETESB and IPPS coefficients by total production in Brazil, show that CETESB total pollution is lower in organic and higher in particulate and SO2, and almost the same in inorganic. Such a result is expected because, as pointed out by Seroa da Motta (1994) water pollution control in Brazil dominates public concerns over air pollution. Water pollution is based mostly on organic matter, which is easier to spot and monitor than inorganic matter. Whatever the explanation, the application of U.S. coefficients should not be recommended for Brazil.

14. These coefficients were arranged according to the classification of the Brazilian input-output matrix by Young (2002).

15. This dynamic is not necessarily true if technological changes occur, so it is really a *ceteris paribus* assumption.

16. Information obtained directly from the CTCCA.

17. Information obtained directly from the Brazilian Institute of Siderurgy (IBS), which is the national association of steel and iron producers.

18. Revenue figures were of doubtful quality.

19. That is, lack of number of observations to deal with a larger number of variables.

20. See Seroa da Motta (2001) for other econometric exercises with investments and control costs also confirming these results.

21. See Ferraz and Seroa da Motta (2002) for details on the econometric exercise and its tests confirming these results, including one for selection biases.

22. See Seroa da Motta, Huber, and Ruitenbeek (1999) for a detailed analysis of these market-based instruments in environmental management in Latin America and the Caribbean.

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Annex

A.1. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sector - Import Changes

Sectors	Particulates			SO_2			Organic Matter		
	Base Year Emission	FTAA Change		Base Year Emission	FTAA Change		Base Year Emission	FTAA Change	
	(ton)	(ton)	%	(ton)	(ton)	%	(ton)	(ton)	%
Mineral extraction	1.427.462	17.130	82,2%	2.207	260	14,7%	18	0	0,0%
Oil and natural gas	-	-	0,0%	-	-	0,0%	-	-	0,0%
Non-metallic minerals	10.862	76	0,4%	3.497	70	3,9%	5	0	0,0%
Iron and steel	324	3	0,0%	39	0	0,0%	0	0	0,0%
Non-ferrous metallurgic	2.429	126	0,6%	865	7	0,4%	30	2	0,2%
Other metallurgic	871	47	0,2%	391	20	1,1%	56	3	0,3%
Machinery and equipment	788	53	0,3%	92	5	0,3%	74	5	0,5%
Electric material	1.479	13	0,1%	569	38	2,1%	51	0	0,0%
Electronic material	2	0	0,0%	17	0	0,0%	357	9	0,9%
Motor vehicles	129	8	0,0%	222	5	0,3%	363	24	2,5%
Vehicle parts and other vehicles	807	5	0,0%	561	36	2,1%	128	1	0,1%
Wood and furniture	21	2	0,0%	112	1	0,0%	424	32	3,4%
Pulp, paper and paperboard	3.162	117	0,6%	1.041	79	4,5%	1.733	64	6,7%
Rubber industry	32	2	0,0%	379	14	0,8%	64	3	0,4%
Chemical industry	11.033	883	4,2%	535	29	1,6%	3.587	287	30,1%
Petroleum refineries	4.604	51	0,2%	11.262	901	50,7%	345	4	0,4%
Other chemical products	4.357	105	0,5%	9.794	108	6,1%	1.303	31	3,3%
Pharmacy and veterinary products	426	14	0,1%	327	8	0,4%	2.525	86	9,0%
Plastic products	4	0	0,0%	40	1	0,1%	18	2	0,2%
Textiles	246	19	0,1%	1.080	92	5,2%	1.658	128	13,4%
Wearing apparel	3	0	0,0%	37	3	0,2%	4	0	0,0%
Footwear	37	2	0,0%	35	2	0,1%	737	37	3,9%
Coffee industry	-	-	0,0%	-	-	0,0%	-	-	0,0%
Other vegetable products	890	25	0,1%	1.410	-	0,0%	723	20	2,1%
Meat industry	93	7	0,0%	92	3	0,1%	238	18	1,9%
Dairy products	56	3	0,0%	149	11	0,6%	985	50	5,3%
Sugar factories and refineries	-	-	0,0%	-	-	0,0%	-	-	0,0%
Vegetable oils	750	48	0,2%	33	-	0,0%	374	24	2,5%
Other food products	1.163	34	0,2%	590	38	2,1%	3.146	91	9,6%
Other industries	12.181	2.071	9,9%	1.563	45	2,6%	192	33	3,4%
TOTAL	1.484.210	20.842	100%	36.940	1.777	100%	19.139	953	100%

A.1. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sector - Import Changes
—continued

Sectors	Inorganic Matter			CO_2		
	Base Year Emission	FTAA Change		Base Year Emission	FTAA Change	
	(ton)	(ton)	%	(ton)	(ton)	%
Mineral extraction	-	-	0,0%	175.523	2.106	0,6%
Oil and natural gas	-	-	0,0%	1.552.513	31.050	9,4%
Non-metallic minerals	0	0	0,0%	636.054	4.452	1,3%
Iron and steel	0	0	0,0%	1.867.979	14.944	4,5%
Non-ferrous metallurgic	8	0	3,1%	182.388	9.484	2,9%
Other metallurgic	44	2	16,9%	265.292	14.326	4,3%
Machinery and equipment	10	1	4,6%	216.520	14.507	4,4%
Electric material	2	0	0,1%	98.667	888	0,3%
Electronic material	3	0	0,4%	224.742	5.394	1,6%
Motor vehicles	9	1	4,0 %	109.630	7.126	2,2 %
Vehicle parts and other vehicles	264	2	11,2 %	148.001	888	0,3 %
Wood and furniture	0	0	0,0%	10.963	833	0,3%
Pulp, paper and paperboard	1	0	0,2%	424.718	15.715	4,8%
Rubber industry	0	0	0,2%	21.926	1.184	0,4%
Chemical industry	76	6	43,3%	811.286	64.903	19,6%
Petroleum refineries	5	0	0,4%	2.994.132	32.935	10,0%
Other chemical products	1	0	0,2%	965.817	23.180	7,0%
Pharmacy and veterinary products	8	0	1,9%	74.000	2.516	0,8%
Plastic products	1	0	0,3%	21.926	1.864	0,6%
Textiles	2	0	1,4%	177.678	13.681	4,1%
Wearing apparel	0	0	0,0%	8.222	411	0,1%
Footwear	31	2	11,1%	8.222	411	0,1%
Coffee industry	-	-	0,0%	-	-	0,0%
Other vegetable products	-	-	0,0%	396.392	11.099	3,4%
Meat industry	0	0	0,0%	118.918	8.800	2,7%
Dairy products	-	-	0,0%	198.196	10.108	3,1%
Sugar factories and refineries	-	-	0,0%	-	-	0,0%
Vegetable oils	-	-	0,0%	198.196	12.685	3,8%
Other food products	0	0	0,0%	554.949	16.094	4,9%
Other industries	0	0	0,6%	52.074	8.853	2,7%
TOTAL	466	14	100%	12.514.924	330.436	100%

A.1. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sector - Import Changes
—continued

Sectors	Energy Use			Water Use		
	Base Year	FTAA Change		Base Year	FTAA Change	
	Level (GWh)	GWh	%	Level ($10^3 m^3$)	($10^3 m^3$)	%
Mineral extraction	965	12	0,7%	3.879	47	0,2%
Oil and natural gas	1.082	22	1,2%	36.199	724	3,4%
Non-metallic minerals	167	1	0,1%	7.757	54	0,3%
Iron and steel	1.645	13	0,7%	11.814	95	0,4%
Non-ferrous metallurgic	3.617	188	10,6%	14.439	751	3,5%
Other metallurgic	5.261	284	16,0%	21.003	1.134	5,4%
Machinery and equipment	2.498	167	9,4%	7.081	474	2,2%
Electric material	1.139	10	0,6%	60.457	544	2,6%
Electronic material	2.593	62	3,5%	137.708	3.305	15,6%
Motor vehicles	1.265	82	4,6%	8.929	580	2,7%
Vehicle parts and other vehicles	1.708	10	0,6%	12.054	72	0,3%
Wood and furniture	127	10	0,5%	13.455	1.023	4,8%
Pulp, paper and paperboard	2.159	80	4,5%	43.728	1.618	7,6%
Rubber industry	253	14	0,8%	2.763	149	0,7%
Chemical industry	3.727	298	16,8%	7.240	579	2,7%
Petroleum refineries	2.087	23	1,3%	18.617	205	1,0%
Other chemical products	4.436	106	6,0%	8.619	207	1,0%
Pharmacy and veterinary products	854	29	1,6%	9.308	316	1,5%
Plastic products	253	22	1,2%	2.758	234	1,1%
Textiles	2.035	157	8,8%	32.767	2.523	11,9%
Wearing apparel	95	5	0,3%	5.782	289	1,4%
Footwear	95	5	0,3%	5.782	289	1,4%
Coffee industry	0	0	0,0%	-	-	0,0%
Other vegetable products	474	13	0,7%	32.803	918	4,3%
Meat industry	142	11	0,6%	9.841	728	3,4%
Dairy products	237	12	0,7%	16.402	836	3,9%
Sugar factories and refineries	0	0	0,0%	-	-	0,0%
Vegetable oils	237	15	0,9%	16.402	1.050	5,0%
Other food products	664	19	1,1%	45.925	1.332	6,3%
Other industries	601	102	5,8%	6.563	1.116	5,3%
TOTAL	40.416	1.772	100%	600.076	21.194	100%

A.2. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sector - Export Changes

Sectors	Particulates			SO_2			Organic Matter		
	Base Year Emission	FTAA Change		Base Year Emission	FTAA Change		Base Year Emission	FTAA Change	
	(ton)	(ton)	%	(ton)	(ton)	%	(ton)	(ton)	%
Mineral extraction	18.081.190	(180.812)	99,5%	27.961	(280)	42,0%	229	(2)	0,9%
Oil and natural gas	-	-	0,0%	-	-	0,0%	-	-	0,0%
Non-metallic minerals	14.483	362	1,0%	4.663	117	12,6%	7	0	0,0%
Iron and steel	1.225	336	0,9%	146	40	4,3%	0	0	0,0%
Non-ferrous metallurgic	3.753	(131)	0,1%	1.337	(47)	7,0%	46	(2)	0,6%
Other metallurgic	545	(10)	0,0%	244	(4)	0,7%	35	(1)	0,2%
Machinery and equipment	319	(20)	0,0%	37	(2)	0,4%	30	(2)	0,7%
Electric material	575	(14)	0,0%	221	(5)	0,8%	20	(0)	0,2%
Electronic material	0	(0)	0,0%	2	(0)	0,0%	48	(1)	0,2%
Motor vehicles	106	(3)	0,0%	183	(6)	0,8%	300	(9)	3,5%
Vehicle parts and other vehicles	717	(24)	0,0%	498	(16)	2,5%	113	(4)	1,4%
Wood and furniture	75	(3)	0,0%	391	(14)	2,2%	1.484	(55)	21,3%
Pulp, paper and paperboard	4.378	(105)	0,1%	1.441	(35)	5,2%	2.400	(58)	22,3%
Rubber industry	28	(1)	0,0%	332	(13)	1,9%	56	(2)	0,8%
Chemical industry	4.728	(184)	0,1%	229	(9)	1,3%	1.537	(60)	23,2%
Petroleum refineries	1.364	(40)	0,0%	3.337	(97)	14,6%	102	(3)	1,1%
Other chemical products	1.394	(39)	0,0%	3.134	(88)	13,2%	417	(12)	4,5%
Pharmacy and veterinary products	79	(2)	0,0%	61	(2)	0,2%	468	(12)	4,7%
Plastic products	2	(0)	0,0%	15	(1)	0,1%	7	(0)	0,1%
Textiles	145	13	0,0%	635	57	6,1%	976	87	1,8%
Wearing apparel	1	0	0,0%	12	1	0,2%	1	0	0,0%
Footwear	256	51	0,1%	247	49	5,3%	5.158	1.021	21,5%
Coffee industry	665	(14)	0,0%	272	(6)	0,9%	29	(1)	0,2%
Other vegetable products	2.671	302	0,8%	4.231	478	51,7%	2.168	245	5,2%
Meat industry	464	(1)	0,0%	461	(1)	0,1%	1.192	(2)	0,9%
Dairy products	-	-	0,0%	-	-	0,0%	-	-	0,0%
Sugar factories and refineries	115.145	35.119	97,1%	598	182	19,7%	11.143	3.399	71,5%
Vegetable oils	3.897	(4)	0,0%	169	(0)	0,0%	1.944	(2)	0,8%
Other food products	914	(10)	0,0%	463	(5)	0,8%	2.472	(27)	10,5%
Other industries	3.847	(273)	0,2%	494	(35)	5,3%	61	(4)	1,7%
TOTAL	18.242.967	(145.507)		51.816	259		32.444	4.494	
Positive Total		36.182			924			4.752	
Negative Total		(181.690)			(665)			(258)	

A.2. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sector - Export Changes

—continued

Sectors	Inorganic Matter			CO_2		
	Base Year Emission	FTAA Change		Base Year Emission	FTAA Change	
	(ton)	(ton)	%	(ton)	(ton)	%
Mineral extraction	-	-	0,0%	2.223.292	(22.233)	15,8%
Oil and natural gas	-	-	0,0%	-	-	0,0%
Non-metallic minerals	0	0	0,0%	848.073	21.202	0,9%
Iron and steel	0	0	0,0%	7.056.809	1.933.566	82,6%
Non-ferrous metallurgic	13	(0)	4,3%	281.872	(9.866)	7,0%
Other metallurgic	28	(0)	4,7%	165.807	(2.985)	2,1%
Machinery and equipment	4	(0)	2,3%	87.704	(5.525)	3,9%
Electric material	1	(0)	0,2%	38.371	(921)	0,7%
Electronic material	0	(0)	0,0%	30.148	(332)	0,2%
Motor vehicles	7	(0)	2,0%	90.445	(2.713)	1,9%
Vehicle parts and other vehicles	234	(8)	73,0%	131.556	(4.341)	3,1%
Wood and furniture	0	(0)	0,0%	38.371	(1.420)	1,0%
Pulp, paper and paperboard	1	(0)	0,2%	588.071	(14.114)	10,0%
Rubber industry	0	(0)	0,2%	19.185	(748)	0,5%
Chemical industry	33	(1)	12,0%	347.694	(13.560)	9,6%
Petroleum refineries	2	(0)	0,4%	887.150	(25.727)	18,2%
Other chemical products	0	(0)	0,1%	309.061	(8.654)	6,1%
Pharmacy and veterinary products	1	(0)	0,4%	13.704	(356)	0,3%
Plastic products	0	(0)	0,1%	8.222	(329)	0,2%
Textiles	1	0	0,3%	104.516	9.302	0,4%
Wearing apparel	0	0	0,0%	2.741	315	0,0%
Footwear	219	43	99,7%	57.556	11.396	0,5%
Coffee industry	-	-	0,0%	911.702	(19.146)	13,6%
Other vegetable products	-	-	0,0%	1.189.176	134.377	5,7%
Meat industry	0	(0)	0,0%	594.588	(1.189)	0,8%
Dairy products	-	-	0,0%	-	-	0,0%
Sugar factories and refineries	-	-	0,0%	753.145	229.709	9,8%
Vegetable oils	-	-	0,0%	1.030.620	(1.031)	0,7%
Other food products	0	(0)	0,0%	436.031	(4.796)	3,4%
Other industries	0	(0)	0,1%	16.445	(1.168)	0,8%
TOTAL	546	33		18.262.055	2.198.714	
Positive Total		44			2.339.867	
Negative Total		(11)			(141.153)	

A.2. Environmental Sectoral Impacts of FTAA on the Brazilian Industrial Sector - Export Changes *—continued*

Sectors	Energy Use			Water Use		
	Base Year	FTAA Change		Base Year	FTAA Change	
	Level (GWh)	(GWh)	%	Level (10^3 m^3)	(10^3 m^3)	%
Mineral extraction	12.228	(122)	15,2%	49.128	(491)	5,4%
Oil and natural gas	0	0	0,0%	-	-	0,0%
Non-metallic minerals	223	6	0,2%	10.343	259	0,5%
Iron and steel	6.216	1.703	71,4%	44.630	12.229	23,3%
Non-ferrous metallurgic	5.589	(196)	24,3%	22.315	(781)	8,6%
Other metallurgic	3.288	(59)	7,3%	13.127	(236)	2,6%
Machinery and equipment	1.012	(64)	7,9%	2.868	(181)	2,0%
Electric material	443	(11)	1,3%	23.511	(564)	6,2%
Electronic material	348	(4)	0,5%	18.473	(203)	2,2%
Motor vehicles	1.044	(31)	3,9%	7.367	(221)	2,4%
Vehicle parts and other vehicles	1.518	(50)	6,2%	10.715	(354)	3,9%
Wood and furniture	443	(16)	2,0%	47.092	(1.742)	19,2%
Pulp, paper and paperboard	2.990	(72)	8,9%	60.547	(1.453)	16,0%
Rubber industry	221	(9)	1,1%	2.418	(94)	1,0%
Chemical industry	1.597	(62)	7,7%	3.103	(121)	1,3%
Petroleum refineries	618	(18)	2,2%	5.516	(160)	1,8%
Other chemical products	1.420	(40)	4,9%	2.758	(77)	0,9%
Pharmacy and veterinary products	158	(4)	0,5%	1.724	(45)	0,5%
Plastic products	95	(4)	0,5%	1.034	(41)	0,5%
Textiles	1.197	107	4,5%	19.275	1.715	3,3%
Wearing apparel	32	4	0,2%	1.927	222	0,4%
Footwear	664	132	5,5%	40.476	8.014	15,2%
Coffee industry	1.090	(23)	2,8%	75.448	(1.584)	17,5%
Other vegetable products	1.422	161	6,7%	98.410	11.120	21,2%
Meat industry	711	(1)	0,2%	49.205	(98)	1,1%
Dairy products	0	0	0,0%	-	-	0,0%
Sugar factories and refineries	901	275	11,5%	62.327	19.010	36,2%
Vegetable oils	1.232	(1)	0,2%	85.289	(85)	0,9%
Other food products	521	(6)	0,7%	36.084	(397)	4,4%
Other industries	190	(13)	1,7%	2.073	(147)	1,6%
TOTAL	47.411	1.580		797.183	43.491	
Positive Total		2.386			52.569	
Negative Total		(806)			(9.078)	