Trade Policy and Industrial Pollution in Latin America: Where Are the Pollution Havens?

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It is commonly assumed by economists and environmentalists alike that greater economic "openness" will lead to increased industrial pollution in developing countries. This paper challenges the "pollution haven" hypothesis, arguing that liberalization of trade regimes and increased foreign investment in Latin America have not been associated with pollution-intensive industrial development. From case studies and econometric evidence, we conclude that protected economies are more likely to favor pollution intensive industries, while openness actually encourages cleaner industry through the importation of developed-country pollution standards.

Introduction

The prevailing assumption is that free trade will increase environmental degradation in developing countries. Among environmentalists, one common concern is that liberalized trade regimes and market-driven exchange rates, by increasing the incentive for export, will lead to greater exploitation of natural resources such as native forests. A second concern, and the one we explore in this paper, is that free trade will increase industrial pollution in developing countries, through displacement of dirty industries from developed countries with stricter environmental regulation, and through competitive pressure on developing countries to reduce further their environmental standards.

The question we address is simple: among countries of Latin America, has greater "openness," defined in terms of trade regimes and foreign investment, in fact been associated with pollution-intensive industrial development? More generally, are open economies more likely to be so-called pollution havens?

There are at least three reasons to expect higher pollution intensity (i.e., more pollution per unit of output) in developing countries. First, environmental amenities are normal goods; higher income in the developed countries produces greater demand for clean air and water. Similarly, at lower levels of income and higher discount rates, income gains and jobs may be more valued relative to health and other costs of

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pollution. Second, the relative costs of monitoring and enforcing pollution standards are higher in developing countries, given scarcity of trained personnel, difficulty of acquiring sophisticated equipment, and the high marginal costs of undertaking any new governmental activity when the policy focus is on reducing fiscal burdens. Third, growth in developing countries is associated with a shift out of agriculture into industry with rapid urban growth and heavy investment in urban infrastructure; this is more likely to imply increasing levels of pollution for each unit of output. In developed countries, by contrast, growth is associated with a shift out of industry into services, and thus with decreasing levels of pollution for each unit of output. These structural differences are consistent with differences in comparative advantage and would be reinforced by free trade.

For these reasons, rising pollution intensity in developing countries could simply reflect differences across countries in the social cost comparative advantage of different mixes of polluting activities.[1] Many economists subscribe to this view, arguing that free trade and increased openness should not be resisted even if they increase environmental problems in developing countries.

There are two problems with this common wisdom, however (if not with the general conclusion about support for openness). First, if the social costs of pollution are not appropriately reflected in current environmental standards in developing countries, then freer trade could increase those social costs, possibly even eclipsing the conventional economic gains of openness. Though secondary instruments to address the pollution problem could be designed (rather than using trade policy, which would increase economy-wide distortions), the failure to use such secondary instruments in the first place implies they are not easy to design or implement. Furthermore, if free trade increases pollution in developing countries, total world pollution may rise. This could impose additional costs on developed countries if some polluting activities have negative transnational externalities.

Second, the premise—that freer trade and more open economies will lead to more environmental degradation—may be wrong in itself. From a policy point of view, this would mean that an important argument in favor of more openness is being overlooked, and that the potential for a happy marriage of economists and environmentalists is being lost.[2]

The question of what effect openness has on the extent of industrial pollution in developing countries is, of course, an empirical one. In the rest of this paper, we suggest why the effect may be negative (i.e., benign) rather than positive; and present some qualitative evidence for one country (Chile) that tends to support the likelihood of a negative

relationship. We then use new estimates of pollution intensity for Latin American industry during the period 1960-1988 to show that (1) the pollution intensity of industry grew more slowly in higher-income countries, and has generally grown more slowly where income growth was more rapid; (2) the slower growth of pollution intensity in relation to income growth was attenuated in the 1970s and 1980s compared to the 1960s—consistent with the possibility that dirty industries grew slightly more in Latin America than they would have once Organization for Economic Cooperation and Development (OECD) environmental standards began tightening in the early 1970s; and (3) most importantly, the more open the economy the less pollution-intensive its pattern of industrial development—so that any "displacement" of dirty industries from OECD to Latin America is associated with protectionist and not open economies.

How Free Trade Could Reduce Industrial Pollution

Industrial pollution at the country level can be decomposed as follows:

Industrial Pollution/GDP = [Output (Q) of industry/GDP] ×
[Q (dirty industries) / Q (all industries)] ×
[Pollution from dirty industries / Q (dirty industries)].

The first term (or "development effect") measures the tendency for the industrial and urban share to be increasing in the product of developing countries. The second term (or "composition effect") measures the effect of distribution among industries whose pollution intensity differs greatly (e.g., petrochemicals and cement vs. beer). The third term (or "process effect") measures the extent to which polluting industries reduce or fail to reduce emissions. The degree of openness could affect the size of any of these terms. We concentrate on possible pollution reduction from composition and process effects.

First, labor is relatively more plentiful in developing countries; there is also evidence that more capital-intensive sectors are more pollution-intensive. As Kosmo[3] demonstrates for Turkey, protection therefore tends to bias industrial composition toward pollution intensity.[4]

Second, exports must often meet product standards higher than those of the producing country. To the extent that clean products require clean processes, an export-oriented economy will have cleaner processes for some industries. In Chile, the need to maintain access to industrial countries' markets for fruit and vegetable exports was a consideration in the country's decision to invest in a new sewage collection system. To ensure the sanitary quality of these food exports,

it was essential to stop using raw wastewater in their production.[5] Katz[6] refers to two other examples for Chile: the fishmeal industry is treating its effluents to eliminate bacterial contamination of its product; and the pulp and paper industry has had to treat its effluents and change some of its processes to eliminate trace amounts of dioxin.

Third, foreign investors may simply impose a common international emission standard wherever they invest. Multinational corporations may face high costs in implementing different business practices (different pollution standards) in different settings. High costs could come in the form of stockholder pressure not to "exploit" populations of poor countries by using dirty processes; in the form of stockholder pressure to avoid liability for damages;[7] or in the form of costs associated with retraining managers and changing familiar production processes. Low[8] suggests that the costs to industrial firms of clean technology and processes are now small in the U.S. (less than 1 percent of total costs); for new investments by firms that maintain some production in several countries, the business and information costs of differentiating in different settings could easily exceed any direct cost advantage of dirtier production.[9]

Fourth, openness and resulting competitive pressure will increase investment in the latest technology, all other factors remaining the same. To the extent that the newest and most efficient technology embodies cleaner processes, this will reduce overall emissions.[10]

Fifth, if the costs of being clean are low for new investment but high for retrofitting, then a higher overall growth rate is likely to induce cleaner processes. This is independent of but complementary to the possibility that the more efficient technology embodies cleaner processes.

The first point above suggests a benign compositional impact for openness: the comparative advantage of developing countries is actually with labor-intensive industries that are intrinsically less polluting. The second and third points rely on a process effect, i.e., the possibility that irrespective of local demand for pollution control and short-run local comparative advantage, openness would induce industries in developing countries to adopt cleaner processes. The fourth and fifth points also rely on process effects, though in both cases those effects are fully consistent with long-run comparative advantage. Openness, by increasing competitive pressures, would accelerate investment in new technologies, which tend to be cleaner because they are imported from countries with higher pollution standards. Such new technologies are also generally more efficient in terms of overall factor productivity, even if not perfectly suited to the factor proportions of a particular developing country. In addition, openness, through its effect on

growth, would increase the rate of retirement of older, dirtier equipment and processes.

Note that of the five potentially beneficial effects of openness (beneficial in the simple sense of reducing pollution intensity), only one works through a shift in the composition of industry (the composition effect); the others affect the cleanliness of the process in given industries (the process effect). This distinction is important for assessing the relevance of the empirical work reported in the section on cross-country evidence.

The Chile Case[11]

Chile provides a useful example of a country with limited or no controls on industrial emissions, and openness to trade and foreign investment. Is Chile a "pollution haven"?

The former military government that assumed power in 1973 established an economic system based on limited intervention by government in markets and on export-led growth under a liberalized trade regime. Barriers to foreign investment were eliminated; import restrictions were eliminated and tariffs reduced to their current low of about 15 percent. Restrictions on industry for environmental reasons were presumably not considered; they would have been seen as discouraging growth and as an example of a potentially welfare-reducing intervention by government in the affairs of the market.

The democratic government that assumed power in 1990 has announced its intention to address the country's environmental problems, and is exploring alternative instruments for control of industrial air and water pollution. However, current responsibilities are widely diffused among various agencies, and the legislative and regulatory arrangements and capacity for enforcement of any policies or programs that might be desirable will take time to be put in place.

The most visible immediate environmental problem is air pollution in Santiago; after Mexico City, Santiago has the most polluted air in the world, due in part to a recurring thermal inversion layer that traps pollutants. This problem has demanded the attention of the new government, which has so far responded with short-term emergency measures, including restrictions on vehicle use during periods of high pollution. The visibility of the air pollution problem and the need for recurrent imposition of emergency measures have put environmental problems, especially air and water pollution, high on the public agenda. For this reason if for no other, industry executives anticipate that the government will eventually impose emissions and ambient standards;

their chief concern is not whether such standards will be imposed, but how and at what level.

Thus Chile represents a case study of an open economy with virtually nonexistent pollution standards, in which, however, there is a credible threat of future imposition of standards.

We have only anecdotal evidence on the behavior of industrial firms in Chile with respect to pollution. That evidence suggests, however, that the situation is not consistent with the notion that Chile has become a pollution haven—either by attracting multinational companies seeking a cost advantage because standards are low, or by leading to even weaker government enforcement of any existing standards in order to attract more foreign investment through regulatory competition.

For example, several representatives of the largest and apparently most profitable pulp and paper and petrochemical firms report they do not know the extra costs they incur in the form of "cleaner" equipment; they invest in modern, efficient, clean equipment—as a package. In some cases they accept higher costs to reduce emissions and ensure that the exported product meets foreign standards; for example, paper produced with chlorine will have traces of dioxin and cannot be exported to Germany. But even where product standards can be met with dirty processes, the fact that the newest technology is clean dominates any search for lower costs. Representatives of large multinational firms with operations in Chile report that, in any event, they face pressure from shareholders in Europe to avoid polluting the environment in developing countries.[12] In contrast, state-owned enterprises that enjoy relative monopoly positions within Chile and have access to government subsidies to shield them from international competition are the dirtiest polluters; the state-owned copper company is an example.

Government and industry representatives report that industry itself is prodding the government to establish pollution standards, and that through the industry association, firms are sponsoring development of self-regulating standards. Scarsborough[13] points out that, in the face of the threat of future regulation, the least-cost way for the industrial sector to respond is to urge the government to adopt a mutually negotiated set of standards; this is particularly attractive to the larger cleaner firms, as it would permit them to eliminate local cost competition from dirtier firms.[14] For multinational firms the least-cost way to meet the threat is to adopt the standards prevailing in their home countries.

A stylized summary of the effect of openness on the intensity of industrial pollution in Chile, abstracting from the effects of economic

growth per se on pollution, would thus be as follows. Openness to foreign investment and the absence of barriers to technology imports encourage multinational companies to invest in Chile, and ensure that domestic producers will have to compete with them. Industry is, in effect, pushed toward exceeding local standards because cleanliness is embodied in newer equipment, processes, and/or the shareholder effect. The larger, often multinational, firms then attempt to reduce local competition by encouraging the government to introduce or raise standards. The threat of future regulation may reinforce the process, but may not actually be necessary to it.

The overall effect is that openness in Chile is associated with, if not contributing to, the opposite of a pollution haven effect—perhaps even implying higher standards than are actually efficient given social preferences in Chile.[15]

Cross-Country Evidence

The Chile evidence refers entirely to the "process" effect in the three-part decomposition set out above. We now turn to evidence regarding the "composition effect" in Latin America, i.e., the trend in the mix of "dirty" vs. "clean" industries. Our database is a pooled cross section of time series for 25 Latin American countries during the period 1960-1988. We estimate an equation that describes the relationship between changes in pollution intensity and three variables: per capita income, growth of per capita income, and the degree of openness. We use the results to test three hypothesized effects: The positive income elasticity of environmental protection, which should reduce pollution intensity at higher incomes (ceteris paribus); the displacement effect of stricter OECD regulation, which should raise pollution intensity for Latin America after the early 1970s; and the compositional impact of openness, which should affect the pollution intensity of more open economies (ceteris paribus).

Wheeler and colleagues in the World Bank have constructed indices of the toxic intensity of industries per dollar of output in the U.S. for all four-digit industries on the International Standard Industrial Classification.[16] Their estimates are based on a sample of 15,000 industrial plants in 1987, formed by merging output data from the U.S. Census of Manufactures with pollution data from the Toxic Release Inventory (TRI) of the U.S. Environmental Protection Agency. TRI reports releases of 320 toxic substances into the air, water, and as underground and solid waste. Three indices are constructed, which incorporate different assumptions about the health and other risks of various toxic

Table 1

DETERMINANTS OF POLLUTION INTENSITY GROWTH, 1960s THROUGH 1980s, 25 COUNTRIES OF LATIN AMERICA

Variable	Parameter Estimate	t-statistic
INTERCEP	0.437405	3.105
NAS	0.043748	2.588
PCGR	3.331180	2.989
LINC	-0.081427	-3.382
PCGRD70	-4.454373	-3.276
PCGRD80	-6.009647	-2.519
LINCD70	0.023213	3.780
LINCD80	0.025131	4.411
PGRD70	0.144721	0.440
PGRD80	1.268344	1.868
R-square 0.6055		
Adj R-sq 0.4575		

NOTES: Dependent Variable: Toxic intensity growth rate, from log regression. Independent Variables: **NAS** = Dummy variable for non-Andean South American countries. **LINC** = Log of per capita income in the decade's initial year (thus represents 1960s in the results). **PCGR** = Per capita income growth rate for the decade (from log regression) (thus represents 1960s in the results). **PCGRD70** = PCGR × Dummy variable for the 1970s. **PCGRD80** = PCGR × Dummy variable for the 1980s. **LINCD70** = LINC × Dummy variable for the 1970s. **LINCD80** = LINC × Dummy variable for the 1980s. **PGRD80** = PCGR × Dummy variable for the 1980s × Dollar openness index. **PGRD70** = PCGR × Dummy variable for the 1970s × Dollar openness index.

emissions; the results reported below use one index but are not sensitive to the index used.[17]

The measures of toxic intensity are applied to the mix of industrial outputs for the 25 Latin American countries, using data reported in the United Nations *Industrial Statistics Yearbooks*. This yields an annual index of pollution intensity for each country. The index is of course related solely to the mix of industries, and not to unobserved and unmeasured differences in technologies and enforcement standards.[18]

Table 1 reports the results from a pooled regression of pollution intensity change over three decades—the 1960s, 1970s and 1980s—on three sets of variables: the log of per capita income at the beginning of each decade, representing the initial level of per capita income; the growth of per capita income in each decade; and, for each decade, the interaction of per capita income growth with an openness

index developed by David Dollar[19] for the World Bank's 1991 *World Development Report*.[20]

The results for initial per capita income are consistent with a positive income elasticity of environmental protection. The negative and statistically significant coefficient on LINC indicates that pollution intensity growth is lower (although still positive) at higher levels of per capita income in all three decades. The significant, positive dummy variable interactions for the 1970s and 1980s (LINCD70 and LINCD80) show that the positive income elasticity of environmental protection was somewhat attenuated in the 1970s and 1980s, compared to the 1960s. One interpretation for the attenuation of the benign income effect in the later decades is a displacement of dirtier industry to Latin America after OECD environmental regulation (which began to take hold in the early 1970s) became stricter. Any such displacement effect, however (i.e., higher growth or more entry of polluting industries in Latin America than there might otherwise have been) was not itself associated with the degree of openness to trade of the different economies—as will be seen below.

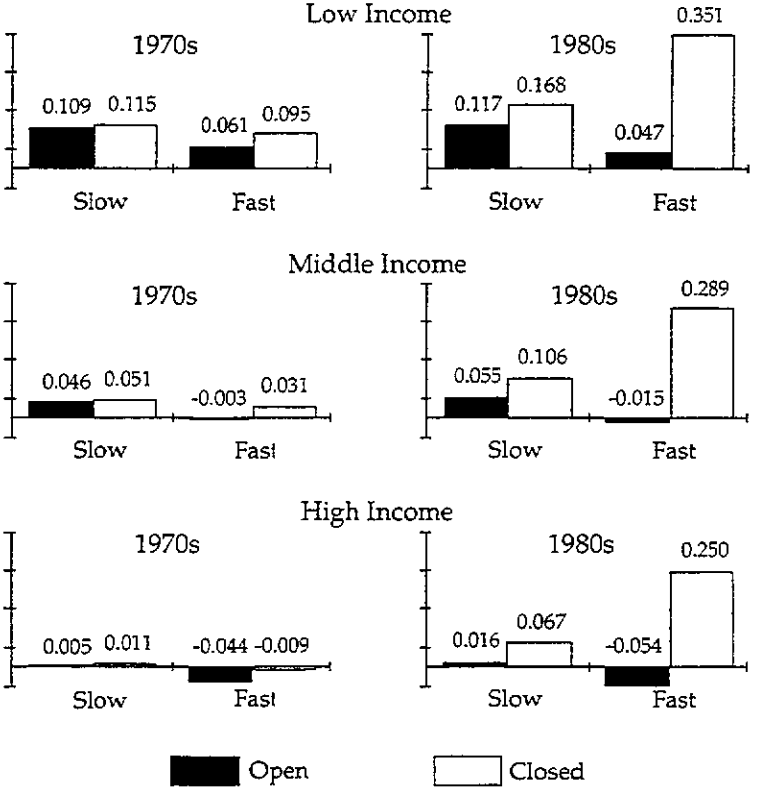
The effects of per capita income growth (as opposed to initial income level) are also fundamentally benign. A positive effect of income growth on pollution intensity in the 1960s (PCGR) appears to have been more than offset in the 1970s and 1980s (PCGRD70, PCGRD80). In fact, as shown below in Figure 1, the overall effect of income growth was negative on growth of pollution intensity in the open economies.

This effect of openness is the critical result. The positive interaction of Dollar's index with income growth for the 1980s (PGRD80) indicates that openness to trade is systematically associated with less pollution intensity growth (the more positive the index, the more closed the economy). The implied intensity elasticity of income growth was much higher in relatively closed economies (i.e., those with high numerical rankings on the index). The coefficient for the interaction of the openness index with income growth for the 1970s (PGRD70) shows a similarly positive effect of openness, though it is not statistically significant.

Figure 1 is designed to illustrate the regression results. It shows how predicted pollution intensity changes as income, growth, and the Dollar index vary independently across their full range of values in the data set.[21] The effect of initial income level on pollution intensity can be seen in Figure 1 by comparing the bars in the low-, middle-, and high-income panels. Pollution intensity growth was the fastest for those countries that were initially the poorest. For example, the predicted pollution intensity growth for slow-growing closed economies in the 1970s is 11.5 percent (low); 5.1 percent (middle); 1.1 percent (high). In

Figure 1

RATES OF ANNUAL GROWTH IN POLLUTION INTENSITY:
25 COUNTRIES OF LATIN AMERICA



the 1980s, it is 16.8 percent (low); 10.6 percent (middle); 6.7 percent (high). In every case, the predicted transition is toward lower intensity growth rates at higher incomes. Indeed, the prediction for fast-growing open economies is negative intensity growth rates at high incomes.

Similarly, faster growth is associated with less pollution intensity growth—as can be seen by comparing the slow vs. fast groups in each panel. The exception is closed economies in the 1980s, where pollution intensity growth was the greatest.

By looking at equivalent cells for the 1970s and 1980s, we can gauge the apparent size of a possible displacement effect. Most paired cells suggest the possibility of progressive displacement from OECD environmental regulation—typical Latin American pollution intensity

growth was higher in the 1980s. Again the exception is made by the fast-growing open economies. At low, middle, and high incomes, they show lower rates of pollution intensity growth in the 1980s compared to the 1970s.

More generally, the effect of openness is clearly a major reduction in the growth of pollution intensity during the 1980s, particularly for fast-growing economies where sectoral shares in total output can change rapidly. For low-income, fast-growing economies, switching from closed to open status is predicted to decelerate pollution intensity growth from 35.1 percent annually to 4.7 percent. In middle-income, fast-growing economies, the predicted change is from 28.9 percent to negative 1.5 percent.

Conclusions

This paper began by asking: among countries of Latin America, has greater "openness," defined in terms of trade regimes and foreign investment, been associated with pollution-intensive industrial development? *Our evidence suggests the opposite conclusion—openness encourages cleaner industry.* Anecdotal evidence from Chile suggests several reasons why the elimination of barriers to importation of new technology and to foreign capital may lead to importation of industrialized country pollution standards. Once these higher standards are introduced (and despite the fact that they may be too high from the point of view of local demand for environmental quality), the larger multinational firms are likely to push for enforcement so as to reduce the cost advantage of smaller local firms. The econometric evidence, though at best exploratory, suggests that over the last two decades, the more open economies have ended up with a cleaner set of industries. This is consistent with a growing literature suggesting that it is capital- and materials-intensive industries that have both enjoyed protection and have been heavy polluters.

Our evidence is also consistent with the possibility of displacement: pollution intensity grew more rapidly in Latin America as a whole after rather than before 1970—as OECD environmental regulation became stricter. This effect is not, however, associated with more trade openness. Instead, it is possible that as OECD countries shifted out of dirtier industries, the protectionist countries of Latin America shifted in. We conclude, in short, that "pollution havens" can be found, but not where they have generally been sought. They are in protectionist economies.

Endnotes

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1. Judith Dean, "Trade and the Environment: a Survey of the Literature," paper prepared for the *World Development Report 1992*, mimeo, April, 1991.

2. This is more than a philosophical issue. Some groups of environmentalists may continue to resist through political channels a free trade agreement between the United States and Mexico, for fear of the environmental effects. Similarly, the agreement is resisted by groups that fear a loss of jobs in the U.S. if firms move south to avoid environmental standards in the U.S. Some of the resistance to this and future free trade agreements could arise because of incorrect predictions about the actual links between free trade and environmental standards.

3. M. Kosmo, "Economic Incentives and Industrial Pollution in Developing Countries," Environment Department Division Working Paper No. 1989-2, World Bank, 1989.

4. For evidence that import substitution policies in Turkey led to inefficient and material and energy-intensive activities, see Anne Krueger and Baron Tuncer, "Empirical Test of the Infant Industry Argument," World Bank, 1982.

5. World Bank, *World Development Report: Environment and Development* (New York: Oxford Union Press, 1992): 100.

6. Ricardo Katz, "Urban Air Pollution and Standards. The Case of Mexico City and Santiago," paper prepared for the World Bank, May-June 1991.

7. Changes in the chemical industry following the Bhopal incident provide evidence of this phenomenon. See Cornelius C. Smith, "Bhopal Aftermath: Union Carbide Rethinks Safety," *Business and Society Review*, 75 (Fall 1990).

8. Patrick Low, "Trade Measures and Environmental Quality: The Implications for Mexico's Exports," mimeo, June 1991.

9. For further discussion that there was no evidence of environmentally induced industrial relocation or foreign investment patterns — apparently due to such countervailing factors as poor labor quality, high transport costs and political risks in settings with laxer standards, see Ingo Walter, "Environmentally Induced Industrial Relocation to Developing Countries," in Seymour J. Rubin and Thomas R. Graham, eds., *Environment and Trade: The Relation of International Trade and Environmental Policy* (Totowa, NJ: Allanheld, Osumun, 1982): 67-101. See also World Resources Institute, "Improving Environmental Co-operation: The Roles of Multinational Corporations and Developing Countries," World Resources Institute, 1984

10. If the new technology has higher operating costs, its effectiveness may still depend on regulatory pressure or penalties.

11. This section relies heavily on Erik Scarsborough, "The Environmental Effects of Macroeconomic and Sectoral Policy in Chile and Peru," World Bank, draft, October 1991; and on discussions between one of the authors and Scarsborough while working jointly on a study of the effects of macroeconomic and sectoral policies on environmental problems in Chile.

12. The manager of a large pulp and paper plant in Chile was quoted recently in the *New York Times* (November 10, 1991, p. E6) as conceding that the investment in pollution control by his company was not to abide by Chilean law, but rather to be able to sell his pulp in Europe, where Green movements have persuaded many governments to impose high import tariffs on pulp made with a process that creates chlorine gas as a byproduct.

13. Scarsborough, "Environmental Effects."

14. A similar pattern occurred in the baby food industry in at least one developing country. The Swiss multinational Nestle, once it began adhering to WHO marketing guidelines for infant formula and was losing market share in Indonesia, put heavy pressure on the Indonesian government to force all baby food manufacturers, domestic and foreign, to follow WHO guidelines. We are grateful to John Briscoe for pointing out this good analogy.

15. There may still, of course, be a problem of small U.S. firms that go just south of the border to avoid U.S. environmental or occupational health and safety standards. The evidence in the third section suggests that even given this phenomenon, more open economies have cleaner industries.

16. See Paul Martin, David Wheeler, Mala Hettige, et al., "The Industrial Pollution Projection System: Concept, Initial Development, and Critical Assessment," World Bank, 1991.

17. For evidence that all simple correlations between indices are above .94, see Robert Lucas, David Wheeler, and Mala Hettige, "Economic Development, Environmental Regulation, and the International Migration of Toxic Industrial Pollution: 1960-1988," World Bank, 1991.

18. In addition, as Lucas et. al. (1991) note, to apply the U.S. intensities to other countries requires the assumption that the pollution intensity of different products within an industry group is similar or that the mix of products within each industry group is similar across countries; and the assumption that emissions are related to output, not to value added, as in fact seems reasonable.

19. David Dollar, "Outward Orientation and Growth: An Empirical Study Using a Price-Based Measure of Openness," World Bank, 1990.

20. The openness index ranks countries from one to seven with respect to openness. Economies with rank one are the most open.

21. The ranges are as follows:
Income: High ($3000 (US 1987), Middle ($1500), Low ($500);
Income growth: Fast (6%), Slow (1%);
Dollar index value: Open (1), Closed (5).

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