**Measuring Environmental Compliance Costs and Economic Consequences:
A Perspective from the U.S.**

Prepared for the World Bank Conference: Quantifying the Trade Effect of Standards and
Regulatory Barriers: Is It Possible?

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Abstract

This paper discusses the possibility of measuring international differences in environmental
compliance costs, for the purpose of assessing their effect on international trade and investment,
using lessons learned from comparing compliance costs in U.S. states.   Two major lessons stand
out.   The first is the critical importance of measuring standard stringency in more than one year, in
order to study the effect of changes in standard stringency on changes in international trade.
Cross-section analyses, done at one point in time, are doomed by omitted variable bias and the
endogeneity of the standards.   Intertemporal comparisons could be generated by planning to
conduct surveys over successive years, or perhaps more easily by replicating a previously
completed survey.   The second lesson is that comparisons of national environmental policies can
easily be distracted by lots of issues unrelated to manufacturer costs.   If the goal is studying the
effect of policies on trade, only those policies directly related to manufacturers' costs need to be
included.

Measuring Environmental Compliance Costs and Economic Consequences:
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For decades now, policymakers and policy analysts have been concerned with the effect of domestic environmental standards on international trade. The concerns come from all sides. Business interests and organized labor in developed countries worry that high environmental compliance costs will cause industry (and jobs) to relocate to developing countries. Free trade advocates express concern that nations may be able to evade international tariff agreements by strategically setting environmental policies (Ederington, 1998; Copeland, 1990). Environmental organizations at one extreme fear that industries will use international trade to avoid strict environmental regulations by relocating the pollution-intensive parts of their manufacturing processes overseas. At the other extreme, however, environmentalists have also expressed concern that linked trade agreements will prevent nations from setting their desired levels of environmental protection.

Many of these concerns have been reflected in policy proposals. Twenty years ago, CBS News Anchor Walter Cronkite wrote a letter to the *New York Times* arguing that the United States should act unilaterally to "protect both American industry and the environment by barring products from any country that does not enforce pollution standards as strict as our own."[1] In 1991, U.S. Senator Boren (D-OK) sponsored the International Pollution Deterrence Act, which, had it been enacted, would have imposed a tariff on imports of products from countries without "effective pollution controls." The proposed tariff was to be equal to the costs foreign producers would have had to incur in order to comply with U.S. environmental standards.

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[1]*New York Times*, October 8, 1980, cited in Leonard (1988).

These policy proposals, and their accompanying concerns, are based on several unverified assumptions. First, they presume that international trade, and international industry locations, are sensitive to differences in countries' environmental compliance costs. Second, they presume that those compliance costs are higher in industrialized nations than in developing countries. And third, in the case of Senator Boren's bill, they presume that such compliance cost differences are measurable.

This paper discusses the possibility of measuring international differences in environmental compliance costs, for the purpose of assessing their effect on international trade and investment, using lessons learned from comparing compliance costs in U.S. states. The next section discusses the practical and theoretical problems inherent in such an exercise. Section 2 describes an attempt to measure compliance costs and their effects on international trade using data from U.S. states. Section 3 provides a summary of previous attempts to measure regulatory stringency differences internationally, and, drawing on lessons learned from the U.S. experience, and from past international surveys, suggests general strategies that might be implemented in any future international survey of compliance costs.

1. Problems measuring compliance costs.

The first item to clarify is the *goal* of the measurement task. One can easily imagine a research project designed to measure differences across countries in environmental *quality*, or in citizens' valuation of the environment, relative to other goods, or in protection of endangered species, depletion of natural resources, automotive emissions control, or recycling efforts. For example, in 1991 Island Press published the widely cited *Green index: A State-by-State Guide to the Nation's Environmental Health* (Hall and Kerr, 1991). The index essentially sums the number

of statutes each U.S. state had from a list of fifty common environmental laws. These include statutes pertaining to consumer recycling programs, parks and recreation, agriculture, and transportation. The majority of these statutes are unlikely to be related to manufacturing costs, and would not be useful in assessing the effect of environmental regulations on interstate or international commerce.

However, the goal of this paper, and indeed this conference, is to measure the effect of environmental regulations on international trade. Consequently, we focus on those regulations that affect manufacturers' compliance costs. In fact, for the purpose of measuring the effect of compliance costs on trade, we do not care whether those costs result from government imposed regulations, or from some other source. Environmental compliance costs may be driven by geographical features of the country, by citizens' preferences and citizens' activism, by differences in factor cost of inputs to pollution abatement, or by self-imposed industry norms. Regardless of their source, we are interested in measuring compliance costs that put manufacturing industries at a relative disadvantage with respect to manufacturers in other countries or other states.

In the end, we would like to be able to answer the question "how much higher would the environmental compliance costs be for a given manufacturer if it were to locate in country Y rather than in country X ?" This turns out to be a difficult concept, both practically and in theory. First, in practice, it involves surveying many manufacturing plants of different sizes, in different industries, and of different vintages. Even with the resources to conduct such a survey, however, compliance costs will be difficult for manufacturers to assess. Many costs associated with pollution abatement also generate a certain amount of cost savings -- so-called "cost offsets." And many efficiency enhancing investments that firms might have made in the absence of

pollution regulations may be environmentally friendly. Segregating the components of investment or operating costs that have purely environmental purposes will be difficult.

Because of the difficulty of acquiring such information, in theory and in practice, many studies have relied on proxies for these cost differences. By far the most common approach is to assume that developing countries have lower standards and compliance costs than industrialized countries. This assumption runs through the 1992 World Bank volume, edited by Patrick Low. Its most recent manifestation is in a working paper by Matthew Kahn (2000). Kahn finds little evidence that the U.S. has increased its imports of pollution-intensive manufactured goods relative to clean goods, or that imports of pollution-intensive goods from poorer nations have increased, from 1972 to 1992.

Alternative proxies for compliance costs that have been used by researchers attempting to measure their effect on international trade include ambient environmental standards, observed emissions by firms, ambient environmental quality, and specific provisions of national laws. These proxies, by virtue of their being indirect measures of compliance costs, all suffer from one or more biases and problems of interpretation. A nation's ambient environmental standards may be more or less difficult to comply with depending on its geography. Similarly, ambient environmental quality may be a function more of geography than of regulatory stringency. For example, here in the U.S., the Los Angeles metropolitan area has the worst air quality, the most stringent regulations, and the highest associated compliance costs (Berman and Bui, 1999). Specific provisions of national environmental laws are not necessarily better proxies for compliance costs, as those laws may or may not be enforced strictly.

In an ideal world, we would have a direct measure of compliance costs for a variety of industries, firm sizes, and years. This would enable us to compare compliance costs for similar

manufacturers in different countries.   While we recognize that such data would be difficult to gather, both conceptually and practically, and that most studies make do with a rough proxy for the hypothetical ideal compliance cost data, it is worth describing the ideal before resorting to the proxy.

Furthermore, it turns out that even with the ideal data, measuring the effect of compliance costs on trade requires overcoming several enormous pitfalls.   These include the endogeneity of policies, capital vintage effects, and industrial composition effects.   Below we describe each of these three problems.

Problem #1:   Endogenous policies.

The most important obstacle to measuring the effect of compliance costs on trade is that regulatory stringency and compliance costs themselves may be driven by the trade.   Consider, for example, a country endowed with an attribute desirable to a polluting industry: a great natural harbor, an abundant key resource, inexpensive energy, etc.   Such a country will be likely to attract export-oriented investment in that polluting industry.   If the resulting pollution is bad enough, the country will be induced to regulate stringently the pollution emanating from the industry, increasing that industry's environmental compliance costs.   In this example, both investment and compliance costs will be *positively* correlated with the presence of the desirable attribute, inducing a spurious positive correlation between investment and environmental stringency.

As another example, suppose that some country has a tendency to favor polluting industries, perhaps because those industries are particularly important to the country's economy, or because those industries have long histories in the country, or because the leadership of the country is "pro-business" in some sense.   Such countries, in addition to providing lax environmental

regulations, may also provide tax relief or other subsidies to lure foreign investment.   In that case, because the low environmental compliance costs are correlated with other inducements, compliance costs and investment will be *negatively* correlated, though not necessarily due to the environmental compliance costs.

In both examples, some unobserved characteristics of countries, key attributes or pro-business climates, were correlated with both compliance costs and investment, inducing a spurious correlation between the two.   If the estimation strategy used to measure the effect of compliance costs on investment fails to account for this spurious correlation, then it will impart an omitted variable bias on the predicted effect of regulatory compliance costs on investment.

By far the easiest way of accounting for countries' unobserved characteristics that do not change over time is to collect a panel of data and examine how *changes* in compliance costs affect *changes* in investment.   In other words, if we look at investment in various countries as a function of their compliance costs *in one year*, we will be unable to discern whether investment and compliance costs are high due to the presence of natural assets desirable to polluting industries, or whether more investment flows to low-cost countries merely because of other non-environmental inducements provided by high-cost countries.   However, if we collect data from two different years, and examine how investment or trade changed in countries where compliance costs grew more, relative to how investment or trade changed in countries where compliance costs grew less, assuming that key resources and pro-business sentiments remained unchanged, that will provide a closer approximation to the true effect of compliance costs on investment.

Unfortunately, *all* of the existing surveys of environmental regulations across countries are single cross-sections.   Such surveys tend to be funded once, for a specific subset of countries, with a specific set of questions, and then abandoned.   In many ways, research on this topic would

be aided most if the next international organization to fund a survey of environmental regulations, rather than designing a new survey with new questions for yet another subset of countries, would instead merely repeat some of the surveys conducted in the past, using the same countries and methodologies as was used before.   Later, in section 3 of this paper, we describe some of those previous international comparisons of regulatory stringency.

Problem #2:   Capital vintage.

The second conceptual problem facing measurement of compliance costs involves differences across countries in the age of their manufacturing capital stock.   Any survey of manufacturers will, by necessity, measure the compliance costs for *existing* manufacturers.   For a variety of reasons, this may be starkly different than the compliance costs for *new* investment.   In the U.S., for example, many state laws, and the federal New Source Performance Standards, impose more costly regulations on new sources of pollution than on existing sources.   These laws effectively "grandfather" existing sources from the new, more stringent standards.

This grandfathering of existing sources of pollution raises several problems.   Recall that the goal of this project is to measure differences in compliance costs as they affect investment. Now imagine that all countries have exactly the same environmental regulations and associated compliance costs, and that all countries grandfather existing polluters.   Furthermore, imagine that some countries receive more investment than others, perhaps even just by chance.   In this situation, the countries receiving more investment will, as a consequence of the grandfathered regulations, have higher average compliance costs than the countries receiving less investment. An empirical test of the effect of compliance costs on investment will measure a spurious positive

correlation: investment will seemingly flow to the high-cost countries, even though all states have the same regulations and there can be no true effect.

What is worse, now suppose that some countries have more stringent regulations for new investment than others. In this case *less* investment flows to those countries with stringent regulations, and more flows to the countries with lower costs for new investment. If all countries' regulations are nevertheless tighter for new investment than existing investment, the country receiving the new investment will have the higher measured costs. In this example, the apparent flow of investment to the high-cost countries will be even more dramatic, even though the true effect is that high-cost countries deter investment.

Because of the tendency for environmental compliance costs to vary by capital vintage -- higher costs for newer capital -- an international survey of average compliance costs by country will not be sufficient to estimate the effect of compliance costs on investment. Rather, we need a survey that includes questions about the age of manufacturing equipment.

Note, however, that this is not an easy concept. Manufacturing facilities are built over many years, updated and retrofitted periodically, and occasionally undergo drastic remodeling. Here in the U.S., where the laws explicitly grandfather existing sources of pollution, a great deal of controversy and litigation surrounds cases where manufacturers extensively retrofit existing sources of pollution and claim protection from the new more stringent standards.[2]

Problem #3: Industrial composition.

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[2]"EPA Finds Broken Rules At Coal Plants, Officials Say" *New York Times*, Jul 16, 1999, Matthew L. Wald.

The third major conceptual hurdle facing surveys of compliance costs is that they vary tremendously by industrial composition. The average pollution abatement cost in a region, by production worker, or per dollar of value added, will be largely a function of the industrial composition of that region. Even if each region has identical regulations, but some regions have more pollution-intensive industrial compositions than others, the regions with more polluting manufacturers will have higher abatement costs. In this case, there will be no measurable effect of environmental regulations on investment.

Worse, suppose some regions have low compliance costs and *attract* polluting manufacturers. In this case, regions with lax regulations will have more pollution-intensive industrial compositions, and may well have *higher* average compliance costs than regions with more stringent standards. Here the measured effect of environmental regulations and investment will be spuriously positively correlated.

By far the closest approximation to the ideal data comes from the United States Census Bureau's Pollution Abatement Costs and Expenditures (PACE) survey, collected from 1972 to 1994, to be resumed in 2000, and from Statistics Canada's Environmental Protection Expenditures survey, begun in 1995. In the next section we describe an approach to estimating compliance cost differences across U.S. states using the PACE data, and use those estimates to examine the effect of costs on international investment.

2. An example using U.S. data.

Many researchers have relied on the Census Bureau's Pollution Abatement Costs and Expenditures (PACE) survey to construct indices of environmental costs in U.S. states.[3]   The PACE survey collected data from manufacturing establishments about their pollution abatement operating and capital costs.   Most commonly, studies use these costs divided by some measure of state economic activity, such as total employment or gross state product.[4]   The most significant problem with such measures is that they fail to adjust for differences in states' industrial compositions.   States that have pollution-intensive industries will incur high pollution abatement costs, whether or not they have stringent regulations.   Ideally, one would use the pollution abatement costs in the relevant industry as an index of regulatory stringency.

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[3]The entire PACE survey, and summary statistics for 1994, can be seen at
http://www.census.gov/prod/2/manmin/ma200x94.pdf.

[4]Crandall (1993), Friedman *et al.* (1992), or Co and List (1998).   Consulting firms specializing in industrial siting decisions have also relied on such simple indices of environmental regulatory stringency (Alexander Grant & Co., 1985).

One method might be to use the plant-level data to estimate how much manufacturers pay for pollution abatement in each state, holding constant characteristics of the manufacturer, including its industry. Levinson (1996), contains such an estimate. It uses the raw, establishment-level PACE data from 1988, merged with data on plant characteristics from the 1987 Census of Manufactures. (Unfortunately the PACE data were not collected in 1987.) It then regresses the log of gross pollution abatement operating costs on the log of the book value of capital, the log of the number of production workers, the log of value added, a dummy for new plants, dummies for 4-digit SIC codes, and individual state dummies:

$$\ln(\text{PACE}) = \beta_0 + \beta_1 \ln(K) + \beta_2 \ln(L) + \beta_3 \ln(\textit{value added})$$
$$+ \beta_4 \ln(\textit{age}) + \beta_5 \ln(4\textit{-digit industry}) + \beta_6 \ln(\textit{state}) + \varepsilon$$

where K is the book value of capital, and L is the number of production workers at the plant.

Note that this specification can be interpreted as an inverted Cobb-Douglas production function, where output (value added) is a function of capital (K), labor (L), and pollution (P), and dummy variables for new plants, industries, and states: $Y = A \bullet K^{\beta_1} \bullet L^{\beta_2} \bullet P^{\beta_3}$. The model in equation **(1)** substitutes pollution abatement, which is measured by the PACE data, for pollution, which is unobservable, takes the logarithm of both sides, and inverts the function to estimate abatement as a function of the other variables.

The results are reproduced in Table 1, and the coefficients on the state dummy variables are interpreted as measures of compliance costs. A large state coefficient indicates that plants in that state spend more on pollution abatement operating costs, all else equal. Because the omitted state, New York, has relatively high costs, all of the statistically significant coefficients on other states are negative.[5] In many ways, the coefficients in Table 1 represent *exactly* what we would

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[5]The asterisks in Table 1 merely indicate where the relevant coefficients are statistically

like to know in order to examine the effect of environmental costs on trade: They tell us how compliance costs for similar manufacturers differ across jurisdictions.

There are, however, several remaining problems with this measure of compliance costs. First, respondents to the PACE survey presumably have a great deal of difficulty reporting the true economic costs of pollution abatement, including efficiency gains or losses due to input substitution or altered production processes. At best, they provide direct dollar amounts spent on pollution abatement, less some amount for "cost offsets" due to efficiency gains, reported in recent PACE surveys. As a consequence, the plant-specific abatement operating costs may overstate or understate true compliance costs, and the dummy variable coefficients in Table 1 may contain an associated bias. If the respondents' error estimating their compliance costs is distributed randomly, it will amount to little more than standard measurement error, and will bias associated cost coefficients downwards unless appropriately treated, perhaps via instrumental variables. If, however, the error is systematic in some way, it poses a more complicated problem.

Second, the coefficient on the state dummy variable measures how much more a plant would have to spend on pollution abatement if it located in that state rather than in the omitted state, holding constant capital, labor, value added, and industry. But it is unlikely that plants locating in two different states would hold all of those other factors constant. Given that manufacturers can respond to regulations in ways aside from spending more on pollution abatement, this measure may overstate true compliance cost differences.

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different from zero. More importantly, however, many coefficients are statistically different from *each other*.

Still, the coefficients in Table 1 come as close as we can imagine to our ideal measure of compliance cost differences across regions, by holding constant other observable characteristics of firms, including size, industry, and age.   Unfortunately, however, it is impossible to estimate versions of Table 1 for many years, as the U.S. Census Bureau has not retained the historical, disaggregate, plant-level data.   Thus it is not possible to use these data to construct a time series of *changes* in relative compliance costs.   And consequently, it is impossible to control for unobserved characteristics of regions that may be correlated with both compliance costs and investment, as outlined in the section above labeled "*Problem #1*."   Using this single cross-section of compliance cost coefficients, Levinson (1996) concluded that there does not seem to be evidence that states with high relative compliance costs experience fewer new plant births, but could not rule out biases due to this unobserved heterogeneity.

As an alternative, it is possible to use the aggregate published PACE data to generate a long panel of compliance cost data.   Although the U.S. Census Bureau does publish annual abatement costs by state and industry, many of the observations are censored to prevent disclosure of confidential plant-level information.   Instead, Levinson (1999) proposes an alternative index.

The alternative index compares the average abatement costs in each state, across all industries, to a *prediction* of abatement costs by state, based on national average abatement costs by industry, and on and each state's industrial composition.[6]   Denote the average abatement costs per dollar of output as

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[6]The index uses pollution abatement operating expenses rather than capital expenses, though both are available from PACE data.   Operating expenses may be easier for survey respondents to identify separately, while capital expenses are likely to be more difficult to segregate from investment that is unrelated to pollution abatement.   Also, abatement capital expenditures peak when new investment occurs, which means that states with relatively more investment have relatively higher abatement capital costs, regardless of the stringency of those

$$S_{st} = \frac{P_{st}}{Y_{st}}$$

where P_{st} is pollution abatement operating costs in state s in year t, and Y_{st} is the total

manufacturing sector's value added in state s in year t. This calculation, S_{st} is the type of

aggregate measure of compliance costs commonly used.   It fails to adjust for the industrial

composition of each state, and so it probably exaggerates compliance costs in states with relatively

more polluting industries and understates costs in clean states.

Now compare **(2)** to a *prediction* of pollution abatement costs:

$$S_{st} = \frac{1}{Y_{st}} \sum_{i=20}^{39} \frac{Y_{ist} P_{it}}{Y_{it}} \quad ,$$

where i indexes 2-digit SIC codes for manufacturing industries, 20 through 39,[7] Y_{ist} is industry i's

value added in state s at time t, Y_{it} is the national value added of industry i, and P_{it} is national

pollution abatement operating costs for industry i. $\tilde{S}_{st}$ is a weighted average of pollution

abatement operating costs (per dollar of value added), in which the weights are relative shares of

output for each industry in state s at time t.

states' environmental laws.

[7]The PACE survey omits SIC code 23 (apparel) because it is relatively pollution-free.

The alternative, industry-adjusted measure of compliance costs in Levinson (1999) is the ratio of average state expenditures in **(2)** to the predicted state expenditures in **(3)**

$$S_{st}^{\star} = \frac{S_{st}}{S_{st}} \quad .$$

When $S_{st}*$ exceeds 1, industries in state s at time t have spent more on abatement than the same industries spent in other states. When $S_{st}*$ falls below 1, industries in state s at time t spent relatively less on abatement. One interpretation of $S_{st}*$ is that states with high $S_{st}*$ have more stringent regulations than states with small $S_{st}*$.[8]

Keller and Levinson (1999) use this index, $S_{st}*$, to try to assess the effects of compliance costs on foreign direct investment. As a measure of international investment flows, they use the value of gross property, plant and equipment belonging to foreign manufacturers from the U.S. Department of Commerce, Bureau of Economic Analysis (BEA), *Foreign Direct Investment in the United States*.

Table 2 contains an example of this type of analysis. The first column presents the average industry-adjusted index $S*$, from 1977 to 1994, for various combinations of states. The average $S*$ for the five states with the lowest compliance costs is 0.64, indicating that those states have 64 percent of the compliance costs they could be expected to have given their industrial compositions. The average $S*$ for the highest five states is 1.59, suggesting their compliance costs are 59 percent higher than would be predicted by their industrial compositions. Rows (3) and (4) of Table 2 present that same information for the 20 lowest and highest states, respectively.

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[8]For more details about the index, and summary statistics for individual states over time, see Levinson (1999). Interested readers can also find the data for this index at ***www.georgetown.edu/faculty/aml6/index2.htm***.

Column (2) of Table 2 presents the average value of gross property, plant and equipment (PP&E) investment by foreign-owned manufacturers from 1977 to 1994, for all manufacturers, scaled by each states Gross State Product (GSP -- the state equivalent of Gross Domestic Product). On average, in the five states with the lowest compliance cost indices, FDI is a *lower* fraction of GSP than in the five states with the highest indices. The same is true for the bottom panel of Table 2, which compares the states with the 20 lowest and 20 highest indices.

Because most pollution abatement expenses are incurred by a few industries, the results in column (2) may be dampened by the vast majority of industries that have relatively minor abatement expenditures. Consequently, column (3) examines SIC 28, chemicals and allied products, as an example of a pollution-intensive industry. Of polluting industries, this industry has the most consistently reported uncensored FDI data in the BEA publications. However, as column (3) shows, for the chemical industry the counter-intuitive gap between the most and least costly states is even *larger*. It appears as if investment flows to states with high environmental compliance costs, and that pollution intensive investment has an even greater tendency to migrate to high cost states.

This is the type of result that pervades the empirical literature on trade and environmental regulations. It suggests no evidence of a pollution haven effect, no industry relocation response to environmental regulations, and no need to worry about a race to the bottom in environmental standards. In fact, it suggests that pollution-intensive industries are *attracted* to states with high compliance costs. We fear, however, that results are due to the endogeneity of pollution regulations and compliance costs. States that attract relatively little polluting manufacturing need not enact stringent regulations, whereas states that *do* attract polluting manufacturing may respond by enacting more costly regulations. Consequently, comparing investment in costly and

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inexpensive states, we find that more investment flows to the costly states.   Furthermore, when

we look at polluting industries in particular, the endogeneity bias becomes worse.

This endogeneity bias is an example of what above we described as "*problem #1.*"   The

clearest solution comes from comparing compliance costs over time.   In other words, rather than

examining *levels* of investment and compliance costs, we look at *changes* in investment and

compliance costs.

Table 3 thus examines *changes* in compliance costs and FDI.   We calculated the average

stringency and FDI for the first five years of the data (1977-1981) and for the last five years

(1990-1994), and subtracted the latter from the former.   The five states whose average S^*

declined most over the 18 year period had an average change of   -0.597.   For these states,

average annual value of PP&E foreign direct investment as a fraction of GSP grew by 4.09

percentage points.   In contrast, the five states whose S^* increased most over the period saw their

FDI as a fraction of GSP grow by 2.83 percentage points.   Taken at face value, this comparison

suggests that states that became more costly attracted less FDI.

Column (3) of Table 3 examines the chemicals industry, SIC 28.   Here, the distinction

between the five states whose S^* increased most and the five whose S^* declined most is even more

stark than in column (2).   Furthermore, these distinctions are robust to the set of states examined

(20 greatest and smallest index changes, 5 greatest and smallest, or other combinations in

between.)

Although Table 3 appears to present strong evidence of a deterrent effect of environmental

regulations, we do not want put too much emphasis on that result.   The analysis in Table 3

controls for no other observable characteristics of states that may be correlated with both

compliance costs and foreign investment.[9]   Rather, we think the most important lesson comes

from comparing Tables 2 and 3.   Table 2 finds a positive correlation between *levels* of

investment and *levels* of costs, while Table 3 demonstrates a negative correlation between *changes*

in investment and *changes* in costs.   From the comparison, one can see quite clearly the bias

associated with cross-sectional analyses of investment and compliance costs.   The lesson, we

think, is clear: Any study that relies on a measure of stringency or compliance costs across

regions at a single point in time is likely to suffer from large and unavoidable endogeneity biases.

　　　To conduct a study like this at the international level is at this time, unfortunately,

impossible.   No agency that we know has collected compliance costs by industry internationally,

let alone over time.   Therefore, to examine the effect of compliance cost differences across

countries rather than *states*, one is forced to use more indirect measures of costs.   In the next

section, we discuss some of the existing international measures of standard stringency, with an eye

towards the lessons learned from studying U.S. states.

3.   International measures of standard stringency.

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[9]In Keller and Levinson (1999), when other observable characteristics of states are accounted for, the measured deterrent effect of environmental costs is mitigated but not completely erased.

Analyses of international environmental standards all face a similar problem: they lack data. This data shortage impedes efforts to explore the degree, causes, and effects of international differences in environmental standards. And, this information shortage seriously handicaps efforts to analyze the links between international trade and environmental protection.

Lacking compliance cost data, discussions of environmental standards often seem to resort to anecdotes. At hearings on the proposed "International Pollution Deterrence Act of 1991," U.S. Senator Max Baucus (D-MT) described pictures of "poorly buried drums of hazardous waste" in Mexico as evidence of "different levels of environmental protection around the world" that gave a "competitive advantage" to nations that maintain "inadequate environmental protection" (U.S. Congress, Senate 1991). Senator Earnest Hollings (D-SC), at 1994 hearings on trade and the environment, described "mounds of lead and...shanty homes" as evidence of "weak standards" (U.S. Congress, Senate 1994).

This section reviews past efforts to construct systematic data on international standard stringency, and, drawing on the lessons learned from earlier analyses, proposes general guidelines for assembling such data.

The United States Government

The "International Pollution Deterrence Act of 1991," sponsored by U.S. Senator David Boren (D-OK), included provisions for a comprehensive assessment of international environmental standards. The proposed legislation, though never enacted, called for:

"... a pollution control index for each of the top fifty countries identified by the Office of

Trade and Investment of the Department of Commerce based on the value of exports to the

United States from that country's attainment of pollution control standards in the areas of

air, water, hazardous waste and solid waste as compared to the United States.   The

purpose of this index is to measure the level of compliance within each country with

standards comparable to or greater than those in the United States.   The Administrator

shall analyze, in particular, the level of technology employed and actual costs incurred for

pollution control in the major export sectors of each country formulating the index."

According to U.S. Senator Max Baucus (D-MT), a major goal of the legislation was to "level the

playing field" with nations that have "inadequate environmental protection."

Whatever one thinks of its motives, the proposed index could have provided useful data

concerning international differences in environmental standards and pollution-control costs.

And, to be consistent with its goals, the law would have had to require that the EPA estimate these

cost differences at regular intervals, generating exactly the type of time-series data needed.

Despite its limitations and eventual failure to gain the required support, this proposal stands out as

a particularly ambitious (perhaps overly ambitious)   proposal for measuring international

differences in environmental standards.

The United Nations

The United Nations has sponsored two efforts to document global differences in

environmental standards.   The first emerged in connection with the 1972 Stockholm Conference

-- known formally as the United Nations Conference on the Human Environment.   Conference

leaders commissioned the United Nations Conference on Trade and Development (UNCTAD) to

study the ways in which differences in environmental standards could influence trade patterns.   In

investigating the differences in environmental policies, UNCTAD researchers sent questionnaires

to 145 member states and received a total of 40 replies (Walter and Ugelow, 1979).   Ten of the

responses provided small amounts of useful data. Fourteen offered helpful but not outstanding information. Another 14 supplied detailed descriptions. (Two of the responses apparently eluded classification.) The analysts ranked the responses along a continuum from "tolerant policies" (i.e., very little control over polluting activity) to "strict policies" (i.e., extensive and articulated controls over polluting activity). The ranking used the United States as a benchmark for "strict."

While the UNCTAD survey deserves credit for producing useful data, it also leaves room for improvement. First, the researchers experienced a very low response rate – 28 percent responded, 10 percent responded in detail. Second, the survey, evidently in an effort not to overburden the respondents, included a very small number of questions.[10] Third, UNCTAD evidently asked open-ended questions that allowed strategic responses -- so that countries could rightly or wrongly portray themselves as environmentally active. Fourth, analysts' judgements played a large role in assembling the scale. Fifth, the questionnaire's ability to assess enforcement seems particularly limited. Sixth, the results apparently did not help researchers to estimate specific differences in environmental costs. Despite its flaws, UNCTAD's survey marked an important first attempt to characterize international differences in environmental standards.

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[10]The original questionnaire has proved impossible to locate. Later comment on the questionnaire suggests that the original contained only ten questions (Blond, 1974). A 1979 follow up survey seems to have included only 3 questions (UNCTAD, 1979).

Another U.N.-sponsored effort to assess environmental standards occurred in association with the 1992 "Rio Earth Summit."   In preparation for that summit, the United Nations Conference on Environment and Development (UNCED) asked participants to describe their environmental policies.[11]   The reports proved noteworthy for many reasons.   First, they formed a thorough compendium of environmental policies.   Second, the descriptions of "Past and Present Capacity Building Initiatives" depicted great progress in nations' that many presumed had not formulated meaningful policies (e.g., India, Burkina Faso, The Russian Federation and Venezuela).   Third, only 15 of 169 reports met the original deadline.   Only 57 met the extended deadline.   The response rate might suggest some countries lacked either the will or the ability to provide the reports.   Fourth, political considerations seem to have influenced some of the reporting.[12]   Fifth, although the committee requested data on "enforcement procedures," national reports contained very little information on the extent to which they enforce the current laws. Many countries (e.g., Suriname, Nepal and Ethiopia), in other sections of their reports, alluded to a

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[11] Paragraph 16-1-a of the "Guidelines for National Reports" provided the following instructions for report-writers:

> "Outline the major approaches that have been developed and implemented at the national level over the past two decades to address environmental and resource problems as they relate to development, and indicate the principles that guide policy, the key goals, targets and priorities of development, and the policies, legislation and institutions that enable their achievement."   (UNCED, 1992)

Paragraph 16-2-b instructed those reporters to describe "new departments or councils on the environment, establishment of rules and regulations and enforcement procedures" (UNCED, 1992).

[12]For example, Haiti's report, written by allies of then-exiled President Aristide, stands out as a notable exception to the upbeat tone.   Haiti reported that "a large number of institutions were set up to take care of the environment ... (but) the tasks are at times neglected... Their establishment was a result of clan struggles for control or embezzlement of capital.   The functioning of these state bodies is often quite arbitrary."

need for stricter enforcement.   Finally, like the UNCTAD study that preceded it, the UNCED

analyses did not allow for a calculation of regulation-based differences in production costs.

The Inter-American Development Bank

Writing for the Inter-American Development Bank (IADB), Raul Branes (1991) authored a

detailed investigation of its member countries' environmental policies.   Its stated   purpose was to

"provide a comprehensive picture of the way in which environmental management is organized in

(member) countries... (and to provide) information on legal and institutional aspects of

environment issues..." for the public and for IADB bank employees.   The report evaluated eight

types of environmental legislation for ten nations.[13]

Like the U.N. projects and the proposed U.S. project, the Branes study stands out as a

commendable first step in a comprehensive assessment of international environmental standards.

Like those studies, this one did not provide specific information about regulation-based

differences in production costs.   Neither did it evolve into a steady flow of environmental

intelligence.   Branes himself also identified a number of caveats that should accompany any

interpretation of his findings.   First, he warns that the laws differ dramatically from one country to

another.   Some countries' environmental legislation deal only in superficialities, while others'

laws address deep roots.   Second, he cautions that within most nations, the environmental laws

lack coherence.   Third, Branes points out that "general enforcement of environmental legislation

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[13]The countries were Argentina, Bolivia, Brazil, Colombia, Chile, Ecuador, Paraguay, Peru, Uruguay and Venezuela.   The environmental sectors were water, forests, wildlife, soils, marine and coastal ecosystems, non-renewable natural resources, human settlements and environmental sanitation.   (Of course, not all of these can be expected to affect manufacturers' costs.)

in the countries of the region has run into serious problems of efficiency and efficacy."   He

defines "efficacy" as the extent to which the law is observed and "efficiency" as the extent to which

the law is suitable for meeting the identified needs. Widespread inefficacy, he claims, results

mostly from "shortages of human, material and financial resources" and from "shortcomings in

judicial enforcement."

Other Efforts

In addition to the efforts described above, a number of other organizations have tried to

construct systematic evaluations of international environmental standards and laws.

UNEP/WHO   –   In 1992, The World Health Organization (WHO), in conjunction with

the United Nations Environment Programme (UNEP), published *Urban Air Pollution in the*

Megacities of the World, a review of the air quality in 25 of the world's largest cities.   The data,

taken from the Global Environmental Monitoring System (GEMS), reported on each city's

ambient concentrations of sulphur dioxide, suspended particulate matter, oxides of nitrogen, lead,

ozone, and carbon monoxide.   The report, in addition to evaluating the overall air pollution

situation and control measures, provides specific recommendations for each city.

NRDC and CAPE 21   – In 1994, The Natural Resources Defense Council (NRDC) and the

Campaign for Action to Protect the Earth (CAPE 21), released *Four in '94: Two years after Rio –*

Assessing National Actions to Implement Agenda 21.   The report evaluated the extent to which

73 nations, all participants in the 1992 "Rio Earth Summit," had carried through on four

agreements made at the Rio conference: reducing lead exposures, cleaning up freshwater

resources, ratifying and implementing the Basel convention, and protecting natural rivers.   The

study identified a variety of successes and failures.   Prior to releasing *Four in '94,* the two groups

had published *One Year After Rio,* which broadly examined what nations had done to follow up on the environmental summit.

OECD – The Organization for Economic Cooperation and Development (OECD) has, since 1985, published *The Compendium of Environmental Data* on a bi-annual basis. Most of the information comes from questionnaires, originally developed by the OECD Group on the State of the Environment, that are sent to member countries. The 1999 *Compendium* provides somewhat detailed reports on the quality of air, land, water, forests, wildlife waste management and risks. It also surveys critical trends in the energy, transport, industry and agriculture sectors, and key developments in environmental management.

Smaller scale attempts to describe international differences in environmental standards frequently appear in periodicals such as the *International Environment Reporter, Environmental Policy and Law*, and the *International Journal of Environmental Affairs.*

Lessons Learned

Perhaps obviously, it is difficult to summarize all previous attempts to compare countries' environmental standards. However, we feel it is fair to make the following observations. First, no survey has been repeated. This impedes efforts to control for unobserved attributes of countries by comparing changes in regulations and changes in trade or investment. Second, many of the surveys asked numerous questions unrelated to manufacturers' costs. These questions likely reduced response rates and distracted respondents from the central issue. Consequently, if we can make a few suggestions for future attempts to measure international *compliance cost* differences, they would be the following.

Repetition –   First, because repeated observations over time are so valuable for these types of analyses, plan on (a) repeating the survey periodically in the future, and (b) repeating, as closely as possible, a few of the questions asked by previous studies.   The repetitions would allow for comparisons across time and would help to reveal influences that might otherwise go unobserved.

Focus –   Second, focus on questions related to manufacturers' compliance costs.   If the survey is to have other goals besides assessing the trade-environment tradeoff, then other questions may make sense.   But if the sole goal is to measure regulatory effects on trade, then it makes no sense to ask countries or companies about their consumer recycling programs, national parks, endangered species protection programs, or automobile emissions standards. The meager response rates to the UNCTAD and UNCED surveys suggest that many respondents lack the ability or the will to provide the desired data.   Assessment efforts will certainly achieve better results if they focus their inquiry so as to simplify the response process and minimize the demands imposed on respondents.   A limited number of questions on a limited number of topics will work best. The survey could certainly be designed to provide more data than the original UNCTAD study.   Still, it should recognize the limited results achieved by ambitious surveys and the success of focused efforts such as NRDC's *Four in '94,* which set out to answer four questions for many countries.

Caution – Third, if the survey is to consider issues other than manufacturers' compliance costs, it should be expanded with caution.   Broad analysis of regulation, if it is to be useful, necessarily involves extensive effort.   For example, a thorough survey of environmental legislation would not only identify the laws that are on the books, it would also consider: institutional arrangements, including the role of regulatory agencies, the influence of NGOs and the possibility of environmentally based law suits; the distribution of laws, so that one would know

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whether the regulations apply to the entire nation or only to some region; and, enforcement and compliance, a topic which has provided the greatest challenge to earlier surveys.[14] Attempts to expand a survey's focus, beyond a measurement of what it costs firms to comply with environmental regulations, should be considered with caution as they necessarily involve a great deal more research – and a lower response rate – than one might originally suspect.

Concluding remarks.

In the end, two major lessons stand out.   The first is the critical importance of measuring standard stringency in more than one year, in order to study the effect of changes in standard stringency on changes in international trade.   Cross-section analyses, done at one point in time, are doomed by omitted variable bias and the endogeneity of the standards.   While in practice this means it will be necessary to collect data for many years, in the short run it could involve replicating international surveys conducted earlier, or at least the key successful parts of such surveys.

The second critical lesson is that comparisons of national environmental policies can easily be distracted by lots of issues unrelated to manufacturer costs.   If the goal is studying the effect of policies on trade, only those policies directly related to manufacturers' costs need to be included.

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[14]One alternative to measuring enforcement and compliance is instead to measure performance.   Hilton and Levinson (1998) have taken this approach by measuring lead levels in automotive gasoline.   Unlike studies that examine rules concerning lead phase out, they measure the actual lead content of gasoline.   The focus on actual performance eliminates the need for entry into the quagmire of measuring enforcement

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Table 1: Industry-specific environmental compliance costs in U.S. states.

Dependent Variable: ln(gross pollution abatement operating costs)

Variable	Coefficient	Std. Error
ln(Capital)	0.545*	0.016
ln(Production Workers)	0.439*	0.022
ln(Value Added)	0.084*	0.016
New Plant Dummy	0.060	0.061
AL	-0.035	0.094
AR	-0.072	0.103
AZ	-0.232	0.155
CA	-0.150*	0.064
CO	-0.384*	0.140
CT	-0.001	0.097
DE	0.273	0.194
FL	0.022	0.095
GA	-0.194*	0.084
IA	-0.034	0.104
ID	-0.004	0.190
IL	0.055	0.067
IN	0.013	0.078
KS	-0.330*	0.115
KY	0.065	0.101
LA	-0.102	0.107
MA	-0.109	0.086
MD	0.148	0.108
ME	-0.041	0.163
MI	0.084	0.076
MN	-0.209*	0.091
MO	-0.195*	0.091
MS	-0.255*	0.123
MT	0.110	0.273
NC	-0.144	0.080
ND	-0.566	0.384
NE	-0.196	0.144
NH	-0.276	0.178
NJ	0.117	0.077
NM	-0.500	0.322
NV	-0.239	0.348
NY	na	na
OH	0.056	0.067
OK	-0.396*	0.120
OR	0.122	0.110
PA	0.022	0.067
RI	-0.247	0.148
SC	-0.184	0.096
SD	-0.020	0.264
TN	-0.078	0.088
TX	-0.151*	0.071
UT	-0.494*	0.177
VA	-0.097	0.093
VT	-0.111	0.220
WA	-0.182	0.107
WI	-0.186*	0.078
WV	-0.115	0.143
WY	-0.412	0.365

n=11034, d.f.=10565   R-Squared = .74

* Statistically significantly at 5%.
Includes dummy variables for 4-digit SIC codes.
Reprinted from Levinson (1996).

Table 2: Summary Statistics
Averages 1977-1994

	Industry-adjusted index of abatement costs [S^*] (1)	Foreign direct investment (PP&E as a fraction of Gross State Product)	
		All manufacturing (2)	SIC 28 -- chemicals (3)
Avg. for lowest 5	0.64	0.0233	0.0073
Avg. for highest 5	1.59	0.0604	0.0335
Avg. for lowest 20	0.75	0.0273	0.0112
Avg. for highest 20	1.33	0.0487	0.0257

Table 3:
Changes in Average Pollution Abatement Costs and FDI
(1977-1981)   to   (1990-1994)

	Change in industry-adjusted index of abatement costs [S^*] (1)	Change in foreign direct investment (PP&E as a fraction of Gross State Product)	
		All manufacturing (2)	SIC 28 -- chemicals (3)
Largest 5 declines	-0.597	0.0409	0.0428
Largest 5 increases	0.447	0.0283	0.0004
Largest 20 declines	-0.230	0.0394	0.0217
Largest 20 increases	0.190	0.0255	0.0029