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# Alternative Pollution Control Policies in Developing Countries

## *Informal, Informational, and Voluntary*

**Allen Blackman**


# Environment for Development

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# Alternative Pollution Control Policies in Developing Countries: Informal, Informational, and Voluntary

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## Abstract

In developing countries, weak environmental regulatory institutions often undermine conventional command-and-control policies. As a result, these countries are increasingly experimenting with alternative approaches that aim to leverage nonregulatory "green" pressures applied by local communities, capital markets, and consumers. This article reviews three strands of the empirical literature on this trend. The first strand examines the direct impact of nonregulatory pressures on developing country firms' environmental performance. The second and third strands analyze policy innovations reputed to leverage these pressures—public disclosure and voluntary regulation. I find that the econometric evidence that nonregulatory pressures have had a direct impact on firms' environmental performance is thin, at least partly because disentangling such impacts is inherently difficult. Nevertheless, existing empirical research suggests that public disclosure programs have spurred emissions reductions by particularly dirty firms. The evidence on voluntary regulatory policies is far more mixed. Taken as a whole, the literature suggests that policymakers would do well to exercise caution in promoting and implementing alternative pollution control tools: they are only likely to be effective in some incarnations and situations.

**Key Words:** developing country, pollution control, informal regulation, public disclosure, voluntary regulation

**JEL Classification Numbers:** Q52, Q56, Q58, O13

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# Alternative Pollution Control Policies in Developing Countries: Informal, Informational, and Voluntary

Allen Blackman *

## 1. Introduction

After decades of rapid urbanization, population growth, and industrialization, developing countries are now home to many of the world's most severe air, water, and solid waste problems. Most are taking action to address these problems, relying principally on conventional command-and-control (CAC) approaches, such as mandatory emissions and technology standards. Although some countries have made enormous progress, the overall track record is mixed at best. The reasons are well known (Russell and Vaughan 2003; Eskeland and Jimenez 1992). Written regulations are often riddled with gaps and inconsistencies. Environmental regulatory agencies lack funding, expertise, and personnel. Public pollution control facilities like wastewater treatment plants have yet to be built. Difficult-to-monitor small and informal firms abound. And perhaps most important, the political will to allocate scarce resources to environmental protection and to enforce environmental regulations is often limited.

The repeated failure of high-profile efforts during the 1980s and 1990s to control emissions from leather tanneries in the Mexican city of León, Guanajuato, a notorious environmental hotspot, illustrates the problem (Blackman and Sisto 2006). The requisites for effective CAC regulation were missing throughout this period. Clear laws governing tannery wastes were not promulgated until 1998, and a state-level environmental regulatory agency was not established until the mid-1990s. Facilities to treat inorganic liquid wastes and hazardous solid wastes have yet to be constructed, and public support for tannery pollution control continues to be negligible.

Given situations like this one—pressing environmental problems matched with ineffectual CAC policies—developing countries, often with funding and guidance from multilateral and bilateral aid agencies, are increasingly experimenting with innovative pollution control strategies that do not depend directly on regulators to issue legal mandates, monitor compliance, and sanction violations. Instead, they seek to leverage or create other pressures for

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environmental quality—including those applied by local communities, capital markets, and consumers—and to lower the costs of pollution control and prevention. The best known strategies of this type are public disclosure programs that collect and disseminate information about polluting facilities' environmental performance, and voluntary policies that invite polluters to commit to improved environmental performance. The hope is that these policies will sidestep the institutional and political constraints that have undermined CAC policies.

The World Bank has probably been the most visible and vocal advocate of environmental policy innovation in developing countries. During the 1990s, its Development Research Group conducted a series of studies of the impact of nonregulatory pressures on environmental performance—a phenomenon they termed informal regulation—and of pollution control policies that leverage them. This group also worked to promote the use of such policies in developing countries. The capstone of this effort was a 2000 book titled *Greening Industry: New Roles for Communities, Markets, and Governments* (World Bank 2000). The authors concluded

> Overall, the proliferation of innovative channels for reducing emissions has created a new model for pollution control in developing countries. In this model, regulation is information intensive and transparent. As environmental agencies exert influence through formal and informal channels, they become more like mediators and less like dictators. Community representatives take their place at the negotiating table, along with regulators and factory managers. Market agents make their presence felt through the decisions of consumers, bankers, and stockholders. (3)

As discussed below, both independent researchers and those at the World Bank have found evidence that informal regulation affects plants' environmental performance and that innovative policies can leverage these pressures.

Yet a number of factors suggest that it could be a mistake to put too much faith in informal environmental regulation in developing countries. First, many of the nonregulatory factors that reputedly motivate firms to improve environmental performance are relatively anemic in developing countries. Niche markets for "green" products are smaller than in industrialized countries; capital markets, including stock markets, are thinner; and environmental nongovernmental organizations and advocacy groups are relatively weak and scarce (Fry 1988; Wehrmeyer and Mulugetta 1999).

Second, informal regulation may depend on strong formal regulation to be effective. Considerable research suggests that firms participate in voluntary environmental initiatives because they expect that a failure to do so may trigger more stringent mandatory regulation

and/or sanctions (Khanna 2001; Lyon and Maxwell 2002). It is easy to see how the same dynamic could motivate firms to respond to public disclosure policies. Hence, both voluntary regulation and public disclosure may perform poorly in countries where mandatory regulation is weak.

Third, small-scale firms are more prevalent in developing countries than in industrialized countries (Blackman 2006). They may be less susceptible to at least some of the regulatory and nonregulatory pressures that create incentives for improved environmental performance, including those generated by green consumers and capital markets.

Finally, as discussed below, public disclosure policies are hypothesized to have an impact by improving information that communities, consumers, and other stakeholders have about individual plants' environmental performance, a mechanism that would seem to depend critically on the free flow of information. But in many developing countries, free speech and free press are limited.

To play devil's advocate, given those arguments, one might posit that informational and voluntary environmental strategies in developing countries amount to a *deus ex machina*—a seemingly convenient but ultimately unrealistic solution to the difficult challenges facing developing country environmental regulators. In the final analysis, these strategies may be a diversion from the hard work of building the requisites of effective CAC policies, including clear and consistent written regulations, strong regulatory institutions, and the political will to use scarce resources for environmental protection. Worse, one might argue that such policies create an environmental Potemkin Village—a false impression that regulators and polluters are making progress on environmental problems—and therefore can have real environmental costs, which must be weighed against any possible benefits.

Over the past two decades, dozens of empirical studies of environmental performance and policy innovations in developing countries have been published. What do they tell us about these arguments and counterarguments? This article aims to answer, or at least begin to answer, this question. We review three strands of empirical literature on environmental regulation in developing countries: (i) studies of the impact of nonregulatory pressures on firms' environmental performance; (ii) evaluations of public disclosure programs; and (iii) analyses of voluntary policies. To make the scope feasible, we focus mainly, although not exclusively, on econometric work published in peer-reviewed journals. Also, we leave aside the considerable literature on the use of economic incentive instruments in developing countries because such

policies rely on incentives created by regulators not communities, markets, and other nonregulatory actors.[1]

The remainder of the article is organized as follows. The second section presents the heuristic analytical framework found in much of the relevant literature. The next three sections discuss the three strands of literature listed above. The last section sums up and presents conclusions. The Appendix provides a brief review of relevant research on industrialized countries.

## 2. Model

To facilitate the discussion of the literature, this section presents a heuristic model of a plant's choice of how much pollution to emit (alternatively, how much to abate). The model appears in much of the World Bank literature cited in Section 4, including, most notably, Pargal and Wheeler (1996), Dasgupta et al. (2000), and World Bank (2000).

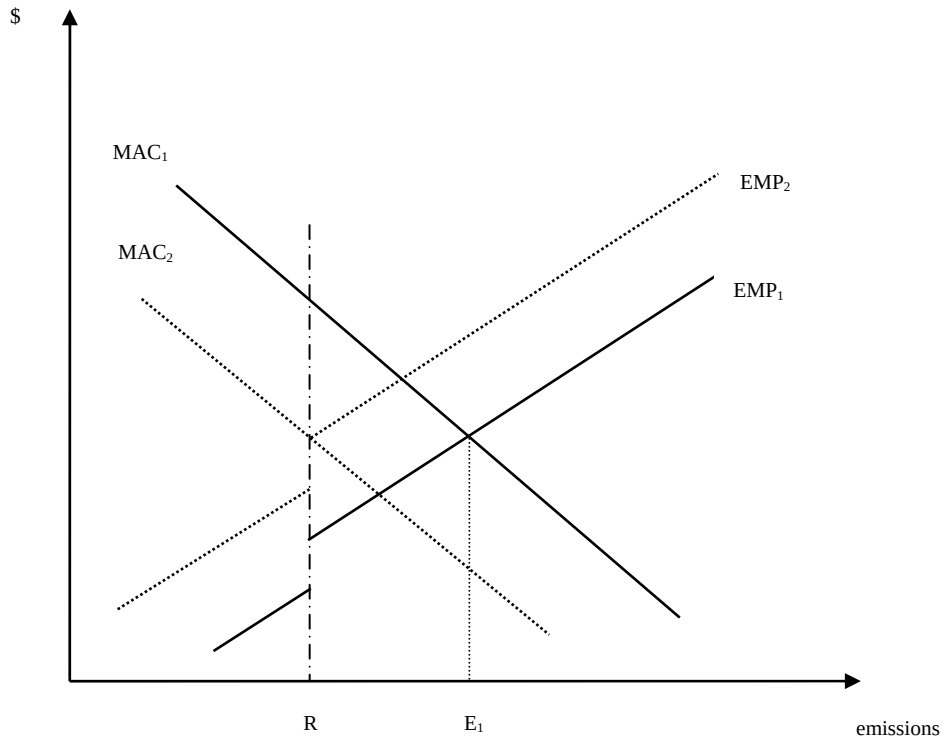
The model assumes that plants incur two types of costs in choosing an optimal level of emissions. First, a variety of parties—regulators, courts, local communities, employees, capital markets, and consumers—penalize the plant for polluting. These penalties, which may be pecuniary or nonpecuniary, are increasing in the level of emissions because each additional unit of emissions generates greater damages to human health and the environment. Second, plants must pay to abate emissions by investing in pollution control and prevention. Abatement costs are decreasing in the level of emissions because these investments generate diminishing marginal returns. The plant chooses a level of emissions that minimizes the sum of these two types of costs—that at which the expected marginal penalty (EMP) is equal to the marginal abatement cost (MAC).

Graphically, the plant's EMP schedule is increasing in the level emissions, and its MAC schedule is decreasing, and the plant's cost-minimizing level of emissions is determined by the intersection of its EMP and MAC schedules, at $E_1$ (Figure 1). When the plant is required by law to meet an emissions standard, R, regulators impose zero penalty if the plant emissions are less than R. As a result, the EMP schedule shifts up by the amount of the regulatory penalty at R, creating a discontinuity. The position of the EMP schedule depends on a variety of factors,

[1] For reviews, see Bell and Russell (2002), Blackman and Harrington (2000), Blackman (2009), and Serôa da Motta et al. (1999).

including the capacity of the regulatory institutions, the environmental activism of the local communities, and the environmental awareness of the plant's customers and their access to more environmentally friendly substitutes. The position of the MAC schedule depends on plant characteristics such as sector, scale, and human capital. For example, large plants that can spread fixed costs of pollution control investments over a large number of units may have lower MAC than small ones.

**Figure 1. Manufacturing Plant's Choice of Emissions [marginal abatement cost (MAC); expected marginal penalty (EMP); emissions standard (R); emissions (E)]**




To see how this graphical model might be used to explain the impact of an environmental policy innovation, consider a public disclosure program. Assume it has two effects. First, the program makes local communities aware of the plant's emissions and increases the implicit penalty they charge the plant for every unit of emissions. In addition, it makes plant managers aware of new pollution prevention processes. Graphically, the program shifts the EMP curve up (from $EMP_1$ to $EMP_2$) and the MAC down (from $MAC_1$ to $MAC_2$). The end result would be a reduction in equilibrium emissions from $E_1$ to R.

## 3. Drivers of Environmental Performance

One strand of the empirical literature on informal regulation in developing countries aims to identify the determinants of manufacturing plants' emissions decisions, focusing on pressures generated by nonregulatory agents such as local communities, shareholders, and output markets. The starting point for these studies is the observation that the environmental performance of manufacturing plants subjected to the same or similar formal regulation differs markedly. For example, among the Mexican tanneries mentioned in the introduction, most have adopted no pollution prevention or control measures, but a small number have adopted multiple measures (Blackman and Kildegaard 2003). Presumably, differences in MAC and MEP across plants explain such variation.

The literature on the drivers of environmental performance in developing countries and that on voluntary regulation in industrialized countries have much in common. Both seek to explain why some plants are "greener" than others and both focus on the same potential explanations: pressures generated by regulators, consumers, local communities, and shareholders. The Appendix provides a brief summary of the literature on voluntary regulation in industrialized countries.

Methodologically, most of the literature on the drivers of environmental performance in developing countries consists of plant-level econometric studies in which the dependent variable is a measure of, or proxy for, environmental performance (e.g., total suspended solids in liquid effluents or the number of environmental management practices adopted), and independent variables are characteristics of the plant (e.g., size, ownership, history of sanctions) and of the community in which the plant is located (e.g., income and literacy) (Table 1).[2] A few studies use ambient water quality in river sections near manufacturing centers as a dependent variable, and one uses data on stock market returns of publicly traded plants. Regression results are used to develop hypotheses about determinants of environmental performance. For example, in a plant-level study of the drivers of environmental performance, a positive correlation between environmental performance and literacy levels in the local community, controlling for other determinants, might be interpreted as evidence that more literate communities are more aware of plants' environmental performance and therefore exact greater EMP.

[2] We omit Hettige et al. (1996) because this article summarizes the results of three other papers, two of which are discussed here: Pargal and Wheeler (1996) and Hartman et al. (1997).

## Table 1. Econometric literature on the drivers of environmental performance in developing countries

| *Article* | *Location and sector* | *Scale* | *Data* | *Dependent variable* | *Key independent variables* | *Model* | *Key findings* |
|---|---|---|---|---|---|---|---|
| Aden et al. (1999) | Korea: 3 regions, 2 sectors (textiles, petrochemicals) | Plant | • Cross section<br>• Original survey of 92 manufacturing plants | Pollution abatement expenditure | • Index of community pressure (number of community complaints + number of voluntary agreements signed)<br>• Index of formal regulatory pressure<br>• Plant characteristics | 2-stage least squares (to control for endogeneity of formal regulatory pressure index) | Significant:<br>(+) community pressure index<br>(+) formal regulation index<br>(+) size<br>(+) domestic ownership |
| Blackman and Bannister (1998) | Mexico: 1 city (Cd. Juárez), 1 sector (brickmaking) | Plant | • Cross section<br>• Original survey of 76 plants | Clean fuel adopted? (0/1) | • Trade association membership (0/1)<br>• Location<br>• Ownership characteristics<br>• Plant characteristics | Endogenous switching regression (to control for endogeneity of production costs) | Significant:<br>(+) association membership<br>(+) location |
| Blackman and Kildegaard (2003) | Mexico: 1 city (León), 1 sector (leather tanning) | Plant | • Cross section<br>• Original survey of 145 small-scale plants | 2 clean technologies adopted? (0/1) | • Trade association membership (0/1)<br>• Inspections/year<br>• Plant characteristics | Multivariate probit | Significant:<br>(+) human capital |
| Goldar and Banerjee (2004) | India: 10 watersheds | Community | • Panel<br>• Ambient water quality measures from 106 monitoring stations on 10 rivers over 5 years matched with secondary community-level data | Categorical water quality variable | • Percentage of electorate who voted<br>• Change in literacy during panel<br>• Formal regulatory actions<br>• Controls for determinants of water quality | Ordered probit | Significant:<br>(+) % electorate that voted<br>(+) change in literacy |
| Dasgupta et al. (2000) | Mexico: national, 4 sectors | Plant | • Cross section<br>• Original survey of 236 manufacturing plants | Self-reported compliance (0/1) | • Adoption of environmental management system<br>• Environmental training of workers<br>• Manager with environmental duties<br>• Size<br>• Sector<br>• Human capital | 2-stage least squares (to control for endogeneity of first 3 independent variables listed to left ) | Significant:<br>(+) environmental management system (IV)<br>(+) environmental training (IV)<br>(+) manager with environmental duties (IV) |
| Dasgupta et al. (2001) | Argentina, Chile, Mexico, Philippines: national, multiple sectors | Plant | • Panel<br>• Daily stock returns for 48 publicly traded firms before and after 126 newspaper articles about their environmental performance over 5 years | Daily stock returns | • Market returns | Event study | • Both positive and negative news articles generate abnormal returns<br>• Negative articles generate larger abnormal returns than in industrialized countries |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hartman et al. (1997) | Bangladesh, India, Indonesia, Thailand: national, 1 sector (pulp and paper) | Plant | • Cross section<br>• Original survey of 26 plants | Weighted index of number of pollution control devices adopted | • Plants subjected to citizen complaint or actions? (0/1)<br>• Population (city)<br>• Per capita income (country)<br>• Index of formal regulation (country and city)<br>• Plant size, competitiveness, ownership, process | Ordinary least squares | Significant:<br>(+) pressure dummy<br>(+) income<br>(+) scale<br>(+) competitiveness,<br>(-) public ownership |
| Kathuria (2007) | India: 4 watersheds | Community | • Panel<br>• Monthly ambient water quality measures from 4 monitoring stations on 4 rivers over 5 years matched with secondary community-level data | Chemical oxygen demand | • Informal regulation index (lagged sum of newspaper articles, press releases, and public interest legislations)<br>• Size of regulatory agency monitoring staff regulatory agency<br>• Controls for determinants of water quality | Ordinary least squares | Significant:<br>(+) informal regulation index (for some monitoring stations in some specifications) |
| Pargal and Wheeler (1996) | Indonesia: national, multiple sectors | Plant | • Cross-section<br>• Water pollution emissions for 243 plants matched with secondary county-level data<br>• 1989–1990 | Biological oxygen demand | • Income per capita<br>• Education<br>• Population density<br>• Share of local employment<br>• Foreign ownership | Ordinary least squares | Significant:<br>(-) income per capita<br>(-) share of local employment<br>(-) education in some specifications<br>(+) age plant<br>(-) productivity plant<br>(+) private ownership<br>(-) size |
| Serôa da Motta (2006) | Brazil: national, multiple sectors | Plant | • Cross-section<br>• Survey of 325 manufacturing plants | Weighted index of number of environmental management practices adopted | • Perception that community and regulatory pressure motivated adoption<br>• Regulatory sanctions<br>• Firm characteristics | Ordinary least squares | Significant:<br>(+) perception variables for community and regulatory pressure<br>(+) other proxies for community and regulatory pressure |
| Zhang et al. (2008) | China: 1 county (Wujin, Jiangsu Province), multiple sectors | Plant | • Cross-section<br>• Survey of 89 plants | Weighted index of number of environmental management practices adopted | • Population density<br>• Effluent fee charged<br>• Perception that market pressure motivated adoption | Ordinary least squares | Significant:<br>(+) population density<br>(+) perception of market pressure |

A critical challenge in this literature—and for that matter in all research on environmental management in developing countries—is acquiring data on environmental performance. In most developing countries, credible plant-level environmental performance data simply do not exist. When they do, they are often self-reported and unverified. Also, such data often suffer from selection bias: plants that regularly self-report tend to be superior environmental performers. Given these problems, most studies rely on plant-level environmental performance data from original surveys or from a preexisting special regulatory program targeted at a specific sector or location. In addition, most use information on the adoption of environmental practices in lieu of actual environmental performance data, such as measures of the quality of liquid emissions.

Although collectively, these studies have made valuable contributions to our understanding of the determinants of environmental performance in developing countries, most fall short of convincingly isolating and identifying causal impacts of regulatory and nonregulatory drivers of environmental performance. The main reason is that the independent variables that purport to capture pressures for improved environmental performance are often problematic. There are three related underlying issues. First, many of these pressures are inherently difficult to measure quantitatively, and the proxies that researchers use tend to be blunt and liable to pick up any number of unobserved effects—that is, they are likely to be endogenous. For example, average community income is sometimes used to measure community pressure. Second, most of these pressures have spillover and feedback effects on each other. For example, community complaints incite formal regulatory pressure and vice versa. Finally, feedback effects aside, these pressures are likely to be correlated with the overall level of economic development and social capital and hence with each other. Again, an example is community and regulatory pressure. Given these three problems, isolating and identifying the causal impact of any one type of pressure is challenging, and the interpretation of regression results tends to be somewhat subjective. Specific examples of these challenges are detailed below.

The next subsections consider the studies listed in Table 1 in more detail. The studies fall into three broad categories. The largest category comprises plant-level studies with a broad geographic scope; that is, they cover multiple regions within a country or multiple countries (Aden et al. 1999; Dasgupta et al. 2000, 2001; Hartman et al. 1997; Pargal and Wheeler 1996; Serôa da Motta 2006; and Zhang et al. 2008). Two plant-level studies focus on a single sector and a single city (Blackman and Bannister 1998; Blackman and Kildegaard 2003). Finally, two studies analyze panel data from water quality monitoring stations on river sections downstream from industrial clusters (Goldar and Banerjee 2004; Kathuria 2007). Rather than summarizing

each study individually, we summarize their findings about the drivers of environmental performance that figure most prominently in this literature: communities, regulators, capital markets, consumers, and plant characteristics.

### *3.1. Communities*

Virtually all of the studies in this literature attempt to identify a causal impact of community pressure on environmental performance. The studies use a variety of approaches to do that.

**Average Community Socioeconomic Characteristics**

Goldar and Banerjee (2004), Hartman et al. (1997), Pargal and Wheeler (1996), and Zhang et al. (2008) use average socioeconomic characteristics of the local community to proxy for community pressure. Each of these studies finds that average community characteristics are correlated with environmental performance. In their study of Indonesian water polluters, Pargal and Wheeler (1996) find that average per capita income, education, and the share of the local workforce employed at the plant are correlated with lower emissions of water pollutants. Zhang et al. (2008) find that population density of the local community is positively correlated with Chinese plants' adoption of environmental management practices. In their study of Asian pulp and paper plants, Hartman et al. (1997) find that population of the city and per capita income of the country in which the plant is located are positively correlated with adoption of pollution control practices. Finally, Goldar and Banerjee (2004) find that the percentage of the local electorate that voted and the change in the local literacy rate help explain water quality in river sections downstream from Indian industrial clusters.

One problem with this approach to identifying the effect of community pressure is that average community-level characteristics may pick up any number of unobserved determinants of EMP and MAC, including formal regulatory pressure and plant managers' access to information and expertise about pollution control and prevention. For example, Pargal and Wheeler's finding that plants in wealthier communities emit less water pollution may reflect stronger formal regulatory pressure and/or better access to pollution control equipment and expertise in such communities. The authors do not control for either effect (although they argue that formal regulatory pressure was negligible in Indonesia during the period in question). Another drawback of this approach is that community characteristics may be endogenous if plants' and people's location decisions are related to each other—for example, if relatively dirty plants locate in low-income communities and poor people locate near relatively dirty plants. Studies from developing

countries suggest that real estate markets encourage this type of sorting behavior (Been and Gupta 1997; Smith et al. 2004).

### Membership in a Trade Association or Voluntary Agreement

A second approach to identifying the effect of community pressure is to use plant membership in an association or a voluntary environmental agreement as a proxy. Two of the three studies that use this approach find that community pressure is correlated with environmental performance. In their study of the adoption of clean fuels by small-scale brick kilns in Ciudad Juárez, Mexico, Blackman and Bannister (1998) find that membership in a trade or community association affiliated with a citywide clean fuels initiative helped explain the adoption. Aden et al. (1999) find that the number of voluntary pollution control agreements signed (added to the number of complaints by local communities) is positively correlated with pollution abatement expenditures by Korean manufacturing plants. However, Blackman and Kildegaard (2003) find that membership in a trade association that promoted clean technologies does not help explain the adoption of clean technologies by small-scale tanneries in León, Mexico, a finding they attribute to the longstanding lack of such pressures in this city and to the difficulty of observing the environmental performance of water polluters that discharge into city sewers.

Using participation in associations and voluntary agreements to identify the effect of community pressure also has weaknesses. As in the case of average community characteristics, these variables may pick up unobserved determinants of EMP and MAC. In addition, they may be endogenous if plants with unobserved characteristics associated with better environmental performance (such as the plant manager's skill and environmental awareness) self-select into associations and voluntary agreements.

### Citizen Complaints and Negative Media Reports

A third approach to identifying the effect of community pressure is to proxy for it using a count of citizen complaints or negative newspaper articles about pollution at a given plant or in a given location. All three papers listed in Table 1 that use this approach find that these proxies are positively correlated with environmental performance or quality. In their study of Korean manufacturing plants, Aden et al. (1999) find that the number of complaints by local communities (added to the number of voluntary pollution control agreements signed) is positively correlated with Korean plants' pollution abatement expenditures. Hartman et al. (1997) find that a dichotomous dummy indicating whether the plant was the subject of citizen complaints helps explain Asian pulp and paper plants' use of pollution control devices. And in

his study of water pollution in India, Kathuria (2007) finds that lagged counts of newspaper articles, press releases, and public interest court cases help explain ambient water pollution in four river sections downstream from industrial clusters.

Unfortunately, this approach also has drawbacks. If complaints and newspaper articles incite regulatory actions, it is not clear whether a count of them measures community pressure or formal regulatory pressure or both. As discussed below, although Aden et al. (1999), Hartman et al. (1997), and Kathuria (2007) all control for formal regulatory pressure, these controls may not be adequate. Also, counts of complaints and media reports may be endogenous, since they can depend on the plant's past environmental performance. For example, dirty plants are likely to receive more complaints than clean ones. Aden et al. (1999) and Kathuria (2007) attempt to control for endogeneity by using instrumental variables and lagged independent variables.

**Plant Managers' Responses to Survey Questions**

A fourth approach to identifying the effect of community pressure is to use plant managers' responses to survey questions about the intensity of community pressure. Serôa da Mota (2006) finds that this proxy for community pressure helps explain adoption of environmental management practices, but Dasgupta et al. (2000) find that it does not. Such responses also may be endogenous, since they can depend on the plant's past environmental performance. For example, the manager of a plant with a history of superior environmental performance is unlikely to report that community pressure is strong.

### *3.2. Regulators*

Although most of the studies listed in Table 1 focus on informal regulatory pressure, most also include measures of formal regulatory pressure as controls. Virtually all of the studies find these measures are positively correlated with environmental performance, implying that formal regulatory pressure drives environmental performance in developing countries despite

conventional wisdom that such pressure is typically lax. The studies use two main approaches to identify the effect of formal regulatory pressure.[3]

**Inspections and Sanctions**

A plurality of studies use a count of regulatory inspections and/or sanctions as a proxy. All but one find that these variables are correlated with environmental performance. Aden et al. (1999) find that a weighted index of inspections and sanctions—for which they instrument to control for possible endogeneity—is positively correlated with Korean manufacturing plants' pollution abatement expenditures. Goldar and Banerjee (2004) find that a count of formal regulatory actions in Indian industrial clusters is weakly correlated with downstream river water quality. Dasgupta et al. (2000) find that a dichotomous dummy variable indicating that a plant has been inspected is correlated with the adoption of environmental management practices. And Serôa da Motta (2006) finds that a count of regulatory sanctions is positively correlated with the adoption of environmental management practices by Brazilian plants. Only Blackman and Kildegaard (2003) present a negative result. They find that the number of scheduled monthly inspections that were actually carried out is not correlated with adoption of clean technologies by Mexican leather tanneries, a result they attribute to the absence of real formal regulatory pressure for their study plants.

The drawback of using counts of inspections and/or sanctions as a measure of formal regulatory pressure is potential endogeneity. Relatively dirty plants are apt to be inspected and sanctioned more often than clean ones. For this reason, most studies that focus on identifying the effect of inspections and sanctions use an instrumental variables approach (Shimshack and Ward 2005). Of the above-mentioned researchers, only Aden et al. (1999) do that.

[3] Several studies adopt idiosyncratic approaches to measuring formal regulatory pressure, with differing results. Kathuria (2007) uses size of local environmental regulatory staff and finds it helps explain ambient river water quality in river sections downstream from industrial clusters in some regression specifications but not others. Zhang et al. (2008) find that effluent fees paid by Chinese manufacturing plants helps explain their environmental performance. Finally, Blackman and Bannister (1998) find that simple awareness of a city regulation governing brick kilns does not help explain adoption of clean fuels. Both of the two significant measures may be endogenous: dirtier Indian industrial clusters could spur regulators to increase staff size, and dirty Chinese plants would pay more effluent fees than clean ones.

**Plant Managers' Responses to Survey Questions**

Two studies use plant managers' responses to survey questions to proxy for intensity for formal regulatory pressure (Dasgupta et al. 2000; Hartman et al. 1997). Both find a positive correlation with environmental performance. This approach has the same drawback noted in the previous section on community pressure: responses may be endogenous.

### *3.3. Capital Markets*

Two of the studies in Table 1 include variables that proxy for pressures applied by equity markets. Both suggest that such markets can influence plants' environmental performance in developing countries. Dasgupta et al. (2000) find that Mexican firms that are publicly traded are more likely to adopt environmental management practices. The implication is that shareholders pressure plants to improve environmental management. Dasgupta et al. (2001) provide evidence to support this hypothesis. The authors use event study methods to identify the impact of positive and negative newspaper coverage of the environmental performance on stock returns of 48 publicly traded firms; that is, they use panel data on daily stock returns and test for abnormal returns in a window of days before and after a positive or negative newspaper article. They find that both positive and negative news articles generate significant abnormal returns. Moreover, negative articles generate much larger abnormal returns than in industrialized countries—4 percent to 15 percent for articles pertaining to complaints about pollution—a finding they attribute to the greater volatility of developing country stock markets, and to their lack of information about environmental performance. Hence, this study suggests that developing country stock markets sanction poor environmental performers and reward good performers. The implicit but untested assumption is that these sanctions and rewards spur subsequent improvements in environmental performance. As noted in the Appendix, this assumption has been supported in the case of U.S. firms that submit Toxic Release Inventory (TRI) reports to the US Environmental Protection Agency (Konar and Cohen 1997). To my knowledge, however, such tests have yet to be conducted for developing country firms participating in public disclosure programs.[4]

[4] Two other articles in Table 1 include shed light on the role of capital markets. Hartman et al. (1997) find that Asian pulp and paper plants that received foreign donor financing were no more likely to be clean than plants that did not. And Serôa da Motta (2006) finds that Brazilian plants that received subsidized credit were more likely to adopt environmental management practices than plants that did not.

### *3.4. Consumers*

Two of the studies in Table 1 include regressors related to consumer pressure. Dasgupta et al. (2000) and Serôa da Motta (2006) test the effect on Mexican and Brazilian manufacturing plants' environmental performance of exporting to countries in the Organization for Economic Co-operation and Development (OECD). Somewhat surprisingly, both fail to find a correlation.

### *3.5. Plant Characteristics*

Finally, virtually all of the studies in Table 1 test for the effect on environmental performance of plant characteristics, including size, vintage, ownership, productivity, human capital, and economic sector. These characteristics affect both EMP and MAC.

#### Size

Nine of the studies test for the effect of plant size on environmental performance, and all but one find that larger firms are cleaner.[5] The one negative result (Blackman and Bannister 1998) stems from the fact that size variation in the study sector (traditional brickmaking) is limited. Plant size could proxy for factors that affect MAC, such as economies of scale in pollution control and prevention, and EMP, such as the plant's impact on the environmental and its visibility.

#### Ownership

Most of the studies test for the effect on environmental performance of various types of ownership. The results contradict conventional wisdom that foreign-owned plants and multinational plants are relatively clean, but they confirm the common view that state-owned plants are relatively dirty. Aden et al. (1999) find that foreign ownership is negatively correlated with Korean plants' expenditures on pollution abatement, and Pargal and Wheeler (1996) find that it does not affect Indonesian plants' emissions of water pollutants. Dasgupta et al. (2000), Hartman et al. (1997), and Serôa da Motta (2006) all find that multinational status does not help explain environmental performance. Finally, Hartman et al. (1997) and Pargal and Wheeler (1996) find that state-owned enterprises tend to be dirtier than privately owned plants.

[5] Measures of plant size include the number of employees (Aden et al. 1999; Dasgupta et al. 2000; Hartman et al. 1997; Serôa da Motta 2006), output (Blackman and Bannister 1998; Blackman and Kildegaard 2003; Pargal and Wheeler 1996), and assets (Zhang et al. 2008).

### Human Capital

Blackman and Bannister (1998), Blackman and Kildegaard (2003), and Dasgupta et al. (2000) all include measures of employee education, and all find that it is positively correlated with environmental performance. Human capital could proxy for MAC, since plants with educated workers presumably pay lower costs to adopt abatement practices, and/or for EMP, since such workers may pressure managers to improve environmental performance.

### Productivity and Competitiveness

Four studies use regressors that measure productivity or competitiveness, including sales per employee (Aden et al. 1999), a dichotomous competitiveness dummy generated from a survey of the plant manager (Hartman et al. 1997), value added per worker (Pargal and Wheeler 1996), and ratio of net income to total assets (Zhang et al. 2008). The first three of these studies suggest that more productive and competitive plants are relatively clean.

### Vintage and Sector

Aden et al. (1999), Dasgupta et al. (2000), Hartman et al. (1997), and Pargal and Wheeler (1996) test for the effect of plant vintage on environmental performance, and somewhat surprisingly, all find that it has no discernible impact. Finally, of the three studies that include sector dummies in environmental performance regressions (Dasgupta et al. 2000; Pargal and Wheeler 1996; Serôa da Motta 2006), two find that they are significant (Pargal and Wheeler 1996; Serôa da Motta 2006).

## 4. Public Disclosure

Public disclosure—the regular collection and dissemination of information about firms' environmental performance—has been characterized as the "third wave" in environmental regulation, after command-and-control and market-based approaches (Tietenberg 1998). Its growing popularity is partly due to evidence, briefly summarized in the Appendix, that public disclosure programs in industrialized countries have caused plants to cut their emissions. Perhaps just as important, public disclosure seems to impose a relatively light burden on the public sector, particularly environmental regulators and legislators. It does not necessarily require an effective enforcement capability or a well-defined set of environmental regulations. The costs of the administrative activities it does require—data collection and dissemination—appear to be falling because of new information technologies. As a result, public disclosure is being touted as a means of circumventing constraints on conventional environmental regulation in developing

countries, including weak regulatory institutions and incomplete written regulations (World Bank 2000; Dasgupta et al. 2007).

As discussed below, empirical research on the means by which public disclosure spurs improved environmental performance is limited. In principle, however, it may have two types of impacts. First, it may leverage the external pressures discussed in the previous section—namely, those applied by regulators, communities, consumers, and shareholders. For example, public disclosure may inform local communities and consumers about the severity of a plant's pollution, which in turn may cause the former to organize protests and the latter to switch to other suppliers. In terms of our heuristic model, disclosure shifts the EMP schedule up. Second, public disclosure may convey new information about pollution and abatement opportunities to plant managers and owners. In developing countries where formal regulatory pressure is limited, plant managers and owners may not have incentives to invest in collecting and analyzing such information, and public disclosure may actually facilitate that. In terms of our heuristic model, public disclosure may shift MAC down.[6]

Two types of national public disclosure programs have emerged over the past two decades (Dasgupta et al. 2007). So-called pollutant release transfer registries simply report emissions or discharge data without using them to rate or otherwise characterize environmental performance. More than 20 countries, including Chile and Mexico, have set up such registries or are in the process of doing so.[7] Like TRI, most focus on toxic pollutants not covered by conventional regulations. To my knowledge, an evaluation of a developing country's pollutant release transfer registry has yet to appear.

The second type of national public disclosure program uses emissions data to rate plants' environmental performance. As far as I know, these environmental performance ratings programs are confined to developing countries and focus mostly on conventional pollutants. Examples include Indonesia's Program for Pollution Control, Evaluation, and Rating (PROPER), which was the first such program to appear and is the best known; India's Green Rating Project (GRP); the Philippines' EcoWatch program; China's GreenWatch program; Vietnam's Environmental Information Disclosure System (EIDS); and South Korea's monthly Violations

[6] See Blackman et al. (2004) for a simple analytical model of public disclosure.

[7] Countries that have at least the inception of a web-accessible pollution release transfer registry include Austria, Australia, Canada, Chile, the Czech Republic, Denmark, England, France, Germany, Hungary, Italy, Japan, Mexico, the Netherlands, Norway, Scotland, South Korea, Spain, and Sweden (Dasgupta et al. 2007; Kerret and Gray 2007).

Report (MVR) program. These programs use a few broad performance rating categories based on plants' compliance with environmental regulations. Typically, the categories are flagrant violation, noncompliant, compliant, and beyond compliant. South Korea's MVR program is an exception. Each month, it simply releases a list of firms found to be in violation of environmental regulations.

As public disclosure programs have proliferated in developing countries over the past two decades, environmental economists have begun to evaluate them (Table 2). Their studies have addressed two broad questions. Do these programs cause plants to improve their environmental performance? If so, how and under what conditions? The next two subsections briefly summarize the findings from this research.

## Table 2. Empirical Literature on Public Disclosure Programs in Developing Countries

| *Article* | *Location, program, scope, sector* | *Data* | *Focus question* | *Dependent variable* | *Key independent variables* | *Model* | *Key findings* |
|---|---|---|---|---|---|---|---|
| Blackman et al. (2004) | Indonesia PROPER: national, multiple sectors | • Cross-section<br>• Original survey of 146 plants<br>• Participants only | How do ratings create incentives for improved environmental performance? | N/A | N/A | Summary statistics from survey data | Good ratings improve plant managers' information about own plants' pollution and abatement; chances of ISO 14001 certification; market value; and relationship with regulators |
| Dasgupta et al. (2006) | South Korea MVR: national, multiple sectors | • Panel<br>• Daily stock returns for 57 publicly traded firms before and after 87 newspaper articles over 8 years | Does release of lists in news media affect value of rated firms' stocks? | Daily stock returns | Market returns | Event study | Announcement of noncompliance leads to large abnormal returns |
| Dasgupta et al. (2007) | • Indonesia PROPER: national, multiple sectors<br>• Philippines EcoWatch: national, multiple sectors<br>• Vietnam EIDS: 1 city, multiple sectors<br>• China Green Watch: 2 cities, multiple sectors | • Panel<br>• For each program, ratings in 2 years | Do ratings affect environmental performance of participating plants? What are opportunities for and challenges facing programs? | No statistical analysis | No statistical analysis | No statistical analysis | Ratings have coincided with higher rates of compliance among participating plants in Indonesia and Philippines; evidence suggests causality |
| García et al. (2007) | Indonesia PROPER: national, multiple sectors | • Panel<br>• Monthly water pollution emissions for 135 plants in various sectors over four years<br>• Participants and nonparticipants | Do ratings affect environmental performance of participating plants? | Monthly BOD and COD emissions | • Lagged rating dummies<br>• Sectoral emissions trend<br>• Self-report dummy<br>• Plant fixed effects | Ordinary least squares | Ratings had significant impact on emissions for noncompliant plant in short run and for all plants in long run |
| García et al. (2009) | Indonesia PROPER: national, | • Panel<br>• Changes in PROPER ratings | What types of participating plants are most | Change in ratings variable (improvement, | • Initial rating<br>• Size<br>• Ownership | Ordered logit | Improvement was more likely for plants with low initial ratings and |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | multiple sectors | of 145 plants in various sectors over 2 years<br>• 3 ratings<br>• Participants and nonparticipants | likely to improve? | no change, decline) for 12 25-month periods | • Sector<br>• Population density around plant | | foreign ownership |
| Gupta and Goldar (2005) | India GRP: national, multiple sectors | • Panel<br>• Daily stock returns for 50 publicly traded participant firms before and after each rating | Does public release of ratings affect value of rated firms' stocks? | Daily stock returns | • Market returns | Event study | Announcement of low rating leads to large abnormal returns |
| Powers et al. (2008) | India GRP: national, 1 sector (pulp and paper) | • Panel<br>• Annual average emissions of water pollutants for 22 plants over eight years<br>• Participants and nonparticipants | Do ratings affect environmental performance of participating plants? | Annual average COD and TSS emissions | • Postrating dummy (0/1)<br>• Initial rating<br>• Time trend<br>• Scale<br>• Composition of output<br>• Prices of inputs<br>• Community wealth<br>• Plant fixed effects | Ordinary least squares | Ratings had significant impact on emissions for plants with low initial ratings and in wealthier communities |
| Wang et al. (2003) | China Green Watch: 2 cities, multiple sectors | • Panel<br>• GreenWatch ratings of 200 plants in 2 cities | Do ratings affect environmental performance of participating plants? | No statistical analysis | No statistical analysis | No statistical analysis | Program has coincided with higher rates of compliance among participating plants |

BOD = biological oxygen demand
COD = chemical oxygen demand
EIDS = Environmental Information Disclosure System
GRP = Green Ratings Project
MVR = Monthly Violations Reports
PROPER = Program for Pollution Control, Evaluation and Rating
TSS = total suspended solids

### *4.1. Does Public Disclosure Have an Impact?*

As discussed above, the best-known public disclosure initiatives in developing countries are environmental performance evaluation and ratings programs. Several studies have sought to determine whether these programs have had measurable environmental benefits. All find that they have—but mainly, and in some cases exclusively, among plants with poor initial environmental performance. This finding makes intuitive sense. All other things equal, MAC of poorly performing plants is likely to be relatively low, since they have yet to exploit low-cost abatement options. Also, for such plants, public disclosure may result in the greatest increase in EMP, since communities, capital markets, regulators, and other stakeholders presumably impose the highest penalties on the worst performers.

Dasgupta et al. (2007) present simple summary statistics on changes over time in the performance ratings of plants participating in four of the programs mentioned above: Indonesia's PROPER, the Philippines' EcoWatch program, Vietnam's EIDS, and China's GreenWatch program (in two pilot cities, Hohot in Inner Mongolia and Zhenjiang in Jaingsu Province).[8] For each program, they find that plants whose performance rating improved over time tended to be those with the lowest initial rating—those in the flagrant violation or noncompliant categories. To make information on changes in ratings across programs comparable, the authors aggregate performance categories into two broad classes: compliant and noncompliant. They find that

> After implementation of performance ratings, the compliance rate increases by 24% in Indonesia, 50% in the Philippines, 14% in Vietnam, 10% in Zhenjiang, China (from a high base), and 39% in Hohot, China. In light of the evident regulatory problems in all four countries, these improvements suggest that performance ratings had a very significant effect on polluters. … After nearly a decade of implementation, environmental performance ratings appear to have had a significant, consistently positive impact on regulatory compliance in several large Asian countries. (103–104)

[8] Wang et al. (2004) provides a more detailed but still primarily qualitative analysis of the Chinese GreenWatch pilot projects.

Two important caveats are in order, however. First, the statistics that Dasgupta et al. (2007) report are from pilot or early program phases that involved relatively small samples.[9] Second, and perhaps more important, as Dasgupta et al. (2007) point out, without any type of baseline or control group, it is not possible to attribute observed changes in compliance status to the ratings programs. They may have resulted from any number of concurrent factors, including ratcheting up of formal regulatory pressure and the diffusion of clean technologies.

In their study of the impact of Indonesia's PROPER program, García et al. (2007) attempt to control for such concurrent factors. Using four years of monthly water pollution data from 145 plants, they analyze changes in biological oxygen demand (BOD) and chemical oxygen demand (COD) emissions before and after PROPER ratings for a treatment sample of plants that were rated and a control sample of plants that were not. They control for sectoral trends in emissions, plant fixed effects, and whether emissions data were self-reported or measured. They find that PROPER ratings spurred significant improvements in environmental performance, for both noncompliant and compliant plants, but that noncompliant plants improved faster. The authors estimate that PROPER caused plants that were initially noncompliant to reduce their emissions by 32 percent.

Finally, Powers et al. (2008) use eight years of annual data to identify the impact of India's GRP on emissions of COD and total suspended solids (TSS) from the country's 22 large-scale pulp and paper plants. Unlike the other programs discussed above, GRP is run by an environmental nongovernmental organization (the Center for Science and the Environment) rather than a state regulatory agency. Lacking a control group (because all large pulp and paper plants were rated), the authors use detailed cross-sectional and panel data to control for factors other than public disclosure that may have affected emissions. They estimate that GRP ratings caused plants with poor initial performance ratings to reduce their COD emissions by 9 percent and their TSS emissions by 19 percent. However, the GRP had no impact on the environmental performance of plants that had good initial ratings.

[9] The Indonesian PROPER statistics are for changes in ratings between 1995 and 1997 for a group of 147 plants rated in 1995, out of hundreds more that were eventually rated. The Philippines EcoWatch statistics are for changes in ratings between 1997 and 1998 for roughly 50 plants involved in a pilot phase. The EIDS statistics are for changes in ratings between 2001 and 2002 for 50 plants. Finally, the Chinese GreenWatch statistics are for changes in ratings between 1999 and 2000 for 91 plants in Zhenjian and 56 plants in Hohot.

### *4.2. How Does Public Disclosure Have an Impact?*

Several studies have focused on understanding how publicly disclosed ratings cause plants to improve their environmental performance (Blackman et al. 2004; Dasgupta et al. 2006; García et al. 2009; Gupta and Goldar 2005; Powers et al. 2008). They suggest that disclosure both lowers plants' MAC and raises their EMP, particularly penalties applied by shareholders.

Blackman et al. (2004) report summary statistics from an original survey that asked managers of 146 Indonesian plants rated by PROPER to rank the importance of various means by which the ratings created incentives for improved environmental performance, including enhancing pressures generated by communities, regulators, and consumers. The results suggest that a primary means by which PROPER spurs abatement is improving plant managers' information about their own plants' emissions and abatement opportunities, a finding that contrasts with the prevailing view that public disclosure enhances pressure from external agents, such as community groups and shareholders.[10]

García et al. (2009) aim to identify the characteristics of plants participating in PROPER whose ratings improved following a rating. The characteristics they consider include the plant's initial rating, ownership, sector, and the population density of the community in which it located. Hence, the explanatory variables are quite similar to those used in the "direct pressures" econometric studies discussed in the previous section. The authors find that plants that improved tended to be those with a low initial rating and those that were foreign owned. In addition, in the short run, plants in densely populated communities were more likely to improve.

Two studies examine the impact of public disclosure of performance ratings on the value of stocks of publicly held firms. Like Dasgupta et al. (2001), both use event study methods. Gupta and Goldar (2005) examine the impact of GRP rating on the stock returns of 50 Indian firms in the pulp and paper, automotive, and chlor alkali sectors. They find that firms that received poor GRP ratings experienced abnormal negative returns. Moreover, these abnormal returns were large—up to 30 percent in some sectors. Dasgupta et al. (2006) examine the impact in South Korea of the release of MVR lists reporting noncompliance on the stock returns of 57 publicly traded firms. They find that most MVR violations were not reported in the media, but

[10] The authors also find that PROPER's "environmental audit" effect operates in concert with external pressures from shareholders, banks, regulators, ISO14001 certifiers, and courts. Moreover, the importance of these external pressures depended upon the plants' initial environmental performance, with poorly ranked plants emphasizing pressure from regulators and courts.

those that were reported led to abnormal negative returns that averaged 10 percent. Together, these two studies suggest that public disclosure may affect publicly traded plants through capital markets. Although the studies show that stock markets sanction plants revealed to be poor performers, they do not show that these sanctions spur subsequent improvements in environmental performance.

## 5. Voluntary Regulation

Regulatory policies involving voluntary commitments to improve environmental performance include environmental agreements negotiated between regulators and industry, public programs (administered by regulators or third parties) that individual firms are invited to join, and unilateral commitments made by firms (Lyon and Maxwell 2002). In industrialized countries, such voluntary regulation has become quite popular (OECD 1999, 2003). Less well known is that environmental authorities in developing countries, particularly those in Latin America, also have embraced this approach and are rapidly putting initiatives in place. For example, over the past decade, regulators in Colombia, Chile, and Mexico have negotiated dozens of high-profile voluntary "clean production" agreements with dirty industrial sectors (Blackman et al. 2009; Jiménez 2007; Blackman and Sisto 2006).

Although the economics literature on voluntary regulation in industrialized countries in now substantial (see the Appendix for a brief summary), economists are just beginning to evaluate such regulation in developing countries. The remainder of this section briefly summarizes these evaluations, focusing first on negotiated voluntary agreements (VAs) and then on public programs (Table 3). To make the exposition manageable, research on unilateral voluntary commitments is not considered (for reviews, see Utting 2002 and Sarkar 2008). We focus on the two broad questions: Did voluntary regulation improve environmental performance? And what drove participation in the initiatives?

## Table 3. Empirical Literature on Voluntary Regulation in Developing Countries

| *Article* | *Location and sector* | *Type of voluntary regulation* | *Data* | *Focus question* | *Dependent variable* | *Key independent variables* | *Model* | *Key findings* |
|---|---|---|---|---|---|---|---|---|
| Blackman and Sisto (2006) | Mexico: 1 city (León), 1 sector (tanning) | Negotiated agreement | Qualitative data from interviews and secondary sources | Why was voluntary agreement used? How have they preformed and why? | N/A | N/A | Qualitative case study of 4 consecutive agreements | Voluntary regulation used because requisites of mandatory regulation lacking; negotiated agreements had little impact on environmental performance |
| Blackman et al. (2007) | Mexico: national, multiple sectors | Public program (voluntary audit) | • Panel<br>• Secondary data on 60,000+ plants over 12 years | What drove participation? | Participation (0/1) | • Regulatory inspections and fines<br>• Plant characteristics | Duration model | Inspections and fines drove program participation |
| Blackman et al. (2009) | Colombia: national, 6 sectors | Negotiated agreements | Qualitative data from interviews and secondary sources | Why were voluntary agreements used? How have they preformed and why? | N/A | N/A | Qualitative case studies of 6 agreements in 6 sectors | Voluntary regulation used because requisites of mandatory regulation lacking; negotiated agreements had little impact on environmental performance but helped build regulatory capacity |
| Christmann and Taylor (2001) | China: national, multiple sectors | Public program (ISO 14001) | • Cross-section<br>• Original survey of 101 firms | What drove participation? | Self-reported likelihood of future ISO 14001 | • Multinational status<br>• Export to industrialized countries (0/1)<br>• Size | Ordinary least squares | Participation correlated with multinational status, exporting to industrialized countries, and size |
| Dvorák et al. (2002) | Czech Republic: national, 2 sectors (packaging, phosphates) | Negotiated agreements | Qualitative data from questionnaire and secondary sources | Why were voluntary agreement used? How have they preformed and why? | N/A | N/A | Qualitative case studies of 2 agreements in 2 sectors | Regulators used negotiated agreements to avoid costs/delays of mandatory rules; ambiguous impacts on environmental performance |
| Freitas and Gereluk (2002) | Brazil: national, 1 sector (petrochemicals) | Negotiated agreement | Qualitative data from interviews and secondary sources | Why were voluntary agreement used? How have they preformed and why? | N/A | N/A | Qualitative study of 1 national agreement in 1 sector | Industry agreed to voluntary rules to avoid strict mandatory rules; agreements coincided with improvements in environmental performance |
| Hu (2007) | China: 1 province (Shandong), 2 | Negotiated agreements | Qualitative | Why were voluntary agreement used? | N/A | N/A | Qualitative study of 2 negotiated agreements meant | National government pressure drove agreements; ambiguous |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | companies (iron, steel) | | | How have they preformed and why? | | | to be pilots for national program | impact on environmental performance |
| Jiménez (2007) | Chile: national, 4 sectors (chemical effluents, chemical packaging, foudries, sawmills, swine) | Negotiated agreements | • Cross section<br>• Original survey of 322 plants including adoption of environmental management practices<br>• Participants and nonparticipants | What factors drove participation? Did voluntary agreements improve participants' environmental performance? | • Participation<br>• Adoption of environmental management practices | • Membership in trade association<br>• Size<br>• Profitability | Propensity score matching (to control for self-selection into agreements) | Membership in trade association, plant size, and profitability drove participation; participation had significant impacts on environmental performance |
| Rivera (2002, 2004) | Costa Rica: national, 1 sector (hotels) | Public program (sustainable hotels) | • Cross section<br>• Original survey of 164 hotels | What drove participation? Did participation drive higher room rates? | • Participation (0/1)<br>• Room rates and sales | • Government monitoring<br>• Trade association membership<br>• Location near park | Heckman selection model (to control for selection into program) | Participation correlated with government monitoring, trade association membership, and location near park; participation did not drive higher room rates and sales |
| Roht-Arriaza (1997) | 18 members of Asia Pacific Economic Cooperation (APEC) | Public program (ISO 14001) | Qualitative | What is potential of ISO 14001 to improve environmental performance in APEC? | N/A | N/A | Qualitative | In isolation, ISO 14001 certification is unlikely to lead to significant improvements |

### *5.1. Negotiated Voluntary Agreements*

Recently, case studies have been published of VAs in Chile, Mexico, Colombia, China, the Czech Republic, and Brazil. Among these, only the case study of Chile provides clear evidence of a positive environmental impact. Case studies of Mexico and Colombia suggest that VAs have not had environmental benefits, and those of China, the Czech Republic, and Brazil are inconclusive. However, the Colombian experience suggests that even if VAs have not had environmental benefits, they may have helped build capacity for environmental management.

Jiménez (2007) analyzes Chile's use of sector-wide negotiated VAs involving hundreds of firms in a variety of sectors, the result of a 2001 national policy aimed at improving both compliance with mandatory regulation and international competitiveness of Chilean industry. The negotiated agreements complemented a reasonably effective mandatory regulatory system and included specific environmental performance targets, clear deadlines, third-party monitoring, sanctions for noncompliance, and pollution abatement subsidies. Jiménez uses detailed survey data from 322 plants (both VA participants and nonparticipants) along with policy evaluation techniques (propensity score matching) to identify the drivers of participation in Chile's first five VAs and to compare the environmental performance of participating plants with that of similar plants that did not participate. He concludes that compared with nonparticipants, participants were more likely to be large, profitable, and members of trade associations. Moreover, he finds that VAs did in fact spur improved environmental performance, additional to what would have taken place absent the VAs.

Blackman and Sisto (2006) reach a very different conclusion in their qualitative evaluation of a series of four VAs between Mexican regulatory authorities and trade associations representing the leather tanning sector in León, Guanajuato. The authors argue that regulators resorted to voluntary agreements because, as discussed in the introduction, the requisites of mandatory regulation, including written regulations and oversight institutions, were lacking. Spanning 1987 to 2000, the four agreements focused on filling these legal and institutional gaps as well as improving environmental performance. Although the VAs were technically nonbinding "gentlemens' agreements," many of the commitments amounted to promises to comply with mandatory regulations, albeit unclear and incomplete ones. The authors find that the VAs' signatories abrogated virtually of their commitments, and as a result, the agreements had very little if any environmental impact. Although regulatory capacity improved significantly during the 13-year period covered by the VAs, it is not clear whether the VAs or the independent evolution of institutions and law was responsible.

Blackman et al. (2009) evaluate the use of VAs in Colombia, where national and local regulatory authorities signed more than 50 agreements with a variety of economic sectors starting in the mid-1990s. The authors find that regulators and industry had strong incentives to negotiate voluntary agreements after a sweeping new environmental law in 1993 created mandates that regulators lacked the capacity to implement, and industry the capacity to comply with. For example, the new law required new facilities to develop environmental management plans and acquire environmental licenses. But regulators lacked sector-specific technical information needed to evaluate the plans. The result was costly delays in new investments in critical sectors such as petroleum exploration and electricity generation. The authors argue that both regulators and industry saw VAs as means of reducing uncertainty about, building capacity for, and managing a transition to a new regulatory regime. As for environmental impact, the authors find that the vast majority of VAs signed had no discernible environmental benefits. Even in a sample of six VAs reputed to be particularly successful, the environmental advances that did occur were mainly driven by factors other than the VA. The authors find that the VAs' most important benefit has been to help build capacity in both regulatory institutions and the private sector.[11]

Hu (2007) presents a qualitative evaluation of Chinese VAs with two iron and steel companies in Shandong Province. The agreements were pilots for a national policy adopted in 2003 that established guidelines for using VAs to promote cleaner production. The three-year agreements aimed at enhancing energy efficiency and included commitments to meet hard performance targets, establish new management systems, and issue periodic progress reports. The authors maintain that virtually all of these commitments were kept. However, they argue that the pilot projects cannot necessarily be scaled up, for several reasons: national government pressure, not local pressure, was the main driver of the experiment; involvement of sector associations was minimal; the two companies that participated were selected specifically for their superior environmental performance; requisite environmental performance data were scarce; and complementary environmental policies were lacking.

Finally, Dvorák et al. (2002) and Freitas and Gereluk (2002) present case studies of voluntary agreements intended to preempt more stringent mandatory regulations. Dvorák et al. analyze a 1995 agreement between the Czech Republic's Ministry of the Environment and a

[11] See Kerret and Tal (2005) for a discussion of VAs and capacity building.

national trade association of washing powder producers that was used by the trade association to head off mandatory rules on phosphate content. The targets set under the agreement were relatively lax, and the authors conclude that as a result, the agreements probably had few environmental benefits. Freitas and Gereluk evaluate a 1995 Brazilian agreement negotiated among the national government, representatives of industry, and labor unions to limit workplace exposure to benzene, a carcinogen. The agreement revamped an unrealistic 1994 regulation that mandated zero exposure: it set less stringent industry-specific standards, established rules for handling and storing benzene, and set up monitoring procedures. According to Freitas and Gereluk, notwithstanding some shortcomings, investment in benzene abatement increased, and benzene exposure and the incidence of benzene-related occupational illness have both declined significantly since the agreement was signed.

### *5.2. Public Programs*

Public voluntary programs set environmental performance criteria that firms are invited to meet. They typically provide participants with some type of public recognition, subsidy, or reward. In developing countries, such programs are less common than VAs, and as a result, case studies, particularly quantitative evaluations, are rare. Moreover, because environmental performance data are scarce, rigorous evaluations of the environmental impact of voluntary programs are particularly rare. Most quantitative studies of public programs simply focus on identifying the drivers of participation.

Of the handful of case studies that have appeared, none provide clear evidence that public programs have had an environmental benefit. Evidence on the drivers of participation echoes the findings from the industrialized country literature. Researchers find that participation is driven by a background threat of formal regulation, green consumerism, trade association membership, and plant characteristics.

Blackman et al. (2007) offer a rare quantitative evaluation of the environmental impact of a public program. The authors examine Mexico's Clean Industry program, the country's flagship voluntary regulatory initiative. The program provides temporary enforcement amnesty for firms that voluntarily submit to an environmental audit by a certified third-party inspector. In addition, it provides public recognition and a second temporary amnesty for firms that correct all regulatory violations that the audit identifies. The authors use plant-level data on more than 60,000 facilities to identify the drivers of participation in the program and its impact on subsequent compliance. They find that plants that were inspected and fined for regulatory violations were more likely to subsequently join the program (as were those that sold their goods

in overseas markets and to government suppliers, used imported inputs, and were relatively large), which suggests that dirty firms, not just already clean ones, participated. The authors also find that participants were less likely to subsequently violate environmental regulations than a matched sample of nonparticipants. Therefore, the program does appear to have a significant environmental impact.

Rivera (2002, 2004) uses original survey data on 164 hotels to analyze Costa Rica's Certification for Sustainable Tourism, a voluntary program that sets environmental standards for hotels. He finds that government monitoring, trade association membership, and orientation toward green customers (proximity to a national park) drove participation. Furthermore, he finds that only participating hotels with particularly good environmental performance were rewarded with higher room prices and more customers, suggesting that poorly performing participants were not able to free-ride on the investments of other participants.

Finally, several papers examine International Standards Organization (ISO) 14001 certification, a voluntary program that requires participating plants to identify their negative environmental impacts, establish goals for reducing them, and design an environmental management plan to meet these goals. Christmann and Taylor (2001) examine the self-reported "future likelihood" of attaining ISO 14001 certification in a sample of more than 100 Chinese firms. They find that firms that were owned by or sold their products to multinationals and developed countries were more likely to be certified. Roht-Arriaza (1997) examines the potential for ISO 14001 certification to generate significant improvements in environmental performance in the 18 countries that belong to the Asia-Pacific Economic Cooperation. She concludes that in isolation, this voluntary program is unlikely to lead to such improvements because it requires firms only to adopt management procedures, not to meet performance standards, and has weak information, reporting, and accreditation requirements.

## 6. Conclusion

This article has reviewed three strands of the economics literature on pollution control in developing countries. The first strand examines various pressures for improved environmental performance in developing countries, and the second and third analyze policy innovations reputed to leverage these pressures—public disclosure and voluntary regulation. This last section briefly summarizes the findings of this review and then considers the implications for policy and future research.

### *6.1. Summary*

The first strand of literature focuses on econometrically identifying the impacts of various pressures. Virtually every study in this literature claims to have identified the effects of pressures applied by local communities and regulators. In addition, one article presents evidence that stock markets penalize poor environmental performers but does not show that such penalties spur plants to improve their performance. Finally, these studies suggest that certain types of plants—those that are relatively large and productive, privately owned, and that employ more educated staff—tend to be cleaner, and provide a number of hypotheses for why these correlations are observed.

Although this set of articles certainly suggest that nonregulatory pressures have a significant effect on plants' environmental performance in developing countries, in my opinion, they do not provide conclusive evidence. This is partly because of the inherent difficulty of trying to disentangle and identify these pressures—most resist measurement, have spillover effects on each other, and are correlated with overall economic development. It is also partly because of the data and methodological limitations of some studies. A third factor is a suspicion that positive results tend to be published but negative ones do not.

As for the literature on public disclosure, a handful of studies have examined environmental performance ratings programs in Asia to determine whether and how the programs alter abatement decisions. They show that after environmental performance ratings are released, many plants that were not in compliance with written regulations subsequently achieved compliance. The only two rigorous econometric studies of this phenomenon suggest the effect was causal: disclosure caused dirty (but not clean) plants to clean up. There is less consensus on how public disclosure had this effect. Although most analysts hypothesize that public disclosure enhanced expected marginal penalties applied by regulators, communities, shareholders, and others, at least one study suggests a different mechanism: disclosure lowered marginal abatement costs by providing new information about pollution and abatement opportunities to plant managers. Other studies indicate that shareholder pressure may be important. They show that disclosure of poor performance resulted in significant dips in publicly traded plants' stock value. But again, research has yet to show that these dips spurred improved environmental performance.

Like the literature on public disclosure in developing countries, that on voluntary regulation is thin. The overall findings about impacts on environmental performance are less encouraging, however. Of half a dozen case studies, only two—of negotiated agreements in

Chile and a public program in Mexico—finds that a voluntary initiative had a significant impact on participants' environmental performance. One other study finds that voluntary initiatives had little or no environmental benefit, and three are inconclusive. A study of Colombian experience suggests that voluntary agreements helped build much-needed environmental management capacity, however. In addition to assessing environmental impacts, this literature also examines the drivers of participation. The available evidence suggests that green consumerism, trade association membership, and a background threat of formal regulation spur participation—all findings that echo industrialized country research.

### *6.2. Policy and Research Implications*

What are the broad policy implications of the research findings summarized above? Of the two categories of innovative environmental policies discussed in the literature—public disclosure and voluntary regulation—research to date indicates the former is more promising. But it is probably too early to conclude that environmental performance evaluation ratings programs are the effective low-cost environmental management tool that proponents claim. Only two rigorous studies—that is, evaluations that control for changes in environmental performance that would have occurred absent the program—have been conducted. Additional research is needed to determine not only whether performance ratings spur improved environmental performance, but also how and under what conditions. Happily, by definition, such programs generate the environmental performance data needed to conduct such studies. It will be important to report negative results as well as positive ones. Finally, further research is needed on the sustainability of this approach: some of the programs discussed in this article appear to have been shuttered after an initial pilot phase supported by external donors.

As for voluntary regulation, it would be difficult to advocate this type of policy based on the available evidence. But here, too, the literature is too thin to draw definitive conclusions. In some cases (Mexico and perhaps Colombia), voluntary regulation arguably has done at least as much harm as good by creating a false impression of concerted action and diverting scarce financial and political resources to unproductive uses. But in other cases, it appears to have spurred significant improvements in environmental performance (Chile and Mexico) and regulatory capacity (Colombia). Again, further study is needed, including of failed experiences.

In making policy recommendations about whether and how to incorporate informal regulation in to environmental management policy in developing countries, two thorny issues merit consideration. The first is the relationship between informal and formal regulatory pressure. Say a local community organizes a highly visible protest against a dirty plant, and the

plant subsequently cuts its emissions. Were the protests themselves directly responsible for these emissions reductions? Or did they create a political dynamic that increased formal regulatory pressure on the plant? In general, to what extent do the nonregulatory pressures operate through formal regulators? The answer has important policy implications. If nonregulatory pressures have a significant independent effect on environmental performance, then it makes more sense to develop and advocate policies that leverage these pressures in countries where formal regulatory capacity is weak. If the opposite is true, it may make more sense to focus on building regulatory capacity in these countries. Notwithstanding the challenges of disentangling the effects of regulatory and nonregulatory factors, well-designed future studies could help shed light on this issue.

A second issue that needs to be considered is the relationship between policy innovation and regulatory capacity building. Implementing some policy innovations may help build capacity needed to implement CAC—or for that matter, any type of environmental regulation. For example, the partial success of an innovative wastewater emissions fee program in Colombia may have been largely due to efforts to strengthen basic regulatory functioning (monitoring and enforcement) needed to implement the new policy (Blackman 2009). A similar dynamic could be created by an environmental performance and evaluation program, which presumably would help build capacity for collecting and managing credible information about plants' environmental performance, a building block for a CAC regime. Why use innovative policies to build regulatory capacity? It may be more difficult to generate policies and financial support for shoring up the requisites of CAC policies with a spotty track record than to implement new policies that promise to be more effective and efficient.

To sum up, a broad policy recommendation would be to exercise considerable caution in promoting and implementing policies that leverage informal regulation. They are not a panacea for the difficult challenges of environmental regulation in developing countries. They are likely to be effective in some situations—for example, where preexisting regulatory and nonregulatory pressure for environmental performance are strong—and in some incarnations—for example, where policies emphasize public disclosure and are designed to create appropriate incentives for plants and regulators—but not in others.

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## Appendix: Industrialized Country Research

In many respects, environmental economics research on informal, informational, and voluntary regulation in developing countries extends the literatures on voluntary regulation and public disclosure in industrialized countries. Although these literatures are certainly relevant to developing countries, their findings do not necessarily generalize to them. Obviously, institutional and socioeconomic contexts are dissimilar in industrialized and developing countries. At least as important, environmental policy innovations are used for different purposes: policymakers in industrialized countries typically use public disclosure and voluntary regulation to encourage firms to overcomply with mandatory regulations; those in developing countries generally use them to help remedy rampant noncompliance with mandatory regulation. Despite these differences, it is helpful to summarize the main themes and findings from the research on industrialized countries.

### *A.1. Voluntary Regulation*

Rivera and de Leon (in press), Lyon and Maxwell (2002), and Khanna (2001) review the literature on voluntary regulation in industrialized countries, and their findings are relevant to each of the three strands of literature reviewed in this paper. They examine the same set of drivers of environmental performance discussed in Section 3 and Section 4. Also, they take up the same issues as the literature on voluntary regulation in developing countries, summarized in Section 5.

#### Drivers of Voluntary Overcompliance

Among the drivers of overcompliance discussed in the literature on voluntary regulation in industrialized countries, regulatory pressure has probably received the most attention. Both theoretical and empirical research suggests that firms participate in voluntary initiatives to preempt a background threat of more stringent mandatory regulation (Segerson and Miceli 1998; Maxwell et al. 2000; Glachant 2007). For example, in 1995, the German Federation of Businesses, the country's umbrella industrial trade association, negotiated voluntary carbon emissions reductions to preempt a mandatory tax (Lyon and Maxwell 2002). Similarly, firms may participate in voluntary initiatives to soften enforcement of existing regulation and/or to take advantage of program subsidies, such as tax breaks and technical assistance (Decker 2003; Cothran 1993; Marcus et al. 2002).

Regulatory carrots and sticks are not the only focus of the literature on voluntary regulation. Arora and Gangopadhayay (1995) show that, in theory, firms may voluntarily overcomply to attract green consumers. Some empirical evidence supports this proposition. For example, Arora and Cason (1995) and Vidovic and Khanna (2007) find that firms with a higher ratio of advertising expenditures to sales and those selling directly to final consumers were more likely to participate in voluntary initiatives. Communities, nongovernmental organizations, and trade associations also create incentives for firms to join voluntary programs. For example, Henriques and Sadorsky (1996) find that community pressure motivated plants to adopt environmental management plans, and Khanna and Damon (1998) find that firms belonging to the Chemical Manufacturers Association were more likely to join an Environmental Protection Agency voluntary program.

**Impacts of Voluntary Initiatives**

Have voluntary tools actually succeeded in improving environmental performance in industrialized countries? This has proven a difficult question to answer, for three reasons. Many, if not most, voluntary initiatives lack clear baselines, environmental performance targets, and monitoring. In addition, disentangling the impact of voluntary and mandatory regulation is problematic because they are almost always implemented concurrently. Finally, by definition, voluntary tools entail self-selection, and program evaluations must therefore control for it.

Most studies that have attempted to overcome those challenges fail to find compelling evidence that voluntary initiatives have had significant environmental impacts. For example, based on original case studies and extensive review of the literature, OECD (2003) concludes, "There are only a few cases where [voluntary] approaches have been found to contribute to environmental improvements significantly different from what would have happened anyway." Similarly, in a review of the findings from seven quantitative case studies, Morgenstern and Pizer (2007) conclude that voluntary initiatives have had minimal environmental impacts compared with a business-as-usual scenario. And in a meta-analysis of nine quantitative studies of voluntary programs, Darnall and Sides (2008) conclude that collectively, participants "do not improve their environmental performance over nonparticipants. Rather, nonparticipants improve their environmental performance by 7.7% more than [program] participants."

### *A.2. Public Disclosure*

By contrast, empirical evaluations of public disclosure initiatives in industrialized countries frequently suggest that they can have a significant impact on environmental

performance. For example, Bennear and Olmstead (2008) find that a U.S. program requiring community drinking water systems to publicly report their regulatory violations reduced the incidence of subsequent violations. Similarly, Delmas et al. (in press) find that U.S. regulations requiring electric utilities to disclose their reliance on fossil fuels led to a significant decrease in fossil fuel use. And Foulon et al. (2002) find that a Canadian policy of disclosing the identity of poorly performing pulp and paper plants spurred emissions reductions.[12]

Finally, research has established that stock markets in industrialized countries react to public disclosure of information about plants' environmental performance (Laplante and Lanoie 1994; Hamilton 1995). Some evidence suggests that these reactions spur improvements in environmental performance. For example, Konar and Cohen (1997) show that firms that experienced the largest abnormal negative returns following TRI reports subsequently reduced their emissions more than similar firms, even those with higher initial levels of emissions (see also Khanna et al. 1998).

[12] Three papers have examined the U.S. Toxic Release Inventory (Khanna and Anton 2002; Bui 2005; Koehler and Spengler 2007). Since the program began in 1986, total reported releases of the toxics it covers have fallen by at least 45 percent. However, it is not clear that public disclosure has been responsible. Data on toxic releases are not available for the period preceding the program, or for plants that fall outside the program, and as a result the usual means of estimating releases absent the program are not available (Bennear and Olmstead 2008). Moreover, several papers propose alternative explanations for the observed reductions in toxic releases, including the imposition of more stringent conventional regulation (Bui 2005), plants' practice of substituting unlisted toxics for listed ones (Greenstone 2003), and simple underreporting of emissions (Koehler and Spengler 2007).