Symposium:
Environmental Quality and Economic Development

Alternative Pollution Control Policies in Developing Countries

Allen Blackman*

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 pollution problems. Most are taking action to address these problems, relying principally on conventional command-and-control (CAC) approaches, such as mandatory emissions limits and technology standards. Although some countries (e.g., Mexico) have made good progress, the overall track record is mixed at best. The reasons for this uneven performance are well known (Eskeland and Jimenez 1992; Russell and Vaughan 2003). Written regulations are often riddled with gaps and inconsistencies. Environmental regulatory agencies lack adequate funding, expertise, and personnel. Public pollution control facilities such as wastewater treatment plants have yet to be built. Difficult-to-monitor small and informal firms abound. And, perhaps most importantly, the political will to allocate scarce resources to environmental protection and enforcement of environmental regulations is often limited.

Faced with these challenges, developing countries, often with funding and guidance from multilateral and bilateral aid agencies, are increasingly experimenting with alternative pollution control strategies that do not depend directly on regulators to issue mandates, monitor compliance, and sanction violations. Instead, they seek to leverage "informal" nonregulatory pressures for environmental quality—including those applied by 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 reducing their emissions. The hope is that these policies will sidestep the institutional and political constraints that have undermined CAC policies.

However, a number of factors suggest that it could be a mistake to put too much faith in this strategy. First, many of the nonregulatory factors that reputedly motivate firms to improve environmental performance are relatively weak in developing countries. For example, niche

*Resources for the Future, 1616 P Street, N.W., Washington, DC 20036, USA, and Environment for Development, Center for Central America, Turriabla, Costa Rica; Telephone: 202-328-5073; e-mail: blackman@rff.org

Review of Environmental Economics and Policy, volume 4, issue 2, summer 2010, pp. 234–253
doi:10.1093/reep/req005
Advance Access publication on August 7, 2010

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 require strong formal regulation to be effective. Considerable research suggests that firms participate in voluntary environmental initiatives because they believe that a failure to do so may trigger more stringent mandatory regulation (Lyon and Maxwell 2002; Koehler 2008). 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). These firms may be less susceptible to at least some regulatory and nonregulatory pressures for emissions cuts, including those generated by capital markets and green consumers.

Finally, as discussed below, it is hypothesized that public disclosure policies have an impact by disseminating information about individual plants' environmental performance. But in many developing countries, the free flow of information is limited.

Taking these arguments even further, one might posit that informational and voluntary environmental strategies in developing countries amount to nothing more than a *deus ex machina*—a seemingly convenient but ultimately unrealistic solution to the difficult challenges facing environmental regulators. In the final analysis, these strategies may turn out to 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 a false impression that regulators and polluters are making progress on environmental problems, in which case these policies can have real environmental costs that must be weighed against any possible benefits.

Over the past two decades, dozens of empirical studies of environmental performance and alternative pollution control policies in developing countries have been published. What do they tell us about the arguments for and against the use of these policies? This article, which is part of a symposium on Environmental Quality and Economic Development, aims to answer, or at least begin to answer, this question.[1] I review three strands of the 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, I focus mainly, although not exclusively, on econometric work published in peer-reviewed journals. Also, I leave aside the considerable literature on the use of market-based instruments in developing countries because such policies rely on incentives created by regulators, not communities, markets, and other nonregulatory actors.[2]

[1]The symposium includes an introductory article by Vincent (2010); an article by Pattanayak, Wunder, and Ferraro (2010), which reviews the literature on payments for environmental services in developing countries; and an article by Somanathan (2010), which discusses the impact of information on environmental quality in developing countries.

[2]For reviews of experience with market-based instruments in developing countries, see Blackman and Harrington (2000) and Blackman (2009).

The studies reviewed in this article complement the literature on voluntary regulation and public disclosure in industrialized countries. Although the findings from the industrialized-country literature are certainly relevant to developing countries, they are not necessarily directly applicable. Clearly, the institutional and socioeconomic contexts are very different in industrialized and developing countries. At least as important, the alternative environmental policies differ. Whereas voluntary and public disclosure policies in industrialized countries typically aim to spur overcompliance with mandatory regulations, those in developing countries generally aim to stem noncompliance with mandatory regulation or to build environmental management capacity. Despite these differences, it is helpful to occasionally compare and contrast findings from the two literatures, and I do this in the course of the discussion.

The remainder of the article is organized as follows. The next section presents the analytical framework found in much of the relevant literature. The following three sections discuss the three strands of literature listed above. The last section sums up and presents conclusions, including implications for policy and future research. An online Appendix provides a brief summary of the industrialized-country research on public disclosure and voluntary policies, as well as three detailed tables summarizing the developing-country literature reviewed here.[3]

Analytical Framework

To facilitate the discussion of the literature that follows, this section briefly presents the heuristic model of a plant's choice of how much pollution to emit (alternatively, how much to abate) that appears in much of the World Bank literature cited in the next section (e.g., Pargal and Wheeler 1996; World Bank 2000). The model assumes that plants consider two types of costs when 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. The expected marginal (pecuniary and nonpecuniary) penalty (EMP) increases with 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. The marginal abatement cost (MAC) decreases with the level of emissions because these investments generate diminishing returns. The plant will choose a level of emissions that minimizes the sum of these two types of costs—that is, the level at which the EMP is equal to the MAC.

As illustrated in Figure 1, the plant's EMP schedule increases with the level of emissions and its MAC schedule decreases with the level of emissions. The plant's cost-minimizing level of emissions, E_1, is determined by the intersection of the EMP_1 and MAC_1 schedules. If the plant is required by law to meet an emissions standard, R, the EMP schedule is discontinuous at R. Policies that enhance regulatory or nonregulatory pressures will shift the EMP schedule up (to EMP_2) and those that cut abatement costs will shift the MAC schedule down (to MAC_2). Both types of policies will reduce E_1.

[3]See http://www.reep.oxfordjournals.org for online supplementary material for this article.

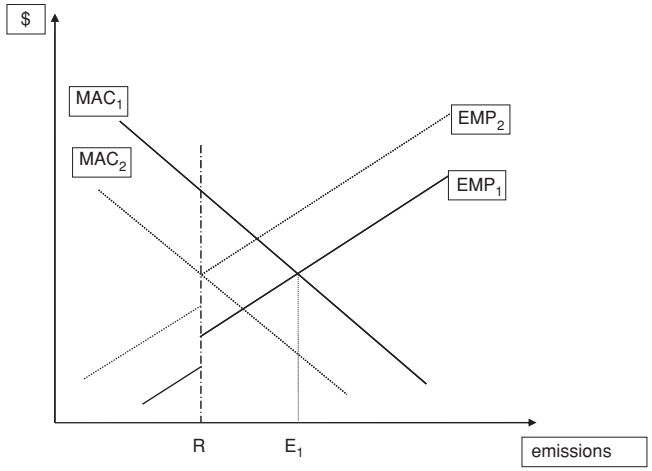

Figure 1. Manufacturing plant's choice of emissions.
MAC = marginal abatement cost; EMP = expected marginal penalty; R = emissions standard; E = emissions

Drivers of Environmental Performance

The first strand of literature I review aims to identify the determinants of manufacturing plants' emissions decisions, focusing on pressures generated by nonregulatory agents such as local communities, shareholders, and consumers. These studies are listed in Appendix Table 1, column 1. The starting point for this research is the observation that plants subject to the same or similar formal regulation often have markedly different environmental performance. For example, among the hundreds of tanneries in León, Guanajuato, Mexico's leather goods capital, most have adopted no pollution prevention or control measures, but a small number of plants have adopted many (Blackman and Kildegaard forthcoming). Presumably, differences in EMP or MAC across plants help explain such variation.

Methodologically, most of this literature consists of plant-level econometric studies in which the dependent variable is a measure of, or proxy for, environmental performance (e.g., the number of environmental management practices adopted), and the independent variables are characteristics of the plant (e.g., size) and the community in which the plant is located (e.g., per capita income). Of the eleven studies listed in the first column of Appendix Table 1, only three do not fit this mold: Goldar and Banerjee (2004) and Kathuria (2007) examine the relationship between river water quality and characteristics of upstream industrial clusters, while Dasgupta, Laplante, and Mamingi (2001) study the effect of environmental news on stock prices. In all eleven studies, regression results are used to develop hypotheses about determinants of environmental performance. For example, in a plant-level study, a positive correlation between environmental performance and average literacy in the local community (controlling for other determinants) might be interpreted as evidence that communities that are more informed about plants' environmental performance impose a greater EMP.

A critical challenge for this literature—and for that matter for all research on environmental management in developing countries—is acquiring reliable 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 data from original surveys and most use information on the adoption of environmental practices as a proxy for actual environmental performance.

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 nonregulatory (and regulatory) pressures for environmental performance. The main reason is that the independent variables that purport to capture these pressures 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 unobserved factors—that is, they are likely to be endogenous. Second, most pressures for improved environmental performance have spillover and feedback effects on each other. 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.

In the remainder of this section, I discuss this strand of the literature in more detail, particularly as it relates to these issues. The discussion is organized around the drivers of environmental performance that figure most prominently in this literature: communities, capital markets, consumers, regulators, and plant characteristics.

Communities

Virtually all of the studies in this literature attempt to identify a causal link between community pressure and environmental performance. The following approaches are commonly used to identify this link.

Average community socioeconomic characteristics

Pargal and Wheeler (1996), Hartman, Huq, and Wheeler (1997), Goldar and Banerjee (2004), and Zhang et al. (2008) use average socioeconomic characteristics of the local community to proxy for community pressure. They find significant correlations between environmental performance and per capita income (Pargal and Wheeler 1996; Hartman, Huq, and Wheeler 1997); population and population density (Hartman, Huq, and Wheeler 1997; Zhang et al. 2008); literacy (Goldar and Banerjee 2004); education (Pargal and Wheeler 1996); participation in elections (Goldar and Banerjee 2004); and the share of the local workforce employed by the plant (Pargal and Wheeler 1996). One problem with this approach is that average community-level characteristics may pick up any number of unobserved determinants of EMP and MAC. For example, Pargal and Wheeler's (1996) finding that Indonesian plants in wealthier communities emit less water pollution may reflect stronger formal regulatory pressure or better access to pollution control expertise and equipment 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 the location decisions of plants and people affect each other—for example, if relatively dirty plants deliberately locate in low-income communities and poor people deliberately locate near relatively dirty plants. Studies from industrialized countries suggest that real-estate markets encourage this type of sorting behavior (Been and Gupta 1997; Smith et al. 2004).

Participation in a trade association or voluntary agreement

Blackman and Bannister (1998), Aden, Hong, and Rock (1999), and Blackman and Kildegaard (forthcoming) use plant participation in a trade association or voluntary environmental agreement as a proxy for community pressure. The first two studies find a positive correlation between participation and environmental performance, while the third does not. This approach to identifying the effect of community pressure also has drawbacks. As in the case of average community characteristics, participation variables may be endogenous if they pick up unobserved determinants of EMP and MAC, that is, if plants with unobserved characteristics that are correlated with environmental performance (such as the plant manager's skill and environmental awareness) self-select into trade associations and voluntary agreements.

Citizen complaints and negative media reports

Hartman, Huq, and Wheeler (1997), Aden, Hong, and Rock (1999), and Kathuria (2007) use citizen complaints or negative media reports about pollution (at a specific plant or in the surrounding community) to proxy for community pressure. Unfortunately, this approach can be problematic as well. If complaints and newspaper articles incite regulatory actions, it is not clear whether these variables measure community pressure, formal regulatory pressure, or both. As discussed below, although Hartman, Huq, and Wheeler (1997), Aden, Hong, and Rock (1999), and Kathuria (2007) all control for formal regulatory pressure, these controls may not be adequate.

Plant managers' responses to survey questions

Dasgupta, Hettige, and Wheeler (2000) and Serôa da Motta (2006) use plant managers' responses to survey questions to measure community pressure. The latter study finds a correlation with environmental performance, but the former does not. Such survey responses may also be endogenous because they may 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.

Capital Markets

Dasgupta, Hettige, and Wheeler (2000) and Dasgupta, Laplante, and Mamingi (2001) present econometric results suggesting that capital markets influence plants' pollution abatement decisions. Dasgupta, Hettige, and Wheeler (2000) find that publicly traded Mexican firms are more likely to adopt environmental management practices, implying that shareholders pressure firms to improve environmental management. Dasgupta, Laplante, and Mamingi (2001) provide evidence to support this hypothesis. They test whether newspaper coverage of environmental performance affects firms' stock returns in four developing countries. They find that both positive and negative news articles generate significant abnormal returns. Moreover, negative articles generate much larger price dips than in industrialized countries, a finding attributed to the greater volatility of developing-country stock markets and a general scarcity of information about environmental performance in these countries. The implicit, but untested, assumption is that stock market reactions to environmental news spur subsequent emission

reductions. Although this assumption has been shown to be defensible for the United States. (Konar and Cohen 1997), to my knowledge, it has yet to be tested for a developing country.[4]

Consumers

Two of the studies in the first column of Appendix Table 1, Dasgupta, Hettige, and Wheeler (2000) and Serôa da Motta (2006), include regressors that are specifically related to consumer pressure. These studies test the effect that exporting to Organization for Economic Co-operation and Development countries has on environmental performance. Somewhat surprisingly, neither study finds any correlation.

Regulators

Although most of the studies focus on identifying the effect of nonregulatory pressures, most also include control variables that are meant to capture formal regulatory pressure. Almost without exception, these proxies are found to be positively correlated with environmental performance. The two most commonly used proxies are a count of regulatory actions (Aden, Hong, and Rock 1999; Dasgupta, Hettige, and Wheeler 2000; Blackman and Kildegaard forthcoming; Goldar and Banerjee 2004; Serôa da Motta 2006) and plant manager responses to survey questions about the intensity of regulatory pressure (Hartman, Huq, and Wheeler 1997; Dasgupta, Hettige, and Wheeler 2000).[5] Both of these proxies may be endogenous, however, because relatively dirty plants are apt to be inspected and sanctioned more often than clean ones.

Plant Characteristics

Finally, virtually all of the studies in the first column of Appendix Table 1 control for plant characteristics such as size and ownership, which affect both EMP and MAC. The studies tend to find that environmental performance is positively correlated with size, private (versus state) ownership, human capital, and productivity.

Public Disclosure

The second strand of the literature I review analyzes public disclosure programs. Public disclosure—the regular collection and dissemination of information about firms' environmental performance—has been characterized as the "third wave" in environmental regulation, after CAC and market-based approaches (Tietenberg 1998). Mounting evidence from industrialized countries (summarized in the online Appendix) suggests that disclosure can spur emissions reductions. In principle, this policy tool holds particular promise

[4]Two other articles in Appendix Table 1 examine the role of capital markets. Hartman, Huq, and Wheeler (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. 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.

[5]Several studies use other proxies for formal regulatory pressure, including size of local environmental regulatory staff (Kathuria 2007), effluent fees paid by manufacturing plants (Zhang et al. 2008), and awareness of city regulations (Blackman and Bannister 1998). Although the first two proxies are found to be correlated with environmental performance, endogeneity cannot be ruled out as an explanation.

for developing countries because it does not depend directly on regulatory enforcement (World Bank 2000; Dasgupta, Wheeler, and Wang 2007). Rather, it is thought to encourage emissions reductions by leveraging the external pressures discussed in the previous section (i.e., shifting the EMP curve up) and improving plants' information about pollution and abatement opportunities (i.e., shifting the MAC curve down).[6]

Two types of national public disclosure programs have emerged over the past two decades (Dasgupta, Wheeler, and Wang 2007). Pollutant release and transfer registries simply report plants' emissions without rating their environmental performance. More than twenty countries, including Chile and Mexico, have set up such registries or are in the process of doing so.[7] Most focus on toxic pollutants not covered by conventional regulations. To my knowledge, an evaluation of a developing country's pollutant release and transfer registry has yet to appear.

The second type of national public disclosure program uses emissions data to rate plants' environmental performance. These performance evaluation and ratings programs (PERPs) use easy-to-understand ratings categories that are based on plants' compliance with environmental regulations. In most cases, the categories are flagrant violation, noncompliant, compliant, and beyond compliant. As far as I know, PERPs are confined to developing countries and focus on conventional pollutants. China, Ghana, India, Indonesia, the Philippines, Thailand, Ukraine, and Vietnam have established PERPs, and Egypt and Mongolia are in the process of doing so.

As PERPs have proliferated in developing countries over the past two decades, environmental economists have begun to examine them. Their studies, which are listed in Appendix Table 1, column 2, have addressed two broad questions: Do PERPs cause plants to improve their environmental performance? If so, how and under what conditions? The next two subsections briefly summarize this research.

Does Public Disclosure Have an Impact?

Dasgupta, Wheeler, and Wang (2007), García, Sterner, and Afsah (2007), and Powers et al. (2008) aim to determine whether PERPs have environmental benefits. All three studies find that they do, but mainly—and in some cases exclusively—among plants with poor initial ratings. That disclosure has the greatest impact on dirty plants makes intuitive sense. All other things equal, the MAC of such plants is likely to be relatively low since they have yet to exploit low-cost abatement options. In addition, public disclosure for such plants may result in the greatest increase in EMP, since external agents presumably impose the highest penalties on the worst performers.

Dasgupta, Wheeler, and Wang (2007) present simple summary statistics on changes over time in the performance ratings of plants participating in four PERPs: Indonesia's Program for Pollution Control, Evaluation, and Rating (PROPER); the Philippines' EcoWatch program; Vietnam's Environmental Information and Disclosure System (EIDS); and China's pilot

[6]See Blackman, Afsah, and Ratunanda (2004) for a simple analytical model of public disclosure.

[7]Countries that have at least the beginnings 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, Wheeler, and Wang 2007; Kerret and Gray 2007).

GreenWatch program.[8] For each program, the authors find that plants whose performance rating improved over time tended to be those in the flagrant violation or noncompliant category. To make information on changes in ratings comparable across programs, the authors aggregate performance categories into two broad classes—compliant and noncompliant—and conclude 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. . . . 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. (103–4)

Two important caveats are in order, however. First, the statistics that Dasgupta, Wheeler, and Wang (2007) report are from pilot or early program phases that involved relatively small samples. Second, and perhaps more important, as Dasgupta, Wheeler, and Wang (2007) point out, without any type of baseline or control group, it is not possible to attribute observed changes in compliance to public disclosure. These changes may have resulted from any number of contemporaneous confounders, including the ratcheting up of formal regulatory pressure and the diffusion of clean technologies.

To my knowledge, only two studies—García, Sterner, and Afsah (2007) and Powers et al. (2008)—have attempted to control for such confounders. Both studies find that disclosure has spurred emissions reductions, particularly at dirty plants. García, Sterner, and Afsah (2007) analyze the impact of Indonesia's PROPER program on emissions of water pollution in a sample of 145 plants. They find that disclosure led to emissions reductions (of up to a third) for both noncompliant and compliant plants, but that noncompliant plants improved faster. Powers et al. (2008) analyze the effect of India's Green Ratings Project (GRP) on emissions of water pollutants from the country's large-scale pulp and paper plants. Unlike the other programs discussed above, GRP is run by an environmental nongovernmental organization 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 find that GRP ratings caused plants with poor initial performance ratings to reduce emissions by 9–19 percent.

How Does Public Disclosure Have an Impact?

Blackman, Afsah, and Ratunanda (2004), Gupta and Goldar (2005), Dasgupta et al. (2006), García, Afsah, and Sterner (2009), and Powers et al. (2008) focus, or at least touch, on the issue of how PERP ratings cause plants to improve their environmental performance. These studies suggest that disclosure both lowers plants' MAC and raises their EMP, particularly penalties applied by shareholders. Blackman, Afsah, and Ratunanda (2004) report summary statistics from an original survey that asked managers of Indonesian plants rated by PROPER to rank

[8]This pilot program focused on two cities: Hohot, in Inner Mongolia, and Zhenjiang, in Jaingsu Province. Wang et al. (2004) provides a more detailed but still primarily qualitative analysis of this program.

the importance of the various "channels" through which the ratings prompt emissions cuts, including enhancing various external pressures. The results, somewhat surprisingly, suggest that a particularly important channel is improving plants' information about their own emissions and abatement opportunities.[9] García, Afsah, and Sterner (2009) aim to identify the characteristics of PROPER participants whose ratings improved following disclosure. They find that such plants tended to be dirty, foreign owned, and located in densely populated communities, all other things equal. Finally, Gupta and Goldar (2005) and Dasgupta et al. (2006) study the effect of PERP ratings on stock returns. Gupta and Goldar (2005) examine the impact of GRP ratings on the stock returns of Indian firms in the pulp and paper, automotive, and chlor alkali sectors. They find that firms receiving poor GRP ratings experienced abnormal negative returns of up to 30 percent in some sectors. Dasgupta et al. (2006) test whether a South Korean public disclosure program (that simply releases the names of firms violating environmental regulations) affects stock returns. They find that disclosures that were reported in the media led to abnormal negative returns averaging 10 percent. Although these two studies show that stock markets respond to public disclosure, they do not test whether firms subsequently cut their emissions.

Voluntary Regulation

The third strand of the literature that I review analyzes policies and programs that prompt polluters to voluntarily commit to cut their emissions. Environmental authorities in industrialized countries are increasingly relying on such policies (Morgenstern and Pizer 2007; deLeon and Rivera 2010; OECD 2003). Less well known is the fact that this trend extends to developing countries, particularly those in Latin America. For example, environmental regulators in Chile, Colombia, and Mexico have negotiated dozens of high-profile voluntary agreements (VAs) with polluting sectors. Although the economics literature on voluntary regulation in industrialized countries is now substantial (see the online Appendix for a brief summary), the literature on developing countries is still quite thin. The remainder of this section briefly discusses this nascent literature, focusing on two of the three main types of voluntary regulation: VAs negotiated between regulators and firms, and public programs administered by regulators or third parties that set environmental performance standards and invite individual firms to meet them. The studies included in this literature are listed in Appendix Table 1, column 3.[10]

Negotiated Voluntary Agreements

Researchers have published case studies of VAs in Chile (Jiménez 2007), Mexico (Blackman and Sisto 2006), Colombia (Blackman et al. 2009b), China (Hu 2007), the Czech Republic (Dvorák, Lisa, and Sauer 2002), and Brazil (Freitas and Gereluk 2002). Among these six studies, only the one of Chile provides clear, credible evidence of a positive environmental

[9]The authors also find that PROPER's "environmental audit" effect operates in concert with external pressures from shareholders, banks, regulators, third-party certifiers, and courts. Moreover, the importance of these external pressures depends on the plants' initial environmental performance, with poorly ranked plants in particular emphasizing pressure from regulators and courts.

[10]I do not discuss unilateral voluntary commitments by firms, the third main type of voluntary regulation, because it is less a public policy tool than a corporate one (for reviews, see Utting 2002; Sarkar 2008).

impact. The studies of Mexico and Colombia suggest that VAs have not had environmental benefits, and those of China, the Czech Republic, and Brazil offer mixed or inconclusive results. Given this limited evidence, drawing broad policy lessons is problematic. However, the existing literature does hint at two hypotheses that warrant further investigation.

Background Pressure and Design Features

Studies of developing-country VAs echo key themes of the industrialized-country literature: VAs are unlikely to generate additional environmental benefits absent (i) preexisting formal or informal background pressures for emissions cuts; and (ii) design features that leverage these pressures, including quantified baselines and targets, transparency, monitoring, and some type of penalty for noncompliance (EEA 1997; Lyon and Maxwell 2002; De Clercq and Bracke 2005). Of course, these two requisites are closely related. Industry is not likely to agree to the latter absent the former.

To my knowledge, Jiménez's (2007) analysis of Chile's program of sector-wide VAs during the 2000s is the only rigorous case study of developing-country VAs that finds a significant environmental benefit. It uses detailed survey data from VA participants and nonparticipants along with statistical policy evaluation methods to identify environmental impacts. The study emphasizes that Chilean VAs were part of a national campaign to improve compliance and international competitiveness that had backing at the highest level, complemented a reasonably effective mandatory regulatory system, and included specific environmental performance targets, third-party monitoring, and pollution abatement subsidies.[11]

In contrast, such background pressures and design features were missing from the other, ineffective, VAs described in the literature. For example, Blackman and Sisto (2006) present a qualitative evaluation of a series of four VAs between regulatory authorities and the leather tanning sector in Mexico in the 1980s and 1990s. The VAs' signatories abrogated virtually all of their commitments. The authors attribute this outcome to weak background pressures and to the VAs' poor design. Key building blocks of formal pressure, including written regulations and local environmental management institutions, were missing during the study period. Moreover, community pressure was lacking because tanneries were a leading local employer and had considerable popular and political support. Finally, the VAs themselves focused mostly on process, not environmental performance, and included either vague or unworkable provisions for monitoring.

Blackman et al. (2009b), who analyze the sixty-four VAs signed in Colombia during the 1990s and 2000s, tell a similar story. The authors find that many of these VAs were quickly abandoned by their signatories. Even in a sample of six VAs reputed to be particularly successful, the majority of commitments were soon broken and the environmental advances that did occur were not additional. Here, too, an important reason was that the terms of the VAs were vague and process-oriented.

Some industrialized-country research suggests that VAs are most effective when they substitute for relatively mandatory regulation (Lyon and Maxwell 2002). Of the two published developing-country case studies examining such situations—Freitas and Gereluk (2002) and

[11] Hu (2007) examines VAs with two Chinese iron and steel companies that also appear to have generated environmental benefits. However, these VAs were idiosyncratic. They were pilot projects for a broader national energy efficiency program, intentionally focused on firms that were already well managed and energy efficient, and were driven by top-down pressures from national authorities.

Dvorák, Lisa, and Sauer (2002)—only one provides support for this hypothesis. Freitas and Gereluk (2002) evaluate a 1995 Brazilian VA aimed at limiting workplace exposure to benzene. The VA revamped an unrealistically stringent 1994 regulation mandating zero exposure. According to Freitas and Gereluk, as a result, investment in benzene abatement increased and the incidence of benzene-related occupational illness declined significantly. Dvorák, Lisa, and Sauer (2002) provide a different perspective, however. They analyze a 1995 VA between Czech environmental regulators and a national trade association of washing powder producers that was used by the trade association to head off imminent mandatory rules on phosphate content. The targets set under the agreement were relatively lax, and the authors conclude that as a result the VA has had few environmental benefits.

Capacity building

A second hypothesis suggested by studies of VAs in developing countries is that although their stated purpose is typically to improve environmental performance, an unstated but important—if not paramount—objective is to fill gaps in environmental management capacity. Furthermore, the studies suggest that developing-country VAs may be most successful at achieving this implicit objective. Perhaps the best evidence for this hypothesis comes from the case studies of Colombian and Mexican VAs in Blackman et al. (2009b) and Blackman and Sisto (2006). In the Colombian case, the authors find that although VAs were publicly advertised as short-term pollution control policies, in the eyes of many, if not most, of their signatories, they were a means of creating the environmental management capacity needed to implement a sweeping 1993 environmental regulatory reform. For example, the reform required new facilities to develop environmental management plans and obtain environmental licenses. But in the mid-1990s, regulators lacked sector-specific technical information needed to implement these mandates. The result was costly delays in critical new investments in electricity generation, petroleum exploration, and other sectors. In several cases, VAs appear to have played an instrumental role in the efforts of regulators and industry to overcome this informational barrier.

The Mexican tannery VAs analyzed in Blackman and Sisto (2006) also aimed to compensate for inadequate environmental management capacity. For example, prior to 1998, clear regulations governing hazardous wastes from leather tanneries did not exist. In the mid-1990s, VAs brought regulators and industry together to develop a nontechnical manual explaining exactly what hazardous waste measures were legally required of tanneries and how those requirements could be met.

Public Programs

Research on voluntary public programs in developing countries has focused on two areas: identifying the drivers of participation in these programs, and measuring the impact of participation on environmental performance. Findings echo those in the industrialized-country literature (see the online Appendix): Participation is driven by the background threat of formal regulation, green consumerism, trade association membership, and plant characteristics; and participation generally does not substantially improve environmental performance. The remainder of this subsection discusses the research on public programs in developing countries in more detail.

Blackman et al. (2009a) use plant-level data for a national sample of facilities to analyze the Clean Industry program, Mexico's flagship voluntary regulatory initiative, which provides a temporary enforcement amnesty and public recognition for plants that voluntarily submit to an environmental audit and correct all deficiencies it identifies. The authors find that plants fined for regulatory violations were more likely to subsequently join the program, as were plants that were relatively large, trading in overseas markets, and selling to the government. However, the rate at which participants were fined after joining was not substantially lower than the rate for matched nonparticipants. They conclude that the program has not had a large, lasting environmental benefit.

Rivera (2002) uses original survey data 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 drove participation.

Finally, several papers examine International Organization for Standardization (ISO) 14001 certification, a third-party program that certifies environmental management systems.[12] Blackman (2010) uses national plant-level data to examine the drivers and impact of ISO 14001 certification in Mexico. The results are similar to those for the Clean Industry study: dirty plants, large plants, and those trading in overseas markets were more likely to participate, but participation did not have a large lasting effect on environmental performance. Christmann and Taylor (2001) examine the self-reported "future likelihood" of attaining ISO 14001 certification for a sample of Chinese firms. They find that firms that were owned by, or sold their products to, multinationals and industrialized countries were more likely to be certified. Finally, Roht-Arriaza (1997) examines the potential for ISO 14001 certification to generate significant improvements in environmental performance in the countries that belong to the Asia-Pacific Economic Cooperation (APEC).[13] She concludes that in isolation, certification is unlikely to lead to such improvements because it requires only that firms adopt management procedures, not that they meet performance standards, and it has weak information, reporting, and accreditation requirements.

Summary and Conclusion

This article has reviewed thirty studies comprising 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 strands analyze policy innovations reputed to leverage these pressures—public disclosure and voluntary regulation. This final section briefly summarizes the main findings from this review and considers the implications for policy and future research.

[12]To obtain ISO 14001 certification, which lasts for three years, an independent third-party auditor must verify that plants have defined an environmental management strategy, made a concrete plan to implement it, implemented the plan, conducted periodic internal performance audits, and taken corrective action to promote continual improvement.

[13]APEC is an organization of twenty-one industrialized and developing countries aimed at supporting sustainable economic growth in the Asia-Pacific region.

Summary

Overall, these three strands of literature do not provide widespread compelling evidence that alternative pollution control policies spur significant improvements in environmental performance. A handful of reasonably rigorous studies—in particular those concerning public disclosure—present positive results, but are overshadowed by a larger number of studies that present negative, inconclusive, or unconvincing results.

The first strand of literature focuses on econometrically identifying the impacts of nonregulatory pressures on environmental performance. Eight of eleven studies in this literature claim to show that community pressure promotes emissions reductions. However, most of these claims are not well supported. This is partly because of the inherent difficulty of identifying community pressure—it resists measurement and is correlated with other pressures—and partly because of data and methodological limitations. One study presents evidence that stock markets penalize poor environmental performers. However, it does not test whether this effect, in turn, drives emissions reductions.

As for the literature on public disclosure, eight studies have examined performance evaluation and ratings programs (PERPs) in Asia to determine whether and how they spur abatement. Five of the studies show that after ratings are released, regulatory noncompliance drops significantly. The only two studies of PERPS that control for contemporaneous factors that affect environmental performance suggest the effect was causal: disclosure caused dirty plants to comply. These rigorous studies are certainly intriguing, but too few in number to be conclusive. Two other studies demonstrate that PERP ratings affect stock market returns, but, like the stock market study mentioned above, do not test for an impact on emissions. Finally, studies of PERPs that examine the mechanism by which disclosure affects abatement do not reach a consensus. In particular, it is not clear whether public disclosure spurs abatement by improving plants' internal information or enhancing external pressures, and which external pressures are most important.

Like the literature on public disclosure in developing countries, the literature on voluntary regulation is thin. However, the overall findings about impacts on environmental performance are less encouraging. Out of the eleven case studies, only one—of VAs in Chile—presents reasonably rigorous evidence that a voluntary initiative had a significant environmental impact. Five other studies find that voluntary initiatives had little or no environmental benefit, while five others either do not address the issue, or are inconclusive. This research echoes themes of the literature on voluntary regulation in industrialized countries: VAs do not spur emissions cuts absent strong background regulatory pressure and design features that leverage this pressure, and formal regulatory pressure, green consumerism, and trade association membership drive participation in voluntary public programs. In addition, two studies in this strand of the literature suggest that, whatever their environmental impacts, developing-country VAs can help build much-needed environmental management capacity.

Policy and Research Implications

What are the policy and research implications of these findings? Of the two alternative environmental policies reviewed here—public disclosure and voluntary regulation—the research to date indicates that the former is more promising for developing countries. But it is still too early to conclude that PERPs are the effective low-cost environmental management tool

that their proponents claim them to be. Additional research is needed to determine not only whether PERPs spur abatement, 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 as well as positive results. Further research is also needed on the sustainability of this approach: some PERPs 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 policy tool based on the available evidence. But here, too, the literature is too thin to draw definitive conclusions. In some cases (León, Mexico), 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 led to significant improvements in environmental performance (Chile) and regulatory capacity (Colombia). Again, further study is needed, including examinations of failed experiences.

In making policy recommendations about whether and how to incorporate informal regulation into 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 nonregulatory pressures operate through formal regulators? The answer to this last, more general, question 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 the capacity needed to implement CAC measures—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 a PERP, 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 alternative policies to build regulatory capacity? It may be easier to generate political and financial support for new policies that promise to be more effective and efficient than for shoring up CAC policies that have a spotty track record.

Thus, a broad policy recommendation would be to exercise considerable caution in promoting and implementing policies that leverage informal regulation, as they are not a panacea for the difficult challenges of environmental regulation in developing countries. Such policies are only likely to be effective in some situations—for example, where preexisting regulatory and nonregulatory pressure for environmental performance is strong—and in some forms—for example, where policies emphasize public disclosure and are designed to create appropriate incentives for both plants and regulators.

Appendix Table 1 Literature on alternative pollution control policies in developing countries[a]

Drivers of environmental performance[b]		Public disclosure		Voluntary regulation	
Article	**Location/sector**	**Article**	**Location/sector**	**Article**	**Location/sector**
Aden, Hong, and Rock (1999)	Korea: Three regions, two sectors (textiles, petrochemicals)	Blackman, Afsah, and Ratunanda (2004)	Indonesia: national, multiple sectors	Blackman and Sisto (2006)	Mexico: One city (León), one sector (tanning)
Blackman and Bannister (1998)	Mexico: One city (Cd. Juárez), one sector (brickmaking)	Dasgupta et al. (2006)	South Korea: national, multiple sectors	Blackman et al. (2009a)	Mexico: National, multiple sectors
Blackman and Kildegaard (forthcoming)	Mexico: One city (León), one sector (leather tanning)	Dasgupta, Wheeler, and Wang (2007)	• Indonesia: national, multiple sectors • Philippines: national, multiple sectors • Vietnam: One city, multiple sectors • China: Two cities, multiple sectors	Blackman et al. (2009b)	Colombia: National, six sectors
Goldar and Banerjee (2004)	India: Ten watersheds	García, Sterner, and Afsah (2007)	Indonesia: National, multiple sectors	Blackman (2010)	Mexico: National, multiple sectors
Dasgupta, Hettige, and Wheeler (2000)	Mexico: National, four sectors	García, Afsah, and Sterner (2009)	Indonesia: National, multiple sectors	Christmann and Taylor (2001)	China: National, multiple sectors
Dasgupta, Laplante, and Mamingi (2001)	Argentina, Chile, Mexico, Philippines: national, multiple sectors	Gupta and Goldar (2005)	India: National, multiple sectors	Dvorák, Lisa, and Sauer (2002)	Czech Republic: National, two sectors (packaging, phosphates)

Hartman, Huq, and Wheeler (1997)	Bangladesh, India, Indonesia, Thailand: National, one sector (pulp and paper)	Powers et al. (2008)	India: National, one sector (pulp and paper)	Freitas and Gereluk (2002)	Brazil: National, one sector (petrochemicals)
Kathuria (2007)	India: Four watersheds	Wang et al. (2004)	China: Two cities, multiple sectors	Hu (2007)	China: One province (Shandong), two companies (iron, steel)
Pargal and Wheeler (1996)	Indonesia: National, multiple sectors			Jiménez (2007)	Chile: National, four sectors (chemical effluents, chemical packaging, foundries, sawmills, swine)
Serôa da Motta (2006)	Brazil: National, multiple sectors			Rivera (2002, 2002)	Costa Rica: National, one sector (hotels)
Zhang et al. (2008)	China: One county (Wujin, Jiangsu Province), multiple sectors			Roht-Arriaza (1997)	Eighteen members of Asia Pacific Economic Cooperation (APEC)

[a]See online Appendix for a more detailed summary table that includes data, scale, dependent and independent variables, model type, and key findings.
[b]We omit Hettige et al. (1996) because it summarizes the results of three other papers, two of which are discussed here: Pargal and Wheeler (1996) and Hartman, Huq, and Wheeler (1997).

References

Aden, J., A. K. Hong, and M. Rock. 1999. What is driving the pollution abatement expenditure behavior of manufacturing plants in Korea? *World Development* 27(7):1203–14.

Been, V., and F. Gupta. 1997. Coming to the nuisance or going to the barrios? A longitudinal analysis of environmental justice claims. *Ecology Law Quarterly* 34:3–56.

Blackman, A., ed. 2006. *Small firms and the environment in developing countries: Collective impacts, collective action*. Washington, DC: Resources for the Future Press.

Blackman, A. 2009. Colombia's discharge fee program: Economic incentives for polluters or regulators? *Journal of Environmental Management* 90(1):101–19.

Blackman, A. 2010. ISO 14001 certification in Mexico: Drivers and impacts. Working Paper, Resources for the Future, Washington, DC.

Blackman, A., S. Afsah, and D. Ratunanda. 2004. How does public disclosure work? Evidence from Indonesia's PROPER program. *Human Ecology Review* 11(3):235–46.

Blackman, A., and G. J. Bannister. 1998. Community pressure and clean technology in the informal sector: An econometric analysis of the adoption of propane by traditional Mexican brickmakers. *Journal of Environmental Economics and Management* 35(1):1–21.

Blackman, A., and W. Harrington. 2000. The use of economic incentives in developing countries: International experience with industrial air pollution. *Journal of Environment and Development* 9(1):5–44.

Blackman, A., and A. Kildegaard. Forthcoming. Clean technological change in developing country industrial clusters: Mexican leather tanneries. *Environmental Economics and Policy Studies* (in press).

Blackman, A., B. Lahiri, B. Pizer, M. Rivera Planter, and C. Muñoz Piña. In Press. Voluntary regulation in developing countries: Mexico's clean industry program. *Journal of Environmental Economics and Management*.

Blackman, A., and N. Sisto. 2006. Voluntary environmental regulation in developing countries: A Mexican case study. *Natural Resources Journal* 46(4):1005–42.

Blackman, A., E. Uribe, B. van Hoof, and T. Lyon. 2009b. Voluntary environmental agreements in developing countries: The Colombian experience. Working Paper, Resources for the Future, Washington, DC.

Christmann, P., and G. Taylor. 2001. Globalization and the environment: Determinants of firm self-regulation in China. *Journal of International Business Studies* 32(3):459–58.

Dasgupta, S., H. Hettige, and D. Wheeler. 2000. What improves environmental performance? Evidence from Mexican industry. *Journal of Environmental Economics and Management* 39:39–66.

Dasgupta, S., J. H. Hong, B. Laplante, and N. Mamingi. 2006. Disclosure of environmental violations and stock market in the Republic of Korea. *Ecological Economics* 58(4):759–77.

Dasgupta, S., B. Laplante, and N. Mamingi. 2001. Pollution and capital markets in developing countries. *Journal of Environmental Economics and Management* 42(3):310–35.

Dasgupta, S., D. Wheeler, and H. Wang. 2007. Disclosure strategies for pollution control. In *International yearbook of environmental and resource economics 2006/2007: A survey of current issues*, ed. T. Teitenberg and H. Folmer, 93–119. Northampton, MA: Edward Elgar.

De Clercq, M., and R. Bracke. 2005. On the assessment of environmental voluntary agreements in Europe. In *The handbook of environmental voluntary agreements*, ed. E. Croci, 335–63. Dordrecht: Springer.

deLeon, P. and J. Rivera. 2010. *Voluntary environmental programs: A policy perspective*. New York: Lexington Books.

Dvorák, A., A. Lisa, and P. Sauer. 2002. Negotiated voluntary environmental agreements: Cases in the Czech Republic. In *Voluntary environmental agreements: Process, practice and future use*, ed. P. ten Brink, 206–18. Sheffield, UK: Greenleaf Publishing.

Eskeland, G., and E. Jimenez. 1992. Policy instruments for pollution control in developing countries. *World Bank Research Observer* 7(2):145–69.

European Environmental Agency (EEA). 1997. *Environmental agreements: environmental effectiveness*. Copenhagen: EEA.

Freitas, N., and W. Gereluk. 2002. A national tripartite agreement on benzene in Brazil. In *Voluntary environmental agreements: Process, practice and future use*, ed. P. ten Brink, 176–90. Sheffield, UK: Greenleaf Publishing.

Fry, M. 1988. *Money, interest, and banking in economic development*. Baltimore: Johns Hopkins University Press.

García, J., S. Afsah, and T. Sterner. 2009. Which firms are more sensitive to public disclosure schemes for pollution control? Evidence from Indonesia's PROPER program. *Environmental and Resource Economics* 42(2):151–68.

García, J., T. Sterner, and S. Afsah. 2007. Public disclosure of industrial pollution: The PROPER approach for Indonesia? *Environment and Development Economics* 12:739–56.

Goldar, B., and N. Banerjee. 2004. Impact of informal regulation of pollution on water quality in rivers in India. *Journal of Environmental Management* 73(2):117–30.

Gupta, S., and B. Goldar. 2005. Do stock markets penalize environment-unfriendly behavior? Evidence from India. *Ecological Economics* 52:81–95.

Hartman, R., M. Huq, and D. Wheeler. 1997. Why paper mills clean up: Determinants of pollution abatement in four Asian countries. Policy Research Department Working Paper 1710, World Bank, Washington, DC.

Hettige, H., M. Huq, S. Pargal, and D. Wheeler 1996. Determinants of pollution abatement in developing countries: Evidence for south and southeast Asia. *World Development* 24(12):1891–904.

Hu, Y. 2007. Implementation of voluntary agreements for energy efficiency in China. *Energy Policy* 35:5541–48.

Jiménez, O. 2007. Voluntary agreements in environmental policy: An empirical evaluation for the Chilean case. *Journal of Cleaner Production* 15:620–37.

Kathuria, V. 2007. Informal regulation of pollution in a developing country: Evidence from India. *Ecological Economics* 63(2–3):403–17.

Kerret, D., and G. Gray. 2007. What do we learn from emissions reporting? Analytical considerations and comparison of pollutant release and transfer registers in the United States, Canada, England, and Australia. *Risk Analysis* 27(1):203–23.

Koehler, D. 2008. The effectiveness of voluntary environmental programs—A policy at a crossroads? *The Policy Studies Journal* 35(4):689–22.

Konar, S., and M. Cohen. 1997. Information as regulation: The effect of community right to know laws on toxic emissions. *Journal of Environmental Economics and Management* 32:109–24.

Lyon, T., and J. Maxwell. 2002. Voluntary approaches to environmental regulation: A survey. In *Economic institutions and environmental policy*, ed. M. Frazini and A. Nicita. Aldershot: Ashgate Publishing.

Morgenstern, R., and W. Pizer, eds. 2007. *Reality check: The nature and performance of voluntary environmental programs in the United States, Europe, and Japan*. Washington, DC: Resources for the Future Press.

Organization for Economic Cooperation and Development (OECD). 2003. *Voluntary approaches for environmental policy: Effectiveness, efficiency and usage in policy mixes*. Paris: OECD Environment Directorate.

Pargal, S., and D. Wheeler. 1996. Informal regulation of industrial pollution in developing countries: Evidence from Indonesia. *Journal of Political Economy* 106(6):1314–27.

Pattanayak, S. K., S. Wunder, and P. J. Ferraro. 2010. Show me the money: Do payments supply environmental services in developing countries? *Review of Environmental Economics and Policy*. 10.1093/reep/req006.

Powers, N., A. Blackman, U. Narain, and T. Lyon. 2008. Does public disclosure reduce pollution? Evidence from India's pulp and paper industry. Discussion Paper 08–38, Resources for the Future, Washington, DC.

Rivera, J. 2002. Assessing a voluntary environmental initiative in the developing world: The Costa Rican certification for sustainable tourism. *Policy Sciences* 35:333–60.

Roht-Arriaza, N. 1997. Environmental management systems and environmental protection: Can ISO14001 be useful within the context of APEC? *Journal of Environment and Development* 6(3):292–316.

Russell, C., and W. Vaughan. 2003. The choice of pollution control policy instruments in developing

countries: Arguments, evidence and suggestions. In *International yearbook of environmental and resource economics*, vol. VII. Cheltenham, UK: Edward Elgar.

Sarkar, R. 2008. Public policy and corporate environmental behavior: A broader view. *Corporate Social Responsibility and Environmental Management* 15(5):281–97.

Serôa da Motta, R. 2006. Analyzing the environmental performance of the Brazilian industrial sector. *Ecological Economics* 57(2):269–81.

Smith, K., H. Sieg, S. Banzhaf, and R. Walsh. 2004. General equilibrium benefits for environmental improvements: Projected ozone reductions under EPA's prospective analysis for the Los Angeles air basin. *Journal of Environmental Economics and Management* 47(3):559–84.

Somanathan, E. 2010. Effects of information on environmental quality in developing countries. *Review of Environmental Economics and Policy*. 10.1093/reep/req012.

Tietenberg, T. 1998. Disclosure strategies for pollution control. *Environmental and Resource Economics* 11:587–602.

Utting, P., ed. 2002. *The greening of business in developing countries: Rhetoric, reality and prospects*. London: Zed Books.

Vincent, J. R. 2010. Microeconomic analysis of innovative environmental programs in developing countries. *Review of Environmental Economics and Policy*. 10.1093/reep/req011.

Wang, H., J. Bi, D. Wheeler, J. Wang, D. Cao, G. Lu, and Y. Wang. 2004. Environmental performance rating and disclosure: China's Green-Watch program. *Journal of Environmental Management* 71(2):123–33.

Wehrmeyer, W., and Y. Mulugetta, eds. 1999. *Growing pains: Environmental management in developing countries*. Sheffield, UK: Greenleaf Publishing.

World Bank. 2000. *Greening industry: New roles for communities, markets, and governments*. New York: Oxford University Press.

Zhang, B., J. Bi, Z. Yuan, J. Ge, B. Liu, and M. Bu. 2008. Why do firms engage in environmental management? An empirical study in China. *Journal of Cleaner Production* 16:1036–45.