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Environmental Public Voluntary Programs Reconsidered

Thomas P. Lyon and John W. Maxwell

Environmental "public voluntary programs" (PVPs) involve government offers of positive publicity and technical assistance to firms that reach certain environmental goals. A growing body of empirical work suggests these programs generally have little impact on the behavior of their participants. A natural policy conclusion would be to eliminate PVPs, but we argue that such a conclusion is premature. Many PVPs are best viewed as information diffusion programs, so identifying their effects econometrically is difficult because information is likely to diffuse to nonparticipants. Thus, after the early phases of even a successful PVP, it may well be impossible to detect a difference in the performance between participants and nonparticipants. We argue that new estimation approaches are needed to identify the effects of PVPs. We also explore the design of PVPs in detail, showing how PVPs can potentially enhance the diffusion of cost-effective techniques for pollution abatement.

1. Introduction

For years, environmental regulators have relied upon various forms of taxes, subsidies, and command and control regulations to remedy environmental problems. Recently, however, new tools—including environmental public voluntary programs, or PVPs—have been added to the regulator's toolbox. PVPs typically invite firms to set and achieve environmental goals, and offer modest subsidies to encourage firms to participate. These subsidies consist of various combinations of favorable publicity, technical assistance, and opportunities for positive interactions with regulators. PVPs have been developed to address a variety of issues, including agriculture, air quality, energy efficiency and climate change, labeling, pollution prevention, waste management, and water. Among these, the areas with the most PVP activity are pollution prevention and climate change.

Perhaps the best known U.S. PVP was the 33/50 program operated by the U.S. Environmental Protection Agency (EPA) between 1991 and 1995.[1] This program identified 17 high-priority toxic chemicals, and invited thousands of industrial companies to join the program and reduce their emissions of these chemicals 33 percent by 1992 and 50 percent by 1995. According to the EPA's final report on the program, the most important feature of the program was that the agency "encouraged participants to set their own reduction goals, oriented to their own time frames, and most did so. Of the 1,294 companies participating, 1,066 set measurable goals for reducing

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their releases and transfers of the 17 targeted chemicals against the 1988 baseline."[2] The EPA was very pleased with the apparent success of the program, claiming that "The 33/50 program achieved its goal in 1994, one year ahead of schedule, primarily through program participants' efforts."[3]

President Clinton's Climate Change Action Plan (CCAP), released in October 1993, spawned many PVPs including Green Lights, Climate Wise, Motor Challenge, and Energy Star Buildings, among many others. As in the case of 33/50, participants in these PVPs were provided with case studies detailing the cost savings of other program participants and were offered technical information aimed at aiding the development of a program action plan. The programs also offered access to question hotlines, seminars at which firms could exchange information about cost savings, free software, and access to databases of equipment suppliers and financing programs.

Despite government enthusiasm for PVPs, econometric analysis of PVPs suggests that they are largely ineffective.[4] However, our analysis of PVPs and their design suggests that identifying the effects of PVPs is inherently difficult. An important aspect of most PVPs is an attempt to diffuse information about pollution abatement throughout industry, but this information may be received by nonparticipants, as well as by participants. If so, there will be little or no difference in the performance between firms that join an information-oriented PVP and those that do not. It is possible that a difference would be observed in the early phases of a program, when the government is trying to attract participants who already have information to share. Once the program moves to the dissemination stage, however, there is likely to be no measurable difference between participants and nonparticipants. This is a point that has not been recognized in the empirical literature on PVPs and that demands a reinterpretation of the findings in this literature.

To put PVPs in perspective alongside other policy instruments, we present a framework in which conventional regulation and PVPs can be considered in a unified political/economic approach, thereby allowing a sharper comparison of their relative merits. We show that in the absence of significant political opposition, a mandatory regulatory policy can produce greater environmental improvement than a PVP. However, if there is strong political opposition to mandatory measures, then PVPs may be preferable.

The modest subsidies implicit in PVPs can be provided in a variety of ways, with potentially important implications for the effectiveness of such programs. Hence, we analyze the structure of PVPs in detail, arguing that PVPs can enhance the diffusion of cost-effective techniques for pollution abatement, so long as the information involved is not competitively sensitive. We conclude that PVPs have a role to play in environmental policy, but that it is much more restricted than is sometimes portrayed by advocates of voluntary approaches.

The article is organized as follows. The following section provides an overview of the voluntary programs sponsored by the U.S. EPA and their key features. Section 3 reviews recent empirical findings on the performance of PVPs. Section 4 provides a political-economic framework for understanding PVPs, which raises serious questions about the proper interpretation of the results obtained in the empirical

literature to date. Section 5 discusses the implications of our framework for future empirical work on PVPs, while section 6 discusses its implications for the design of future PVPs. Section 7 concludes.

2. An Overview of EPA PVPs

In this section we review all the PVPs listed on the EPA's "partnership programs" web page on September 1, 2007.[5] Based on a careful reading of the materials on the website, we identify the key environmental issues to which PVPs have been applied and analyze the key elements of the various PVPs.

The EPA identifies 12 categories in which they have PVPs, which are listed below with the number of programs in each category in parentheses:

- Agriculture (3)
- Air quality (15)
- Energy efficiency and global climate change (26)
- Pollution prevention (13)
- Product labeling (1)
- Regulatory innovation (1)
- Sector programs (1)
- Technology (1)
- Transportation (13)
- Waste management (6)
- Water (12)
- EPA's regional partnership programs (none listed)

Summing over all 12 categories yields a total of 92 programs. However, because many programs are listed in more than one category, the total number of independent PVPs is actually only 60. The three categories that encompass the vast bulk of PVPs are Energy Efficiency and Global Climate Change (many of which are also listed as Air Quality or Transportation programs), Pollution Prevention, and Water. Together, these three categories account for over 80 percent of the EPA's partnership programs.

The EPA partnership programs vary greatly in their form and substance. Many are basically websites with links to various documents and other web-sites.[6] Others are essentially programs run by industry trade associations with the encouragement of EPA, such as the Green Suppliers Network, Partnership for Safe Water,[7] and Sustainable Slopes.[8] Still, others, such as the Carpet America Recovery Effort and Hospitals for a Healthy Environment (HHE), are the result of specific agreements

Table 1. U.S. Environmental Protection Agency Voluntary Partnership Program Characteristics

	Primary category	Program	Information provision						Govt. R&D	Certification	Public recognition	Regulatory benefits	Coordination
			Software	Cases	Lists	Tech info	Tech asst	P2P exchange					
1	Water	Adopt Your Watershed			•						•		
2	EEGCC	AgSTAR		•				•			•		
3	EEGCC	Best Workplaces for Commuters									•		
4	WM	Carpet America Recovery Effort			•			•					•
5	Water	Clean Marinas		•		•			•				
6	Air quality	Clean School Bus USA				•				•	•		
7	Water	Clean Water Act Recognition Programs				•					•		
8	EEGCC	Climate Leaders		•							•	•	
9	EEGCC	Coal Combustion Products Partnership		•		•					•		
10	EEGCC	Coalbed Methane Outreach program		•				•					
11	EEGCC	Combined Heat and Power Partnership		•									
12	Water	Decentral. Wastewater Treatment Syst. program	•	•	•	•			•				
13	PP	Design for the Environment				•	•	•	•		•		
14	Air quality	Diesel Retrofit program								•			
15	EEGCC	ENERGYSTAR	•	•	•			•		•	•		
16	Technology	Environmental Technology Verification program								•			
17	PP	Environmentally Preferable Purchasing	•	•	•	•							
18	Water	EPA's Volunteer Monitoring program			•	•							
19	PP	Federal Electronics Challenge		•			•	•			•		
20	Water	Five Star Restoration Program		•									
21	EEGCC	Great Amer. Woodstove Changeout campaign		•		•							
22	PP	Green Chemistry	•			•			•				
23	PP	Green Engineering		•				•					
24	EEGCC	Green Power Partnership			•						•		
25	EEGCC	Green Vehicle Guide		•									
26	EEGCC	GreenScapes	•	•		•							
27	EEGCC	HFC-23 Emission Reduction program											
28	PP	High Production Volume Challenge						•					
29	WM	Hospitals for a Healthy Environment	•	•	•	•		•					
30	EEGCC	Improving Air Quality through Land Use Activities	•			•							
31	Air quality	Indoor Air Quality Tools for Schools		•									
32	Air quality	Indoor Environments		•		•							
33	EEGCC	It All Adds Up to Cleaner Air		•		•			•				
34	EEGCC	Labs 21	•	•		•	•	•			•		
35	EEGCC	Landfill Methane Outreach Program (LMOP)		•	•			•					
36	PP	Lawns and the Environment											
37	EEGCC	Methane to Markets Partnership				•		•					•
38	EEGCC	Mobile Air Cond. Climate Protection Partnership						•					•
39	PP	National Environmental Performance Track						•				•	
40	Water	National Fish Contamination program			•	•		•					•
41	Water	National Nonpoint Source Management program			•	•							
42	PP	National Partnership for Environmental Priorities		•		•		•			•		
43	EEGCC	Natural Gas STAR program	•	•			•	•			•		
44	Water	Partnership for Safe Water				•		•			•		
45	AG	Pesticide Environmental Stewardship Program		•							•		
46	WM	Plug-In to eCycling		•	•	•		•			•		
47	AG	Reduced Risk for Conventional Pesticides											
48	Sector	Sector Strategies program		•	•	•							
49	EEGCC	SF6 Partnership for Electric Power		•		•		•		•	•		
50	EEGCC	SF6 Partnership for Magnesium Industry	•			•		•			•		
51	EEGCC	SmartWay Transport Partnership	•			•					•		
52	PP	Sustainable Futures Initiative	•			•	•					•	
53	Water	Sustainable Slopes	•			•					•		
54	PP	The Green Suppliers Network		•			•						
55	EEGCC	The SunWise School program				•					•		
56	EEGCC	Voluntary Aluminum Industrial Partnership				•		•			•		
57	PP	Voluntary Children's Chem. Eval. program						•					
58	EEGCC	WasteWise		•	•	•	•	•			•		
59	Water	Water Sense			•	•				•	•		
		Number of Programs with Feature	13	28	15	32	7	24	5	6	25	3	4

EEGCC, energy efficiency and global climate change; PP, pollution prevention; WM, waste management; AG, agriculture; Sector,sector program

between industry and government, with multiyear goals and monitoring of industry progress toward reaching them.[9]

In order to get a better understanding of the structure of the EPA's partnership programs, we conducted a thorough review of the partnership website, with an eye to identifying the key program elements for each partnership program. The results are presented in Table 1 (a glossary of terms that appear in Table 1 can be found in Table 2), which reveals certain common features found in many of these programs and characterizes each partnership program according to which features it includes.

Table 1 shows that the two most common elements of PVPs are: (i) disseminating information about abatement techniques more broadly throughout firms in particular industries and (ii) providing public recognition to those companies that go beyond compliance with existing regulations. In addition, there are several other techniques that are sometimes used in PVPs. Some PVPs provide regulatory benefits

Table 2. Glossary of Table 1 Terms

Software	Computer programs made available by EPA, dealing with how to measure or control emissions and/or costs.
Cases	Case studies of successful abatement efforts by participants in the program.
Lists	Compilations of suppliers of technical assistance or products
Tech info	Written documents explaining the scientific or technical aspects of pollution generation, or of technologies for abatement.
Tech assist	Live interaction with human experts who can provide customized technical advice.
P2P exchange	Opportunities for peer-to-peer exchange between program participants of information about effective abatement strategies. Typically done through conferences, but sometimes also through online dialogues.
Govt. R&D	Government funded research on abatement technologies, the results of which are disseminated through the program.
Certification	Government-backed assurance that certain technologies or practices achieve their abatement claims.
Public recognition	Plaques and awards that can be displayed prominently within participating organizations, and assistance with external media public relations.
Regulatory benefits	Opportunities for interaction with EPA officials or promises of reduced inspection priority.
Coordination	Encourages all participants to adopt similar policies.
Funding	Financial grants or incentives for selected applicants.
Info disclosure	Participants expected to disclose data on their environmental performance.
Goal setting	Participants expected to set goals for environmental improvement.

in the form of reduced priority for inspection (Performance Track) or improved access to EPA officials (Climate Leaders).[10] Other programs provide third-party certification of the environmental effectiveness of certain technologies (Environmental Technology Verification program) or a reliable compendium of information about the environmental attributes of competing products (Green Vehicle Guide).[11]

Overall, it seems appropriate to characterize PVPs as primarily informational in nature.[12] As Table 1 shows, there are several different types of information-oriented PVPs. First, five involve government-sponsored research aimed at creating new knowledge, which can then be diffused throughout an industry. Second, 28 programs codify the knowledge of certain leading firms through case studies and make that information available to other firms in the industry. Third, 24 programs include peer-to-peer sharing of information, in addition to transmitting information through the regulator as intermediary. Each of these types of programs has certain special characteristics, which we now discuss.

Government-sponsored research is relatively unusual among PVPs. Design for the Environment and Green Chemistry are among the more prominent programs that utilize this approach. Even Design for the Environment sponsored little original research. Its focus was instead on pulling together the existing body of knowledge on the environmental impacts of alternative technologies in particular industries, an approach we discuss in more depth below. Government-sponsored original research seems to be used primarily in industries where there are no or few large firms that can generate the knowledge themselves. For example, one of the first projects under the Design for the Environment program was aimed at the dry cleaning industry, whose firms are too small to undertake projects aimed at

generating new knowledge (or even staying abreast of the existing knowledge base) on the environmental impacts of alternative dry cleaning technologies.

Programs that codify the existing knowledge of leading firms are perhaps the most common tool used within the family of EPA partnership programs. For example, many PVPs provide case studies of successful projects undertaken by participating firms. Some types of knowledge, of course, are difficult for the EPA to generate directly, such as learning by doing, that is, knowledge that accrues during the process of conducting business. Government-sponsored research is a poor means for attempting to create this knowledge. Even if the knowledge could be generated directly through government sponsorship, at least in principle, it is often more efficient for the regulator to collect data on the experience firms have already accumulated rather than to try and generate new knowledge on its own, assuming firms can be persuaded to share their existing stock of information.

Peer-to-peer information sharing is an aspect of PVPs that is distinct from the transmission in written form of codified knowledge and case studies. Ongoing interactions with give and take are particularly useful when firms are engaged in long-term processes of continuous improvement in the environmental arena. One-time achievements can be documented and posted on the Web, but Web postings will always lag behind the ongoing creation of new knowledge. Face-to-face interactions are also helpful when one cannot simply replicate one firm's experience in another firm's operational setting. In such cases, the opportunity for immediate feedback helps firms to determine just how applicable other firms' experience is for their own idiosyncratic problems. This may have particular value when the technological processes involved are complex and are difficult for EPA officials to convey accurately without having actual industry experience.

The second key design feature of many PVPs is the provision of public recognition for the firm. This may be quite attractive to firms, as the EPA is likely to be viewed as a more credible source of information about the firm's good works than is self-promotion by the firm itself. The EPA's recognition programs can also help to boost employee morale within the firm by highlighting the efforts of individuals who have played important roles in environmental improvement. For firms that use their environmental performance as a way to attract quality employees, this benefit can have substantial value.

We will refer back to this discussion of the structure of PVPs in section 4.3, where we discuss its implications for empirical evaluation of PVPs, and in section 6, where we discuss in more detail how regulators can design PVPs to function most effectively as information diffusion programs.

3. Empirical Evidence on the Performance of PVPs

In this section, we review the still small body of hard quantitative evidence on how well PVPs perform. While there are many qualitative case studies of individual programs,[13] and quite a few papers that study which firms are likely to join PVPs,[14] our interest here is on whether these programs have any measurable impact on the behavior of firms that join. We begin by discussing the most widely studied PVP, the

EPA's 33/50 program, then we turn to climate change PVPs, and finally discuss other programs, including WasteWise, the Sustainable Slopes program for ski areas, and the EPA's Performance Track program. Overall, the empirical results suggest that participation in these PVPs had little or no impact on firms' environmental performance.

3.1. Toxic Chemical Emissions: The 33/50 Program

The EPA's 33/50 program was initiated in 1988 and is considered the grandfather of all voluntary programs. Its primary goal was to convince companies to set goals for reducing toxic chemical emissions by 50 percent by the year 1995, from a 1988 baseline. The program emerged shortly after the deadly chemical release from Union Carbide's plant in Bhopal, India, which killed over three thousand people. Chemical industry leaders became seriously concerned about the industry's "license to operate," especially after survey results found that the chemical industry's reputation among the public was in the same league with the tobacco and the nuclear industries, both of which had been saddled with intrusive and burdensome regulations. Indeed, the Chemical Manufacturers Association was concerned enough to create the Responsible Care program to improve the public's trust of the industry.[15]

It was in this context that William Reilly, EPA administrator and former head of the World Wildlife Fund, called a small group of chemical industry leaders into his office and told them he expected substantial reductions in toxic emissions, which could be accomplished voluntarily or through regulations. The industry representatives preferred a voluntary approach, but there was clearly a regulatory threat looming behind the program.[16]

According to the EPA, the program consisted of four major elements: "outreach to companies to encourage commitments; public recognition of companies for their commitments, pollution prevention efforts, and achievements; technical assistance to help companies overcome barriers and achieve commitments through pollution prevention practices; and evaluation of the effectiveness of both industry and government efforts in a voluntary, cooperative program."[17]

Outreach was accomplished by sending solicitation letters to companies directly, inviting them to participate. In addition, EPA convened "a series of about a dozen meetings with top executives from different industrial manufacturing sectors: chemicals; transportation related; machinery and electrical equipment; iron, steel, and primary metals; pulp and paper; petroleum refining; pharmaceuticals; wood and metal furniture; rubber and related products; and metal finishings and coatings. Trade associations, such as the Chemical Manufacturers Association, were instrumental in helping arrange these sessions."[18]

Public recognition was to be created in "program publications, press releases, and in speeches and other routine federal and state communications. Companies submitting reduction commitments receive a formal certificate of participation from EPA."[19]

With regard to technical assistance, there were five components: (i) a series of workshops across the country with industry to exchange information on pollution

prevention theory and practices; (ii) the Pollution Prevention Information Exchange System, a free computer bulletin board containing technical and policy information on pollution prevention; (iii) bibliographic reports on pollution prevention and recycling techniques; (iv) a pollution prevention resource guide, which identifies key pollution prevention documents, industry specific guidance manuals, fact sheets, and videos; and (v) a list of successful and innovative pollution prevention practices companies have implemented as part of the 33/50 program.[20]

Because the program builds upon the readily accessible information reported through the EPA's Toxic Release Inventory (TRI), it is the most widely studied of all voluntary programs. However, researchers are divided on the impacts of the program. All four papers that we discuss below employ a two-stage methodology of the sort pioneered by Heckman (1979), in which the first stage predicts the probability a given firm participates in the program, and the second stage estimates performance controlling for the likelihood of participation. This method avoids the selection bias that occurs if one simply includes program participation as a variable, without controlling for the antecedents that explain participation.

Khanna and Damon (1999) were the first to study whether 33/50 participation made a difference in the level of chemical reductions undertaken by firms over the period 1991–93, and concluded that 33/50 program participants reduced emissions significantly more than did other firms in the chemical industry during this period. This paper has been widely cited as evidence that PVPs work. Sam and Innes (2007) also analyze the 33/50 program, using a larger set of explanatory variables and a longer time horizon, and also conclude that program participation reduced emissions, but only had a significant impact on emissions in 1991 and 1992. In later years, they find no evidence that program participants reduced emissions any more than did nonparticipants.

Vidovic and Khanna (2007), in contrast, find no impact at all from 33/50 program participation. They include a variable measuring emission reductions during the two years prior to the inception of the 33/50 program, and find that once this variable is included, the predicted probability of participation has no impact on emissions at the firm level. They thus conclude that most of the reported impact of the program came from "free riding" by early joiners who had already accomplished significant reductions without the benefit of the program. This is consistent with raw data reported in U.S. EPA (1999, p. 2), which shows that industry had already achieved a 32.1 percent reduction in emissions by 1991, when EPA began inviting companies to participate.

Finally, Gamper-Rabindran (2006) revisits the 33/50 program's effectiveness, accounting for some measurement problems inherent in the program.[21] He finds that participants in the fabricated metals and paper industries cut emissions relative to nonparticipants, while in the chemical and primary metals industries, participants actually did less emissions reduction than nonparticipants.[22] Furthermore, even in the industries where participation seemed to be beneficial, the vast bulk of the apparent emission reductions were really transfers off-site rather than true pollution prevention. Gamper-Rabindran thus concludes that the program has been ineffective in achieving its goals.

3.2. Climate Change

Most of the U.S. climate change PVPs aim to increase investments in energy efficiency. They emphasize the private benefits to firms and individuals of adopting energy-efficient equipment, and attempt to solve the "market failures" that limit the spread of these technologies. The climate change PVPs were begun under the first Bush Administration, after President Bush promised to be the "environmental president." Most of them, however, were promulgated as part of the Clinton Administration's efforts to achieve reductions in greenhouse gases after the "Earth Summit" in Rio de Janeiro in June 1992.

In contrast to the 33/50 program's origins, there does not appear to have been a substantial regulatory "threat" driving the adoption of climate-oriented PVPs. Indeed, the first Bush Administration opposed strong actions to combat global warming and was publicly derided by U.S. environmental groups and by most other nations of the world for its refusal at the "Earth Summit" to agree to a timetable with specific targets for reducing emissions of greenhouse gases.

After President Clinton was elected in November 1992, one of his early actions was to announce support for stronger measures to prevent climate change. In the early months of 1993, his administration floated a variety of proposals to tax energy, including a carbon tax and a broader-based "BTU tax" based on the energy content of fuels as measured in British thermal units. The political backlash was fast and furious, and within a few months the administration had abandoned the BTU tax initiative. When the administration presented its CCAP later in the year, the focus was shifted away from mandatory regulations to subsidies (including $200 million per year to stimulate the adoption of more energy-efficient technologies) and voluntary programs. The environmental community was not impressed. Alden Meyer, director of the program on climate change and energy at the Union of Concerned Scientists, argued that the plan placed too much emphasis on voluntary measures, "with no prospect of hammers or sticks to bring us into compliance if those don't work."[23]

Released in October 1993, the president's CCAP spawned many public voluntary programs including Green Lights, Climate Wise, Motor Challenge, and Energy Star Buildings, among many others. Unfortunately, there is little work that attempts to measure the impact of these programs on emissions, although there is a large literature describing the programs and a few papers that assess empirically the factors driving firms to participate and the benefits claimed by participants.[24] However, the Climate Challenge program for electric utilities, sponsored by the Department of Energy (DOE), has been studied by Welch, Mazur, and Bretschneider (2000) and Delmas and Montes-Sancho (2007).

The Climate Challenge program invited utilities to set their own targets for carbon dioxide emissions reductions, develop their own approaches to achieving reductions, and self-report on their progress. Stated benefits of participation included the possibility of preempting binding legislation, public relations advantages, cost savings, and the possibility of obtaining early reduction credits in the event that mandatory climate change legislation is passed.[25] Welch et al. (2000) find

that participation in the Climate Challenge program most likely had no impact on greenhouse gas emissions, although some of their results suggest it may have actually had a detrimental impact. They point out that there was no real regulatory threat during the time period they studied (1995–97), and that this may explain why the program had little effect on participant behavior.

It is also important to note that on average, the 50 largest utilities in their sample cut CO_2 emissions by 6.3 million tons per firm over the sample period. The average reduction pledged by program participants was three million tons, which is less than half the average actual reductions achieved by all firms. Thus, it is not the case that participants took no action; it is just that nonparticipants reduced emissions just as fast as participants. As a result, it is possible that the DOE is correct when it claims that "A significant effect of the Climate Challenge program is the shift in thinking of electric utility management and strategic planners to include the mitigation of greenhouse gas emissions into their corporate culture and philosophy," and that "Climate Challenge has served as a catalyst for utility support of many of the voluntary CCAP actions. . ."[26]

Delmas and Montes-Sancho (2007) also studied the Climate Challenge program, but they distinguished between the behavior of early joiners and late joiners. Like Welch et al. (2000), they found no overall difference in emissions reductions between program participants and nonparticipants. However, early joiners actually did reduce emissions significantly more than nonparticipants; the problem was that this beneficial effect was canceled out by the behavior of the late joiners. The authors argue that late joiners were free-riding on the substantive efforts of the early joiners and were participating in a purely symbolic way to obtain benefits with relevant stakeholders. This suggests their participation can be viewed as a form of greenwash designed to deflect attention from their actual environmental performance.[27] Delmas and Montes-Sancho find that the two groups differed in important ways: Early joiners were larger and subject to greater political pressure than late joiners, had higher regulatory expenses, and were better connected to the industry trade association.

Morgenstern and Pizer (2007, chap. 7) study the EPA's Climate Wise program, a PVP initiated in 1993 and targeted at the nonutility industrial sector, with an emphasis on encouraging energy efficiency, renewable energy, and pollution prevention techniques. In 2000, Climate Wise was renamed and placed under EPA's Energy Star umbrella. The main requirements for a participant were that it develop a baseline estimate of its greenhouse gas emissions, pledge future reductions, and make periodic progress reports. Like most PVPs, the program offered public recognition and technical assistance to participants. At its peak, the program had over six hundred members, with thousands of facilities nationwide. Morgenstern and Pizer's basic conclusion is that the program had only a transient effect on fuel use and emissions, with the best estimate being a 3 percent reduction during the program's initial phase. They note that there is also some evidence that participants actually increased their electricity use in achieving these apparent reductions, so the program's overall impact on the environment is unclear. Interestingly, they speculate that "it may be fair to say that the effect of Climate Wise was to accelerate energy-saving behavior that eventually arose among program participants and nonparticipants alike."[28]

3.3. Other Programs

There have also been empirical assessments of the EPA's WasteWise program, EPA's Performance Track program, and the Sustainable Slopes program, a voluntary environmental initiative established by the U.S. NSAA in partnership with federal and state government agencies.

Delmas and Keller (2005) studied the EPA's WasteWise program, created in 1994 to promote waste reduction in businesses and other organizations. WasteWise encourages participants to design their own waste reduction and recycling programs and to use emerging technologies in the design and manufacturing process of materials. It offers technical information, free technical assistance, and opportunities for peer-to-peer networking. Although the authors did not have information about actual waste reduction outcomes, they were able to assess whether participants followed through on their commitments to report their results to the EPA. Based on surveys of participating firms, Delmas and Keller found that firms joining the WasteWise program in 1999 were significantly less likely to report on their environmental performance (as required by the program) than were firms that joined in earlier years.

Coglianese and Nash (2007) study the EPA's Performance Track program. This program cut across various industry sectors, and offered additional regulatory flexibility and reduced inspection frequency to firms that had demonstrated a track record of environmental compliance. Although the authors' analysis does not present a formal quantitative analysis of the performance impacts of participation, they conclude that "it appears that many businesses simply do not perceive the rewards offered by government to be very significant at all . . . The conclusion from this analysis is that the level of participation in programs like Performance Track will likely remain quite modest."[29]

Rivera and de Leon (2004) study the Sustainable Slopes program, which was created in response to growing criticism by environmentalists of the Western ski industry's expansion plans, which emphasized concerns about landscape destruction, deforestation, water and air pollution, and damage to wildlife habitats. The program, created by the NSAA in 2000, with the EPA as a partner, aims to promote "beyond compliance" principles that cover 21 general areas of environmental management. Participant ski areas are expected to implement annual self-assessment of their environmental performance; it does not include specific environmental performance standards or third party oversight for participants. In its first year of operation, 160 ski areas enrolled in the program, a number that increased to 170 in 2001, and has since remained constant at 173 ski areas. The self-assessment survey of environmental performance distributed by the program was completed by 79 ski areas in 2003, about 11 percent less than in 2001 and 2002.

Rivera and de Leon (2004) measure the performance of the program using ratings created by the Ski Area Citizens Coalition, an alliance of American environmental organizations. They find that "participant ski areas appear to be correlated with lower third-party environmental performance ratings."[30] They attribute the poor performance of the program to loosely specified performance criteria and lax reporting requirements.[31]

3.4. Overall Empirical Conclusions

The papers we have reviewed here indicate that PVPs have had little or no impact on the behavior of participants. Even the 33/50 program, for which initial studies found significant impacts, seems under further study to have had little effect overall. Climate Wise appeared to create a small and transient beneficial effect on greenhouse gas emissions, Climate Challenge had no measurable effect overall, and Sustainable Slopes arguably had a negative impact. These findings are broadly consistent with the case study literature, as represented in Morgenstern and Pizer (2007). Some case studies suggest a cautiously optimistic conclusion that PVPs may offer modest benefits. However, as Morgenstern and Pizer (p. 184) conclude: "[N]one of the case study authors found truly convincing evidence of dramatic environmental improvements. Therefore, we find it hard to argue for voluntary programs where there is a clear desire for major changes in behavior."

4. The Political–Economic Context of PVPs

The extensive and continued use of PVPs by the EPA stands in marked contrast to the empirical literature that suggests the programs are ineffective. In this section, we discuss whether extant empirical results on the effectiveness of PVPs have been interpreted correctly. First, we argue that once one considers the political environment within which PVPs arise, the objectives of regulators, and the structure of most PVPs, the expectation that PVPs will result in large changes in corporate behavior is misplaced. Second, we argue that the information-oriented design of most PVPs means that the econometric techniques commonly used in the literature may not actually identify the effects of these programs.

4.1. Motives for Voluntary Reductions

As the discussion in section 3 illustrates, PVPs arise in a setting in which society believes that businesses are engaging in activities that produce significant environmental harm. What constitutes significant harm is more often than not a political issue as much as it is a scientific issue. Consequently, participants and nonparticipants alike may face a variety of pressures to reduce the environmental harm they are deemed to cause. These pressures might manifest themselves in the market place, via legislative or regulatory threats, or through threats from nongovernmental organizations (NGOs). Econometric studies need to be careful to control for these factors if they are to obtain unbiased and efficient estimates.

Market-based motivations for voluntary pollution reductions can take several forms. Porter and van der Linde (1995) suggested a so-called win–win motive for voluntary pollution reductions: Firms may clean up their production processes voluntarily because cleaner production processes are cheaper than dirtier ones. While many economists doubt that this hypothesis can explain widespread pollution abatement, Palmer, Oates, and Portney (1995), in rebuttal to Porter and van der Linde,

do find support for the notion that clean production may lower firm costs once the costs of current and possible future regulations are taken into account.

Green consumerism is a commonly suggested driver of voluntary pollution reduction efforts.[32] If consumers are willing to pay a premium for environmentally friendly goods, any firm that can verifiably reduce its pollution in a cost-effective manner should engage in such efforts voluntarily. Employees have also been suggested as an important driver for voluntary corporate pollution reduction efforts. Most employees want to feel good about the company where they spend so much of their lives. One way companies try to attract and retain the best employees is by making environmental commitments that are aligned with those employees' environmental values.[33]

Some studies suggest that even if pollution efforts result in a net cost to the corporate bottom line, green investors may exist in sufficient numbers to prevent the market from disciplining voluntary pollution reduction efforts. Graff Zivin and Small (2005) show that if investors prefer to make their social donations through bundled corporate activities rather than through direct charitable contributions, then companies may find it profit-maximizing to engage in actions such as voluntary pollution abatement to attract investors. Baron (2006) shows that even when activities such as voluntary pollution abatement may lower the value of the firm, its shares trade at a premium, reflecting the utility green investors obtain from holding them.

There is a large theoretical and empirical literature that suggests that voluntary emissions reduction efforts may be motivated by the desire to preempt legislative and/or regulatory threats. Maxwell, Lyon, and Hackett (2000) show that industry self-regulation of pollution emissions can be effective in preempting legislative threats for two reasons. First, self-regulation lowers consumers' desires for additional emissions reductions and, second, it serves as a commitment mechanism for industry to fight harder against legislative efforts aimed at extracting further emissions reductions. In a related vein, Segerson and Miceli (1998) show that if a regulator anticipates legislation that may be forthcoming and costly to enforce, it may negotiate a voluntary agreement with industry aimed at preempting the legislation.

A legislative threat is the manifestation of a desire by the broader public to regulate the emissions activities of firms. However, in some cases, industry may hold sway over the political process, effectively blockading any legislative threats. In this situation, NGOs that wish to change corporate environmental behavior must turn to what David Baron (2001, 2005, 2006, 2007) has termed "private politics," in which NGOs directly pressure firms and/or industries to undertake actions to improve their corporate social performance (via boycotts, negative information campaigns, etc.).

We have dwelt upon the various motives for corporate greening for two reasons. First, as mentioned earlier, econometric studies of PVPs need to be careful to control for these various drivers of behavior, which may affect incentives to join a PVP. Second, and more subtly, these drivers affect the incentives for firms to make use of information about pollution reduction opportunities, whether that information comes through participation in a PVP or through other, more indirect, channels.[34]

Remark 1: Firms' incentives to join PVPs, and their incentives to use the information provided by PVPs, will depend upon the strength of market drivers for corporate greening, including opportunities for cost reductions, the presence of green consumers, employees and investors, and threats of regulation or negative campaigns by NGOs.

4.2. Mandatory versus Voluntary Programs

The previous subsection illustrates that when a regulator offers a PVP, firms may be subject to a myriad of pressures aimed at pushing them to undertake emissions reductions efforts. The 33/50 program is a case in point. At the time the program was introduced, firms were already required by law to report their toxic chemical emissions to the TRI. Because information in the TRI is public, firms (especially the largest emitters) would have already been subject to public pressures to reduce their emissions of the TRI chemicals.[35] The fact that firms were required to report emissions of specific chemicals, and the fact that the 33/50 program identified a specific subset of the TRI chemicals, is a strong indication of a regulatory threat. Additionally, the fact that the share prices of the largest emitters experienced abnormal negative returns on the date that emissions information was released suggests that market forces, including green investors, employees, and possibly even green consumers, likely played a role in motivating firms to engage in emissions reduction.[36]

Although firms face growing pressures to engage in pollution abatement, Bagnoli and Watts (2003) show that market forces are unlikely to be strong enough to induce firms to undertake socially optimal levels of abatement. Assuming there is a need for government intervention, what motivates a government agency to offer a PVP as opposed to using another policy instrument? The best-known theoretical model of PVPs is that of Lyon and Maxwell (2003), which argues that PVPs are chosen based on the regulator's expectations about the political and market responses of industry to mandatory as opposed to voluntary policy alternatives.

Lyon and Maxwell (2003) follow Carraro and Siniscalco (1996) in modeling the public voluntary agreement as a subsidy payable to any plant that adopts the environmental technology.[37] They compare it to a mandatory policy that takes the form of an environmental tax, although their main points would apply to an environmental standard or a cap-and-trade program as well. They assume that the benefits of the PVP can only be collected by plants that participate in the PVP program. In addition, they assume that plants that adopted the environmental technology before the PVP was established cannot be excluded from receiving the benefits of participating in the PVP.[38] As we discuss further, regulators may seek firms that have already undertaken abatement actions to be "early joiners" and often seek to reward such firms with positive publicity.

Using this basic setup, Lyon and Maxwell (2003) show that the welfare gains from taxation, relative to government inaction, come in three parts. First, there are social gains from forcing inefficient plants to exit the industry, as the profits these plants generate are less than the environmental damage they cause. Second is the social value of the tax revenues raised from the emissions tax, which can offset

the need to raise public funds through other means. Third are the social gains from the adoption of the environmental technology by efficient plants.

When regulators do not face political opposition from industry, the optimal pollution tax generates greater social benefits than does the optimal public voluntary program. There are two key reasons for this. First, a fundamental limitation of the PVP is that it cannot subsidize plants to exit the industry; plants must stay in business in order to collect any benefits from the PVP program. Second, in a world with costly public funds, a tax that generates public revenues is preferable to a subsidy that drains public coffers. Both effects make a tax preferable to a PVP when political pressures are irrelevant.

Remark 2: An environmental tax is inherently a more effective instrument than a PVP.

Remark 2 serves as a caution to researchers seeking to investigate the effectiveness of PVPs. As PVPs will provide firms with weaker incentives than traditional regulatory tools, one should not expect PVPs to induce dramatic changes in firm behavior.

If PVPs are necessarily a weaker tool than regulation, resulting in perhaps small differences between participants and nonparticipants, why should regulators include PVPs in their regulatory toolkit? The answer is that PVPs may be useful in achieving regulatory goals either as a complement to existing or forthcoming regulations, or as an alternative when the traditional legislative and regulatory processes have been blockaded. As we noted earlier, many PVPs are structured to enhance information flows about pollution prevention technologies and processes. This is a step that can be taken even when there is no political will to impose mandatory regulations, and it can at least help eliminate pollution whose origin is inefficient production processes. In the following section, we discuss how the structure of a PVP may assist both participants and nonparticipants to achieve pollution reduction goals, and we discuss the implications of this structure for empirical studies of PVP effectiveness.

4.3. The Structure of PVPs

As we mentioned previously, PVPs can be viewed as modest subsidies designed to induce participating firms to adopt cleaner production processes. We now turn to investigating the nature of these subsidies in more detail. The subsidies offered by PVPs do not take the form of direct cash payments, but are instead implicit subsidies created through offering public recognition, regulatory benefits, or information and technical assistance. The first two of these are basically private benefits whose magnitude is unlikely to induce large investments in pollution reduction. The public recognition that government agencies give firms for pollution reduction efforts is likely to have only a small impact on the corporate bottom line. Similarly, regulators are constrained in the level of favorable treatment they can offer to firms with positive environmental profiles. The third form of subsidy is essentially a public

good, as we have noted in section 3, so joining the PVP may not be necessary to collect this subsidy.[39] Why then do firms join PVPs and how do they assist firms in achieving environmental goals?

Firms constantly seek investments that achieve positive returns. The benefit from environmental investments may take the form of a reduction in energy usage, increased employee morale and productivity, or enhanced consumer, community, and regulatory relations. These benefits may vary across firms for several reasons. For example, if there are economies of scale in building employee morale, then larger firms may benefit more from an increase in morale than smaller firms. Similarly, firms that deal with regulatory authorities on a regular basis may benefit more from improved regulatory relations than firms that interact infrequently with these authorities. For these reasons, large firms may find it worthwhile to invest in acquiring information about opportunities for environmental improvement, while smaller firms may be unable to afford this type of investment. A PVP can then be structured so as to enhance information collection from firms that have already undertaken environmental investments, and then to speed the diffusion of information about pollution-abating technologies and practices to firms that would otherwise lack incentives to gather that information.

Because government subsidies are small, firms will be unwilling to provide information concerning investments that give them a competitive advantage. However, many environmental investments may lower a firm's fixed costs rather than variable costs, and are therefore unlikely to result in a dramatic advantage in the firm's competitive position. In these cases, small incentives, such as public recognition and enhanced regulatory relations, may be enough to induce knowledgeable firms to join a PVP that ultimately diffuses their information to other firms. These incentives will be enhanced if the PVP serves to assist industry in preempting costly regulations.

Once the government agency has obtained the relevant information, and decided upon the mechanism it wishes to use to diffuse it, the government must decide with whom the information should be shared. Should it restrict information access to participants in PVPs, or should it to attempt to diffuse the information as broadly as possible? For an agency charged with protecting the natural environment, it is clearly desirable to share information as widely as possible, thereby having the greatest possible beneficial impact on the environment. Once firms join the PVP, the EPA would still have incentives to make information available more broadly. The only reason for the agency to withhold information from nonparticipants would be to "prove" that PVPs work.

> *Remark 3: Once a government agency has acquired pollution abatement information, environmental benefits are greatest if it is made available to all firms who might benefit from it, regardless of whether they participate in a PVP or not.*

This remark has strong implications for the empirical analysis of PVPs. It means that there may be no good reason to expect a difference in performance between firms that join a PVP and those that do not. It is possible that a difference would be observed in the early phases of a program, when the government is trying to attract

participants who already have information to share. Once the program moves to the dissemination stage, however, there is likely to be no measurable difference between participants and nonparticipants. This is a point that generally has not been recognized in the empirical literature on PVPs,[40] and suggests that a reinterpretation of the findings in this literature may be necessary. Existing papers have focused on whether participants in PVPs achieve higher environmental performance than nonparticipants. While these papers have provided useful insights, they do not answer the broader question of whether PVPs have had beneficial effects in the aggregate. As this latter question is the important one from a policy perspective, we would argue that existing empirical analyses are misspecified for the purpose of policy evaluation.

Remark 4: Given that the information offered by a PVP will gradually diffuse beyond PVP members, performance differences between participants and nonparticipants should diminish over time.

It is worth noting that government agencies are unlikely to be the only source of information diffusion. Many environmental investments involve the adoption of new technologies. The suppliers of those technologies have strong economic incentives to promote their innovations to PVP participants and nonparticipants alike. Consequently, even if a regulator does not proactively diffuse information beyond the PVP membership base, it is still reasonable to expect that PVP nonparticipants will become aware of profitable environmental investments and practices over time.

Even if firms do not need to join a PVP to acquire information, some of them will still have incentives to join. The most obvious motivation for joining is to obtain public recognition provided by the program, but some programs also offer the potential for improved relations with regulators. Larger firms and those facing greater external pressure from NGOs are more likely to find that these benefits outweigh the administrative costs of participating, as we mentioned in section 3. Of course, there are also costs to participation. In addition to the administrative costs of filling out the required paperwork, joining a PVP can impose the risk of being targeted by activists for "greenwashing."[41] The expected cost of that risk may exceed the subsidy associated with joining, and thus some firms that make environmental improvements might choose not to join the PVP.

5. Implications for Empirical Research

In this section, we elaborate on the implications of section 4 for empirical research attempting to identify the effects of PVPs. As discussed earlier, our analysis sees PVPs unaccompanied by a regulatory threat as a form of modest subsidy aimed at assisting companies engaged in pollution reduction. As a result, expectations should be low regarding what is possible through PVPs. In addition, it is difficult to disentangle the effect of a PVP from other motivating factors such as state and federal regulatory threats or market forces (from green consumers, employees, or investors). This suggests that useful studies will need to have large numbers of data points, so as to generate small standard errors and facilitate inference.

The framework presented in section 4 implies that recent empirical analyses finding that PVPs have no impacts are misspecified. If information on pollution abatement techniques diffuses to nonparticipants as well as participants, then the empirical studies evaluating PVPs have pursued empirical strategies that cannot possibly identify the true impact of these programs. If a PVP is effective in disseminating information about pollution prevention throughout the manufacturing sector, then all firms would be reducing their emissions at roughly the same rate—which appears to be the case. There would be no evidence that PVP participants performed better than nonparticipants, even if the program actually achieved meaningful goals.

This perspective suggests that different econometric strategies are required to measure the true impact of PVPs. It is not enough simply to apply a Heckman-style two-stage estimation, in which the first stage estimates the probability of a firm participating in the PVP and the second estimates the effectiveness of the PVP, conditional on the probability of participation.[42] As mentioned earlier, this approach will not capture the effects of PVPs if information diffuses to nonparticipants.

We believe that progress in the empirical analysis of PVPs will be facilitated if researchers emphasize that PVPs are information-oriented programs designed to diffuse abatement technologies and practices. In this view, many firms are not operating on the production possibilities frontier, and environmental process improvements can be studied as a form of technology diffusion that may be enhanced by PVPs.

As economists, we are naturally reluctant to believe there are $20 bills lying on the ground, but as business school professors we speak with enough corporate managers to realize that there is considerable waste within industry. Indeed, Leibenstein's (1966) notion of X-inefficiency refers to exactly this failure to squeeze out all waste from the production process.[43] We do not find it hard to believe that there really are "win/win" opportunities for companies to cut emissions and costs at the same time by reducing waste. Porter and van der Linde (1995) provide numerous examples of firms that increased their resource use efficiency, reducing pollution and costs at the same time.

There is a small empirical literature demonstrating that providing managers with information on their environmental performance can produce meaningful improvements. Blackman, Afsah, and Ratunanda (2004) study the Program for Pollution Control, Evaluation, and Rating (PROPER) program in Indonesia, a mandatory rating system for large water polluters, which assigns to each plant a color indicating its performance (from worst to best the ratings are black, red, blue, green, and gold). They find that plants rated black or red improved significantly after the ratings, and that the most important reason was simply that managers previously lacked information about their low performance, although concerns about ISO-14001 certification and shareholder value were also important. Blackman, Lyon, Narain, and Powers (2007) study India's similar Green Rating program, and also find that pulp and paper plants receiving the lowest rating improved significantly afterward.

The studies of PROPER and the Green Rating program support the notion that information diffusion programs can help firms to move up onto the production

possibility frontier. In neither case did high-performing plants improve as a result of the programs, but low performers were able to rapidly improve their environmental performance.

Once we recognize that firms may be operating below the production possibility frontier, it becomes important to come up with a way to control for the true state of efficiency (and, implicitly, of information) possessed by program nonparticipants. One approach is the use of data envelopment analysis (DEA), a tool pioneered by Charnes, Cooper, and Rhodes (1978) that is used to estimate how far individual firms are from the production possibilities frontier. The resulting distance measure gives an indication of the internal inefficiency of each firm, which can be taken as a proxy for a lack of information on pollution control opportunities. Delmas and Montes-Sancho (2007) use DEA to compute the productive efficiency of firms, and then use this measure as an independent variable to help explain participation in the Climate Challenge program. They find that productive efficiency has important explanatory power. Highly efficient firms were more likely to join the program early, which is consistent with our argument that the government wants to attract these firms so as to codify their knowledge and share it with other, less efficient, firms. Interestingly, they also found that even late joiners tended to be more efficient than nonparticipants, but they also tended to spend less on environmental efforts than did nonparticipants. This last finding suggests that including a measure of environmental efficiency (as well as pure productive efficiency) might also be worthwhile as a way to estimate the state of the firm's environmental knowledge.

Our argument suggests that measures of a firm's productive and environmental efficiency should also be included in the second stage of empirical assessments, where researchers estimate the effects of program participation on environmental performance. We expect that less efficient firms will exhibit greater performance improvement, as all firms in the industry gradually converge to the production frontier. Of course, this is likely to be true of program nonparticipants as well as participants, although nonparticipants may exhibit improvement with a greater lag than participants. If this lag is found in the empirical data, it would support our hypothesis that information diffuses beyond the boundaries of PVP participation.

It may be possible to make use of information on the network structure of particular industries to identify the effects of a PVP. If information is transmitted across the links of industrial networks, as argued by Kranton and Minehart (2001), then firms that join a PVP are more likely to diffuse information to firms with whom they share a link. The notion that social networks may play an important role in diffusion processes is supported by the computer simulations of Abrahamson and Rosenkopf (1997). Empirical research could potentially use information on links between firms to trace out the process of information diffusion. Membership in trade associations is one simple way to get at interfirm linkages, but more nuanced network data would be more helpful in assessing the role of PVPs.

Another approach to identifying the effects of a PVP would be to select a program oriented toward a specific industry, and then create a control group consisting of firms from an industry with similar production processes that are not part

of the PVP. It would be especially helpful if the industries were different enough that they could not easily share knowledge on environmental efficiency improvement.

Another identification strategy would be to exploit geographical information, such as policy differences across states or countries. With this strategy, a key issue will be to control for the extent of information spillovers across political boundaries. It should also be possible to learn from the literature on technology diffusion, which has begun to estimate spillover effects explicitly.[44] By including a range of independent variables from the diffusion literature that have not traditionally been part of empirical analyses of PVPs, we may be able to identify the effects of PVPs much more precisely.[45] In particular, it may be worthwhile to control for the geographic proximity of firms, as Audretsch and Feldman (1996) have shown that innovations are more likely to diffuse between firms that are located closer together.

An alternative approach would involve exploiting patterns in the dynamics of PVP participation to test hypotheses regarding PVP performance. In particular, we might expect joiners to perform better than nonjoiners early on, as found by Delmas and Montes-Sancho (2007) and Sam and Innes (2007). However, it is not yet clear exactly why these results are observed. It may be that, as Delmas and Montes-Sancho suggest, late joiners are simply free-riding on the reputation of the PVP. Alternatively, it is possible that the designers of a PVP attempt to first attract those firms that already have knowledge about pollution reduction, and then to draw in firms that can benefit from this information. Empirical results may depend in part upon the strength of regulatory threats at a given time.

It may be some time before the next generation of empirical studies on PVPs establishes with confidence the overall effectiveness of these programs in improving the environmental performance of industry. In the meantime, our analysis—for better or worse—gives the managers of PVPs at the DOE and EPA a bit more ammunition with which to defend their programs in the face of the growing empirical assault on their effectiveness.

6. Implications for the Use and Design of PVPs

The goal of a government agency in offering a PVP is to assist as many firms as possible in enhancing their environmental records, not to ensure that participants outperform nonparticipants. Given that PVPs involve the use of costly public funds, it is important to structure PVPs to enhance their efficiency and to use PVPs only when they improve social welfare. In this section, we draw on the findings of the existing theoretical literature on PVPs to offer suggestions regarding their use and design.

Concerning the use of PVPs, Lyon and Maxwell (2003) have shown that the optimal use of a PVP involves consideration of strategic corporate behavior in the lobbying process over a tax or regulation. In this context, they derive the following result.

Remark 5: Offering a PVP may increase industry political resistance to a tax, thereby reducing the effectiveness of the tax and its likelihood of passage.

The intuition behind remark 4 is simple: If the industry knows a PVP will be offered after a tax fails, it has more incentive to oppose the tax so it can collect the subsidy that is offered under the PVP. Whether the possibility of a PVP is likely to have negative incentive effects depends upon political circumstances. If society has reached the point where there is a reasonable likelihood of passing strong environmental legislation, then it would be best if the regulator could commit *not* to offer a PVP. This would help to maintain the political pressure for strong regulation. In contrast, when the chances of strong legislation are minimal, offering a PVP is unlikely to prevent passage of a strong bill, but can offer at least some environmental improvement. In such a situation, a PVP may be a worthwhile policy.

A well-designed PVP can enhance the diffusion of information about pollution-abating technologies and practices to firms that would otherwise lack incentives to gather that information. A regulator attempting to enhance the diffusion of information about pollution control opportunities is faced with two decisions. First, it must decide how to acquire information about the value of alternative pollution abatement technologies and, second, it must decide how to distribute this information to firms. With regard to the first decision, the regulator has two options: It could undertake research and development itself or it could attempt to obtain information from firms that are already informed. In some cases, such as those in which firm-level experience with the environmental investment is necessary for learning, only the latter option will be open to the regulator.

Obtaining information from firms that are already informed is the most desirable option for the regulator to follow as long as the information being passed to the uninformed firms does not threaten the competitive position of the informed firms and hence undermine their incentives to participate. The EPA's Green Lights program provides such an example. The installation of an energy-efficient lighting system tends to lower a firm's overhead and should consequently have little impact on the firm's competitive position. Furthermore, lighting is used in all types of industries, so much of the sharing will be with firms in other industries. In this case, informed firms need to be offered only minor inducements to provide information to the regulator. Typical benefits provided by PVPs include access to EPA officials, highly visible publicity, or a widely recognized logo that can be used on the firm's products—which may be enough to convince informed firms to participate when information is not competitively sensitive.

> *Remark 6: A cost-effective PVP should offer informed firms inducements that cover their costs of sharing information. It then subsidizes the cost of providing that information to uninformed firms.*

Remark 5 is consistent with the work of Darnall (2003), who reports results from a small-scale survey that asked companies to identify their rationales for participation in the EPA's Environmental Management System Pilot Program, and the benefits actually obtained. Among the findings was a striking difference between privately held and publicly traded firms. For example, privately held firms were more likely to report learning valuable new information from participation than were

publicly traded companies. In our framework, these firms are uninformed firms that did not invest in gathering information on their own.

To improve the effectiveness of PVPs, it may be useful to target the benefits of public recognition more narrowly toward those firms that join during the information collection phase of the program, and that are sharing valuable information with government. Firms that join the program during the dissemination phase are more properly viewed as consumers of information, and should not need (and arguably do not deserve) public recognition for finally implementing cost-effective pollution reduction processes. More careful targeting of public recognition might help to eliminate concerns about free-riding behavior from late joiners of PVPs.

For competitively valuable information, firms will be reluctant to share the information with rivals. Any benefits government regulators can provide are unlikely to outweigh damage to a firm's market position. Hence, PVPs are unlikely to be effective unless the information involved is not competitively sensitive.

Remark 7: PVPs should focus on information that is less competitively sensitive so as to enhance information provision by participating firms.

Once the regulator learns the value of a given abatement technology, it must then decide whether and how to transmit the information to uninformed firms. There are a variety of ways for sharing information, which subsidize information acquisition to different extents and in different ways. For example, in many cases, the regulator places case studies on its website, which provide at least partial information to firms at a cost to the government that is virtually zero. In other cases, such as the Climate Leaders program and the Green Power Partnership, the regulator offers direct technical assistance to participating firms. In still other cases, such as the Natural Gas Star program, the regulator facilitates meetings at which firms can share information among themselves. Such meetings may allow for fuller information transmission, but it is costly for firms to travel to meetings and allocate employee time to attending them. They may be necessary, however, if the information to be shared takes the form of tacit knowledge, which is hard to codify in verbal form.[46] Thus, there is a range of options for the regulator regarding the extent to which it subsidizes the information acquisition of uninformed firms.

Remark 8: Regulators have a variety of options for enhancing information diffusion. Written documentation of case studies and other technical information may suffice for relatively simple information. Personalized technical assistance may be required for more complex information that must be tailored to a firm's unique circumstances. Peer-to-peer knowledge exchange is helpful when firms' experiences are heterogeneous and idiosyncratic.

In summary, there are several implications to conceiving of PVPs as information diffusion programs. Regulators using information programs effectively focus on industries where there is likely to be a lack of knowledge about opportunities for cost-effective pollution abatement. Even so, the regulator's expectations are kept modest, as information alone is not likely to be enough to induce large, costly changes in corporate behavior. Regulators are careful not to deploy PVPs when their

presence may undermine the demand for more effective policies. Regulators seek out the least-cost means of acquiring useful information, which may often be from well-informed firms. There is no need to try and draw all firms in an industry into a PVP. Membership in the PVP can be limited to leading firms with knowledge to share, unless peer-to-peer interaction is needed for successful information transfer. Regulators diffuse the relevant information to a broad array of firms in the industry, regardless of whether they participate in the PVP. Finally, regulators use sophisticated econometric tools for evaluating the success of programs, understanding that simple empirical tools may be unlikely to identify much program impact.

7. Conclusions

There appears to be a growing consensus that PVPs are at best of modest impact and at worst a form of greenwash that diverts public attention from important environmental problems. However, our analysis suggests that these conclusions are premature. Given that these programs are typically created out of political weakness, there is no reason to expect them to have large impacts. However, recent empirical findings that PVPs have no impacts seem to us to be misspecified. If we are correct that information on pollution abatement techniques diffuses to nonparticipants as well as participants, then the empirical studies evaluating PVPs have arguably pursued empirical strategies that cannot possibly identify the true impact of these programs. If a PVP is effective in disseminating information about pollution prevention throughout the manufacturing sector, then all firms would be reducing their emissions at roughly the same rate—which appears to be the case. There would be no evidence that PVP participants performed better than nonparticipants, even if the program was achieving meaningful goals.

Our analysis suggests that new econometric strategies are required to measure the true impact of PVPs. The problem is that it is very difficult to control for the true state of information possessed by program nonparticipants. We have suggested a number of potential approaches to identifying the effects of PVPs empirically, and are hopeful that our analysis will spark a new generation of papers that produce more refined estimates of the impact of these programs. In the meantime, our analysis gives the managers of PVPs at the DOE and EPA a bit more ammunition with which to defend their programs in the face of the growing empirical assault on the effectiveness of these programs.

Thomas P. Lyon holds the Dow Chair of Sustainable Science, Technology and Commerce, and is the director of the Erb Institute for Global Sustainable Enterprise, at the Stephen M. Ross School of Business and the School of Natural Resources and Environment, University of Michigan.
John W. Maxwell is a professor at the Kelley School of Business, Indiana University.

Notes

1. Toxic reductions were measured against a 1988 baseline, but according to U.S. EPA (1999), companies were not invited to participate until the spring of 1991, hence we consider that as the beginning of the program.
2. U.S. EPA (1999, p. 4).
3. U.S. EPA (1999, p. 1).
4. We review several prominent empirical articles on PVPs in section 3.
5. Clearly, this misses some important programs from the past, such as the 33/50 program and Project XL. Nevertheless, our approach has the virtue of providing a complete snapshot at a given point in time. For a more comprehensive review of PVPs, see Lyon and Maxwell (2004, chap. 6).
6. Many of the water-related programs appear to be of this type, e.g., Adopt Your Watershed, Clean Marinas, EPA's Volunteer Monitoring program, Decentralized Wastewater Treatment Systems program, Improving Air Quality through Land Use Activities, and National Nonpoint Source Management program.
7. For example, the site for the Partnership for Safe Water is maintained by the American Water Works Association (AWWA). A visit to the site on September 3, 2007, turned up a web page with the information: "Unable to Find Content." The partnership does not appear to be defunct, however. Searching the AWWA website did produce web pages on the partnership, including photos of a U.S. EPA representative handing out plaques to award recipients at a June 27, 2007 meeting of water utility managers. According to the website, the partnership was created after a 1994 EPA study found that 12 percent of Americans were served by water utilities that were in violation of public health standards. "Immediate concern for safety, and the overall realization that appropriate legislation might take years to implement, lead to the innovative cooperative effort called the Partnership for Safe Water. The Partnership brings regulators and drinking water suppliers together in synergistic advancement rather than an adversarial negotiation." (http://www.awwa.org/Resources/utilitymanage.cfm?ItemNumber=3790&navItemNumber=29263). Thirteen years later, appropriate legislation has still not appeared, according to the 2007 report of the partnership: "The *Partnership* program seeks improved water quality, not by meeting more stringent regulations, but by using flexible technical tools that allow each plant to customize performance improvements at their own pace with limited capital spending." (http://www.awwa.org/files/Resources/PSWInfoCenter/AR08AnnualReport2007.pdf).
8. The EPA website merely provides a link to a site maintained by the National Ski Areas Association (NSAA) at http://www.nsaa.org/nsaa/environment/sustainable_slopes/.
9. The HHE program echoes the EPA's earlier 33/50 program in calling for "a thirty-three percent (33%) reduction in total waste volume in all hospitals by 2005 and an overall goal of achieving a fifty percent (50%) reduction by 2010." See http://www.h2e-online.org/docs/h2emou101501.pdf.
10. Maxwell and Decker (2006) present a model of programs such as Performance Track that reward good corporate behavior with a reduced likelihood of inspection.
11. A few PVPs involve helping industry to solve coordination problems that can inhibit the adoption of environmentally friendly practices. The EPA's Water Alliances for Voluntary Efficiency has helped hotels to coordinate on encouraging hotel guests to reuse towels instead of washing them each day. Similarly, EPA's Energy Star program helped the videocassette recorder industry coordinate on the use of inexpensive circuitry that reduces power consumption during periods when the VCR is not in use.
12. This is consistent with Delmas and Terlaak's (2001) argument that PVPs are likely to be most effective in promoting the diffusion of best practices throughout an industry.
13. See the European Environment Agency (1997) or the Organization for Economic Cooperation and Development (2003). For links to numerous other case studies, see http://www.euractiv.com/en/environment/environmental-voluntary-agreements/article-117478.
14. See, for example, Arora and Cason (1995), DeCanio and Watkins (1998), Karamanos (1999), or Videras and Alberini (2000).
15. See King and Lenox (2000) for a more complete discussion of the Responsible Care program.

16. Personal communication from David Buzzelli, retired vice president and director, Dow Chemical, March 14, 2003.
17. U.S. EPA (1992, p. 3).
18. U.S. EPA (1992, p. 4).
19. U.S. EPA (1992, p. 4).
20. U.S. EPA (1992, p. 5).
21. First, he excludes two ozone-depleting substances—carbon tetrachloride and methylchloroform (or 1.1.1-trichloroethane)—that were included in the 17 chemicals on the 33/50 program's list but whose reduction can better be attributed to mandatory phaseouts under the Clean Air Act. Their reduction accounted for one-fifth of the aggregate reduction of 33/50 chemicals from all TRI plants. He also excludes chemicals whose changes in reporting requirements led to paper reductions in emissions. Changes in the reporting requirement of ammonium sulfate in 1994 accounted for 27 percent of the total reduction in toxic releases reported for 1988–91, while the delisting of nonaerosol sulfuric and hydrochloric acid in 1994 and 1995 led to similar paper reductions.
22. Gamper-Rabindram's results for the chemical industry parallel King and Lenox's (2000) study of the chemical industry's self-regulatory Responsible Care program. King and Lenox found that participants in the program did not reduce emissions more rapidly than nonparticipants. If anything, they may have reduced less rapidly than nonparticipants.
23. Stevens (1993, p. C4).
24. DeCanio (1998) finds that firms participating in the Green Lights program reported rapid payback on their investments, and questions why more firms did not join the program.
25. Climate Challenge Executive Summary, http://www.climatevision.gov/climate_challenge/execsumm/execsumm.htm.
26. Climate Challenge Executive Summary, http://www.climatevision.gov/climate_challenge/execsumm/execsumm.htm.
27. For an economic model of greenwash, see Lyon and Maxwell (2007).
28. Morgenstern and Pizer (2007, p. 134).
29. Coglianese and Nash (2007, p. 112).
30. Rivera and de Leon (2004, p. 417).
31. Rivera, deLeon, and Koeber (2006) conduct a longitudinal analysis of the first five years of the Sustainable Slopes program and find little difference between the five-year time horizon and the earlier one-year snapshot.
32. Arora and Gangopadhyay (1995) were the first to formally model green consumerism as a motivation for firm abatement efforts that exceeded levels required by law. The notion that consumers are willing to pay a premium for environmentally friendly products has been adopted in many contexts, see, for example, Feddersen and Gilligan (2001), Heyes and Maxwell (2004), and Baron and Diermeier (2007).
33. Brekke and Nyborg (2004) model a job market that includes environmentally concerned workers. Companies desire to attract these individuals because it is assumed they are less likely to engage in shirking on the job. One way they can screen for these employees is by adopting socially responsible practices. The authors find that if abatement is inexpensive, the gains from labor market screening outweigh the costs of the abatement needed to accomplish it.
34. The effects of these drivers may depend upon the details of a particular PVP. For PVPs where peer-to-peer information exchange is critical, strong opportunities for cost reduction may make firms more likely to join a PVP. But for PVPs where information can readily be codified through case studies or technical documents, firms facing strong pressure from green consumers or NGOs will be more likely to join.
35. In addition, as we explained earlier, many large emitters of toxins were under general social and political pressures as a result of events such as the Bhopal disaster.
36. See Lyon and Maxwell (2004, chap. 1) for a discussion of studies linking corporate environmental and firm financial performance.

37. They do not assume that voluntary actions are cheaper than actions mandated by law, as doing so would bias the outcome toward simplistic conclusions about the superiority of voluntary measures. They also assume away the possibility of win–win solutions, in which the adoption of environmentally friendly technology lowers cost.
38. For example, in the area of climate change, leading firms that have already begun reducing carbon dioxide emissions hope to acquire "early reduction credits" that they can trade in for emissions credits if and when a mandatory system is put in place. In the case of PVPs based on the provision of technical information, as discussed in Haddad, Howarth, and Paton (2004), matters may be somewhat different, as information on environmentally friendly technology is redundant for firms that have already adopted the technology. Firms that have already adopted then have no incentive to join the program, which would tend to hold down the cost of running the PVP.
39. Indeed, Irwin and Klenow (1994) find that even for firms in a highly competitive industry such as the dynamic random-access memory chip industry, knowledge spillovers across firms were extensive. This is likely to be much more true of government programs designed to push information out to industry.
40. Notable exceptions are Delmas and Keller (2005) and Delmas and Montes-Sancho (2007).
41. Lyon and Maxwell (2007) present a formal model in which NGOs target firms they suspect of greenwashing.
42. This is the standard approach in the literature, and builds on the pathbreaking work of Heckman (1979).
43. For example, he cites evidence from International Labor Organization "productivity missions" in which labor productivity was frequently increased by 25 percent or more, even in technically advanced countries such as Israel.
44. See, for example, Audretsch and Feldman (1996) and Karshenas and Stoneman (1993).
45. Fichman (1992) suggests a typology of diffusion situations and the variables appropriate for each.
46. See Aydogan and Lyon (2004) for a model of information sharing in an industry where tacit knowledge is important.

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