How Do Public Disclosure Pollution Control Programs Work? Evidence from Indonesia

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October 2000 • Discussion Paper 00–44

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Abstract

Although a growing body of evidence suggests that publicly disclosing information about plants' environmental performance can motivate emissions reductions, this phenomenon remains poorly understood. To help fill this gap, this paper presents original data from a survey of plants participating in the Program for Pollution Control, Evaluation and Rating (PROPER), Indonesia's widely-acclaimed public disclosure program. These data suggest that a key means by which PROPER spurs abatement is improving factory managers' information about their own plants' emissions and abatement opportunities. This finding contrasts with the prevailing view in the literature that public disclosure enhances pressures to abate placed on firms by external agents such as community groups and shareholders. But our data also suggest that PROPER's "environmental audit" effect operates in concert with external pressures. Therefore, simply supplying new information to plant managers without making that information public may not be sufficient to motivate significant abatement.

Key Words: Public disclosure, environment, voluntary regulation, informal regulation, Indonesia

JEL Classification Numbers: Q28, Q25, 013

Contents

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1. Introduction

Public disclosure—the regular collection and dissemination of information about firms' environmental performance—has been characterized as the "third wave" in environmental regulation, after command-and-control and market-based approaches (Tietenberg 1998). Its growing popularity is partly due to evidence that pioneering programs like the United States' Toxic Release Inventory (TRI) have had a significant impact on pollution abatement. Just as important, public disclosure imposes a minimal burden on regulators. It does not necessarily require an effective enforcement capability or even a well-defined set of environmental regulations. The costs of the administrative activities it does require—data collection and dissemination—appear to be falling due to new information technologies. As a result, public disclosure holds particular promise for developing countries where environmental regulatory institutions are chronically short of funding, expertise and political support. It is also attractive as a complement to conventional regulatory instruments in industrialized countries, especially for types of pollution (like toxics) that have yet to be strictly controlled.

Although policy makers are increasingly embracing public disclosure, we still know relatively little about how it motivates firms to cut emissions. The thin literature on the topic suggests that public disclosure enhances pressures placed on firms by a variety of private- and public-sector agents including community groups, consumers, financial markets, and state regulators. But little research has been done to identify which of these—or other—factors drive improvements in environmental performance. Such research could help policy makers design more efficient and effective public disclosure programs.

To help fill this gap, this paper presents original data from a survey of plants participating in the Program for Pollution Control, Evaluation and Rating (PROPER), Indonesia's widely

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acclaimed public disclosure pollution control program. The survey data suggest that a key means by which PROPER spurs abatement is improving factory managers' information about their own plants' pollution and abatement opportunities. But our data also suggest that this "environmental audit effect" operates in concert with external pressures. Therefore, simply supplying new information to plant managers without making that information public may not be sufficient to motivate significant abatement.

The paper is organized as follows. The second section reviews the literature. The third section develops an analytical model to demonstrate how public disclosure, operating through the various channels discussed in the literature, can affect a firm's abatement decisions. The fourth and fifth sections provide background on PROPER and discuss its impact on pollution abatement. The sixth section presents the survey data and the last section concludes.

2. Literature

Tietenberg (1998) reviews the thin but quickly growing economics literature on public disclosure. He identifies seven "channels" through which public disclosure of reliable information about firms' environmental performance can affect their behavior. Specifically, public disclosure may

- affect the demand for firms' goods;
- affect the demand for firms' stock;
- affect firms' ability to hire and retain employees;
- convince private citizens to initiate tort law actions against polluters;
- build support for new pollution control legislation;
- motivate private suits—both "citizen suits" and "complaint actions"—to force firms to undertake abatement; and
- give rise to judicial actions in countries like Colombia, Ecuador and Chile where the constitution guarantees citizens the right to a healthy environment.

The empirical literature on public disclosure has mainly focused on the second channel—capital markets. While this research clearly shows that public disclosure can affect stock prices (e.g., Laplante and Lanoi 1994; Badrinath and Bolster 1996; Hamilton 1995; Arora 1999), it is less clear that changes in stock prices can, in turn, affect firms' pollution control activities. However, Konar and Cohen (1997a) and Khanna, Quimio and Bojilova (1998) suggest that they can.

Although economics research on public disclosure *per se* is limited, the more extensive literatures on "voluntary regulation" and "informal regulation" are quite relevant. Both literatures focus on explaining why firms voluntarily overcomply with regulatory standards: the literature on voluntary regulation concerns over-compliance with *de jure* regulatory standards in industrialized countries (see Lyon and Maxwell, 1999 for a review), while the literature on informal regulation mainly concerns over-compliance with lax *de facto* regulatory standards in developing countries. For the most part, explanations proposed in these literatures concern the same pressures discussed in the literature on public disclosure including those generated by consumer demand, capital markets, and labor markets.

A common theme in the literature on voluntary regulation is that firms may over-comply with existing regulations to preempt or weaken future regulation, or to affect the monitoring and enforcement of existing regulation. Maxwell, Lyon and Hackett (1998) construct a model in which consumer lobbying spurs environmental regulation. Effective lobbying requires consumers to acquire information on environmental issues. When information costs are low, the threat of regulation is high; as a result, firms may try to pre-empt new regulation by voluntarily undertaking abatement. Hence, government actions like public disclosure that significantly reduce information costs spur abatement. Maxwell and Decker (1998) develop a model in which firms voluntarily cut emissions, not to pre-empt future legislation, but to reduce how intensely existing regulations are enforced. Decker (1999) provides empirical support for this model. He finds that firms with lower TRI releases per unit output are in fact subject to fewer inspections, all other things equal.

Regarding the link between consumers and environmental performance, Arora and Gangopadhayay (1995) show that firms may overcomply with environmental regulations to attract "green consumers." The empirical evidence to support this proposition is mixed. While Arora and Cason (1996) and Khanna and Damon (1998) show that firms that have more contact with final consumers are more likely to participate in a voluntary program to reduce TRI emissions (the 33/50 program), Arora and Cason (1995) and Konar and Cohen (1997b) are not able to replicate this result.[1]

[1] The existence of markets for "green electricity" (power generated by renewables and priced higher than conventionally generated electricity) as well as for "green mutual funds" suggests that consumer demand affects environmental performance.

As for the link between judicial action and environmental performance, Khanna and Quimio (2000) find a significant relationship between the threat of future liability (measured by the number of Superfund sites for which a firm is the potentially responsible party) and voluntary environmental performance (measured by the number of corporate environmental practices it adopts). Khanna and Damon (1998) investigate the impact of industry associations on environmental performance—a channel for non-regulatory pressure not discussed by Tietenberg (1998). They find that firms belonging to the Chemical Manufacturers Association are more likely to join the 33/50 program, all other things equal.

The literature on informal regulation focuses on pressures to abate generated by private-sector agents in developing countries where state regulators are weak. Most of this research entails cross-sectional, plant-level econometric analysis of the determinants of environmental performance. For example, Pargal and Wheeler (1996) examine the relationship between Indonesian plants' emissions of water pollutants and the characteristics of the surrounding community. They find that plants in communities with higher per capita income and higher levels of education have lower emissions, all other things equal, implying that such communities effectively pressure plants to abate. Using data on Mexican firms, Dasgupta, Hettige and Wheeler (2000) find that firms that are publicly traded, have more highly educated workers, and have adopted ISO14001-type internal management procedures are more likely to be in compliance with environmental regulations, all other things equal. These findings imply that shareholders, employees, and international certification programs can motivate firms to cut emissions. Finally, using data on small-scale Mexican brick kilns, Blackman and Bannister (1998) find that lower emissions are correlated with, among other things, pressure applied by industry and neighborhood organizations.

3. Analytical model

The following simple model of a plant's pollution abatement decision formalizes the foregoing discussion of the channels through which public disclosure operates. In addition, anticipating our survey results, we allow that public disclosure may spur abatement by lowering marginal abatement costs.

To focus attention on pollution abatement, we assume that the plant makes production and abatement decisions sequentially. First it chooses a level of output, q, and a vector of levels of financial and human capital, **k**. Subsequently, it chooses a level of abatement, α, treating both q and **k** as fixed. We model the plant's second stage abatement decision only. The plant chooses α to maximize profit, π, given by,

$$\pi = P[g(\alpha, d)]q - C[\alpha, t(d)] - \mathbf{W}(\alpha, d)\mathbf{k} - H(\alpha, d)$$

where,

$$H(\alpha, d) = r(\alpha, d) + c(\alpha, d) + n(\alpha, d) + m(\alpha, d) + a(\alpha, d) + j(\alpha, d)$$

and,

P(·)is the equilibrium price of output
g is an index of green consumerism—the sensitivity of P to the plant's emissions
d is a measure of the public disclosure of information about the plant's emissions
q is the quantity of output
C(·) is the cost of abatement
t is the plant's information about abatement technologies and its own emissions
W(·) is a vector of the costs of two types of capital: financial and human
k is a vector of two types of capital: financial and human
H(·) is the total cost of the plants' emissions generated by external agents
r(·) is costs generated by formal regulatory authorities
c(·) is costs generated by communities
n(·) is costs generated by non-governmental organizations
m(·)is costs generated by the media
a(·) is costs generated by industry associations, and
j(·)is costs generated by courts

We make the following assumptions about the price and cost functions: the stronger is green consumerism, the lower is the equilibrium price the plant receives for its output (P is decreasing in g);[2] the less the plant abates and the more the public knows about its emissions, the stronger is green consumerism (g is decreasing in α and increasing in d), the higher are the costs of financial

[2] To keep the exposition simple, we implicitly assume that the plant is an inherently dirty one—for example, an aged coal-fired power plant—so that regardless of its choice of α, green consumerism always reduces equilibrium price. We could just as easily assume the plant is an inherently clean one whose equilibrium price is always increased by green consumerism. Allowing green consumerism to increase or decrease equilibrium price depending on the plant's choice of α makes the model needlessly complex given our limited goal of illustrating how various channels discussed in the literature operate.

and human capital (**W** is decreasing in α and is increasing in d), and the greater are the costs imposed on the plant by external agents (r, c, n, m, a, and j are all decreasing in α and increasing in d); and the less the plant abates and the more information it has about its emissions and abatement technologies, the lower is the marginal cost of abatement (C is increasing in α and decreasing in t). Finally, we make the reasonable assumptions that abatement has a diminishing marginal impact on green consumerism, capital costs and costs imposed by external agents, and that it has an increasing marginal impact on abatement costs (g, W, H and C are all convex in abatement).

The first order condition for the choice of the optimal level of emissions, α^*, is,[3]

$$\left\{\frac{dP}{dg}\frac{\partial g}{\partial \alpha}q - \frac{\partial W}{\partial \alpha}k - \frac{\partial H}{\partial \alpha}\right\} - \frac{\partial C}{\partial \alpha} = 0 \qquad (1)$$

The first term in parentheses represents the marginal benefit of abatement due to: an increase in equilibrium price of output (the first term in the parentheses); a reduction in the costs of labor and capital (the second term); and a reduction in costs imposed by formal regulatory authorities, communities, non-governmental organizations, the media, industry associations and the courts (the third term). We will refer to the sum of these three terms as the marginal abatement benefit (MAB). The last term in (1) is the marginal abatement cost (MAC). The plant chooses α^* such that MAB is equated to MAC.

Using (1), it is straightforward to show that the total derivative of α^* with respect to d is unambiguously negative. Therefore, public disclosure will increase abatement. Figure 1 makes this point graphically. Given our assumptions on P(·), C(·), W(·), and H(·), the MAC schedule is increasing in α and the MAB schedule is decreasing in α. The plant chooses the level of emissions where these schedules intersect. An increase in d will cause t(·) to increase and the MAC schedule to shift down. It will also cause g(·), W(·), and H(·) to increase and the MAB schedule to shift up. Each of these shifts will cause α^* to increase.

[3] The convexity of g(·), C(·), W(·), and H(·) guarantee the second order condition is met.

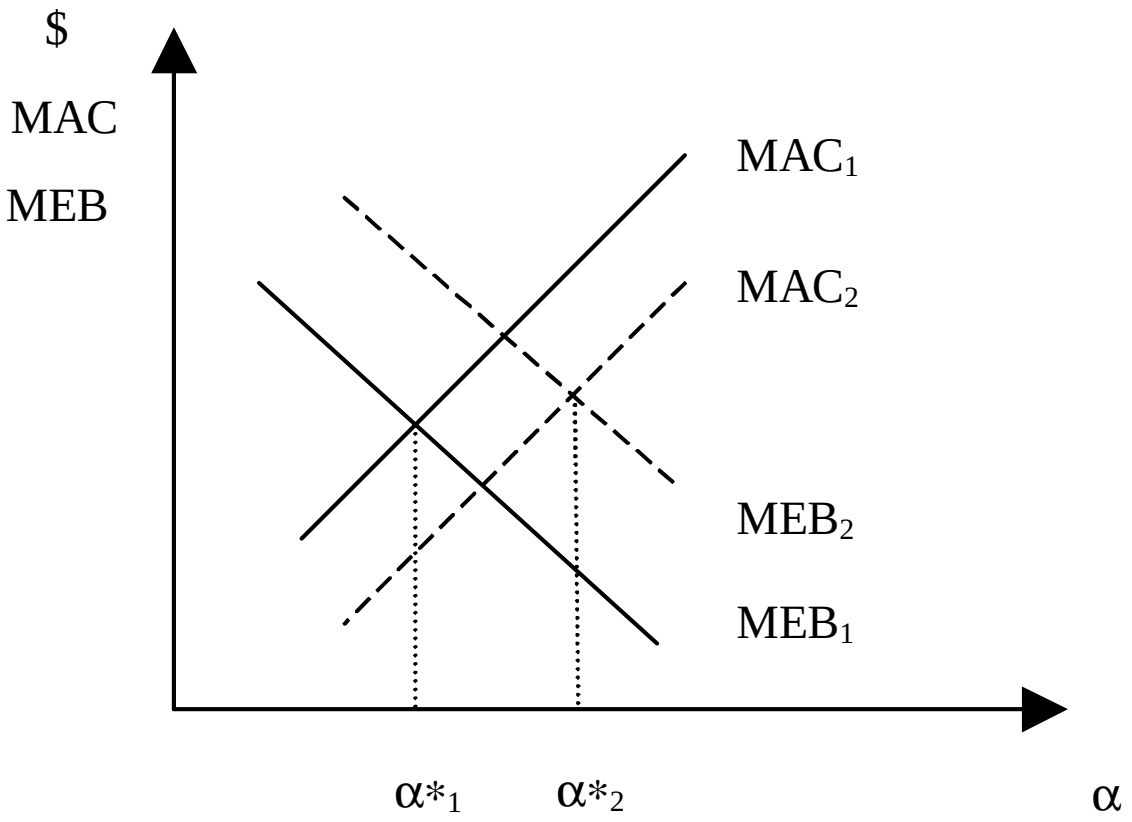

Figure 1. Marginal abatement cost (MAC) and marginal abatement benefit (MAB) schedules; optimal abatement level, α*

4. PROPER

In Indonesia, rapid industrialization, population growth, and urbanization have created severe pollution problems. Although the country has had a command-and-control regulatory system in place since the early 1980s, compliance has been limited, mainly because enforcement has been virtually nonexistent (Afsah and Vincent 1997). In 1995, Indonesia's Environmental Impact and Management Agency (BAPEDAL) established PROPER, to overcome pervasive institutional barriers to enforcement. The idea was to "create incentives for compliance through

honor and shame" (Afsah and Ratunanda 1999). Although only five years old, PROPER is already being widely imitated.[4]

PROPER employs a color-based single-index rating system. Individual plants are assigned one of five ratings—black, red, blue, green and gold—based on their compliance or over-compliance with command-and-control emissions standards (Table 1). This rating system was designed to be simple enough to be easily understood by the public but precise enough to provide incentives for firms to move from one category to the next. The exact criteria for each rating are well-defined and relatively simple (see Afsah and Ratunanda 1999). To minimize both error and discretion, BAPEDAL uses a computerized management and information system to determine ratings.

Table 1. PROPER ratings criteria

Rating	Criteria
Gold	Levels of pollution control for air and hazardous waste similar to that for water; extensive use of clean technology; pollution prevention; recycling, etc.
Green	Emissions less than 50% of regulatory standard; proper disposal of wastes; good housekeeping; accurate emissions records; reasonable maintenance of a waste water treatment system.
Blue	Emissions below regulatory standard.
Red	Some pollution control effort but emissions exceed regulatory standard.
Black	Either no effort to control pollution or responsible for serious environmental damage.

In developing its first set of ratings, BAPEDAL relied on plant-level data from pre-existing voluntary pollution control programs, self-reported survey data, and inspection data. Subsequently, ratings have been based on monthly emissions reports filed by participating plants. Emissions reports are checked against past reports and against the current reports of similar plants. When discrepancies arise, BAPEDAL conducts inspections to resolve them. In 1995, 1996, and 1997 BAPEDAL conducted approximately 200 inspections of PROPER plants per year (Afsah, Dasgupta, and Ratunanda, 1998).

[4] The Philippines introduced a similar program called EcoWatch in 1997. See www.worldbank.org/nipr/ecowatch/ecowatch2.htm. Preparations for PROPER-like programs are also underway in China, Mexico, India, Colombia, Bangladesh, and Thailand.

Participation in PROPER is limited to several hundred relatively large water polluters. BAPEDAL chose to focus on water pollution because it has much less experience with air pollution and hazardous waste, pollutants for which implementing regulations were only introduced in the mid-1990s.[5]

BAPEDAL's first round of ratings, in June 1995, was carefully orchestrated. To enhance transparency and credibility, ratings were screened by an advisory committee which included representatives of environmental non-governmental organizations and other stakeholders. Also, to give firms an opportunity to improve their performance prior to public disclosure, the names of plants rated black, red, and blue were not released to the public until December.

BAPEDAL attempts to ensure that both participating firms and the public have easy access to ratings. Typically, ratings are released at a formal press conference and posted on the Internet.[6] In addition, for each participating plant, BAPEDEL issues a one-page report on environmental performance (see Figure 2). This report serves as an information resource for the plant's managers and environmental engineers. Despite BAPEDAL's efforts to publicize ratings, so far only about 5% of the participants have been named in the press.

One hundred and eighty seven plants were selected to participate in the first two rounds of PROPER ratings in June and December 1995. All but 11 of these plants were selected because they had participated in the Clean River Management Program (PROKASIH), a semi-voluntary pollution control program established in 1989.[7] The 11 remaining plants volunteered to participate in PROPER. There have been two additional ratings since December 1995—in October 1996 and July 1997. Seventy-five plants joined the program during this time.[8]

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[5] Plans call for PROPER to eventually be extended to cover both industrial air pollution and hazardous waste.

[6] www.bapedal.go.id

[7] For history and analysis of PROKASIH see Afsah, Laplante, and Makarim (1996).

[8] Of the 233 plants that were participating in PROPER when our data were collected in early 1998, 158 were rated in the first period, 187 were rated in the second period (154 of the 158 plants rated in the first period plus 33 new plants), 102 plants were rated in the third period (all were plants that were rated in the second period), and all 233 plants were rated in the fourth period (all of the 191 plants that were rated in any of the three previous periods plus 42 new plants).

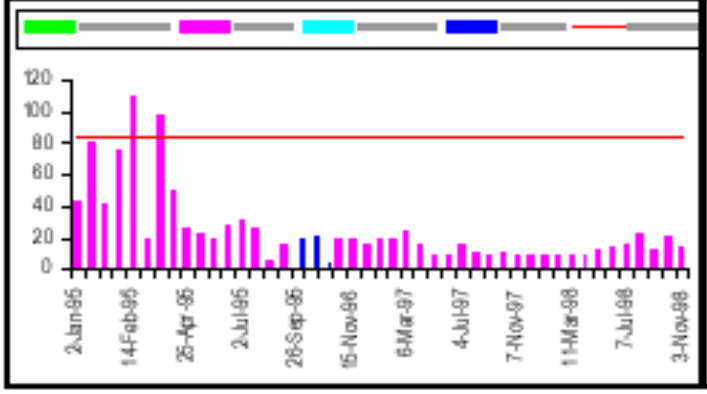
Rating Period: **June-1998**

Final Rating: **BLUE** Previous Rating **BLUE**

Criteria for a BLACK Rating: If the answer to any of the questions 1-4 is a "Yes", the factory gets a BLACK rating	
1. Any portion of the wastewater discharged without treatment?	✗
2. Is there a hidden bypass for wastewater?	✗
3. Is the effluent concentration greater than five times the standard based on the last three months data?	✗
4. Is the pollution load per unit product more than five times the standard based on the last three months data?	✗
Criteria for a BLUE or RED Rating: If the answer to any of the questions 5-11 is a "No", the factory gets a RED rating. If all the answers are "Yes" the factory gets a BLUE rating	
5. Does the factory analyses the wastewater regularly at least once every month?	✓
6. Is there an operational flowmeter in place?	✓
7. Is the flowrate measured at least for 20 days per month?	✓
8. Is the data reported to BAPEDAL once every quarter?	✗
9. If applicable, does the factory has a land application permit? *	**Not Applicable**
10. Is the last six months data for effluent concentration in compliance with the standards?	✓
11. Is the last six months data for pollution load per unit product in compliance with the standards?	✓
Criteria for a GREEN Rating: The factory gets a GREEN rating only if all the answers for questions 12-16 are "Yes"	
12. There is no ongoing enforcement action against the factory	✓
13. Is the last 12 months data for effluent concentration in compliance with the standards?	✓
14. Is the last 6 months data for pollution load per unit output better than the standards by a factor of 50%?	✓
15. Is the factory in full compliance with the hazardous waste regulation?	✗
16. Is the factory in compliance with the AMDAL regulations (Environmental Impact Assessment)?	✓

✗ **No** ✓ **Yes**

BOD5



Wastewater Treatment Plant Information

WWTP Capacity(m3/hour):	**65**
Primary Treatment (PTS):	**INSTALLED**
Year of Installation of the PTS:	**1980**
Secondary Treatment (STS):	**AERATION PROCESS**
Year of Installation of the STS:	**1980**
Type of Flowmeter:	**Magnetic Flow Meters**

Comment:

Figure 2. PROPER rating report

5. PROPER's impact

To assess PROPER's impact on environmental performance, we observe how participating plants' performance ratings changed over time. Our sample is a subset of the 233 plants that were participating in PROPER in early 1998 when our data were collected. Since we require at least two ratings to assess PROPER's impact, we eliminated 42 plants that joined the program in July 1997 and were therefore only rated once. In addition, for the sake of consistency with the analysis in the next section, we eliminated 12 plants that returned incomplete survey responses and 33 plants that returned inconsistent survey responses (we return to the issue of the consistency of survey responses in the next section). Thus, our sample is comprised of 146 plants.

Table 2 gives the first rating (June or December, 1995) and the last rating (July, 1997) for these 146 plants. Ratings improved for over a third of the plants.[9] The percentage of plants whose rating improved—hereafter "improvers"—was much higher among plants initially rated black and red than among plants initially rated blue and green. Both of the two plants initially rated black improved and 46% of the 90 plants initially rated red improved. However, only 11% of the 47 plants initially rated blue improved and none of the plants initially rated green improved (BAPEDAL has yet to assign a gold rating). The reason that plants initially rated black and red were more likely to have improved is straightforward: for such plants, marginal abatement costs are relatively low and the marginal benefits of improvement are relatively high.

Hence, these data strongly suggest that for plants that are not in compliance with regulatory standards—i.e., those initially rated black or red—PROPER motivated significant emissions reductions. The next section presents survey data that indicates which of the channels discussed in Sections 2 and 3 were responsible.

6. Survey results

In the fall of 1998 we administered a survey to managers of plants participating in PROPER that elicited their responses to the question, "How do PROPER ratings create incentives for your firm to improve its environmental performance?" Specifically, the survey asked respondents to rank the importance of 18 different types of incentives for improved

[9] Ratings for all but one of these improvers were non-decreasing over time. That is, all but one were assigned a 1996 rating that was at least as high as its 1995 rating, and a 1997 rating that was at least as high as its 1996 rating.

Table 2. 1995 and 1997 PROPER ratings

		Black	Red	Blue	Green	Gold	All
1995 rating		2	90	47	7	0	146
1997 rating	**Gold**	0	0	0	0	0	0
	Green	0	1	5	3	0	9
	Blue	1	40	35	4	0	80
	Red	1	46	7	0	0	54
	Black	0	3	0	0	0	3
% improvers		100	46	11	0	0	34

performance which, following Tietenberg (1998), we will call "channels" (see Table 3—note that the second column indicates the correspondence between each channel and the variables in the analytical model). Respondents were asked to rank the importance of each channel on a scale of zero (no importance) to five (extreme importance) and then to identify the first, second and third most important channels among the group of 18. The purpose of the first ranking was simply to encourage respondents to think about each channel before comparing them to each other, and also to provide a means of checking the consistency of survey responses.[10]

The survey results are somewhat surprising. While the existing literature on public disclosure and related topics has focused on sources of pressure to improve environmental performance that are external to the firm (e.g., capital markets, the threat of future regulation, discretionary enforcement of existing laws, and product markets), most of our respondents did not view such channels as most important. Rather, the majority indicated that the critical means by which PROPER ratings spur improved performance is providing information to plant managers and owners about their own plant's emissions and abatement opportunities (via reports like the one depicted in Figure 2). Sixty percent of the respondents ranked channel t_1 (PROPER

[10] Survey responses were deemed inconsistent if any channel received a ranking of first, second or third most important among the group of 18 channels but was *not* assigned a rank of either four or five on the scale of one to five.

Table 3. How do PROPER ratings create incentives for improved environmental performance? Survey responses and environmental performance for full sample (n = 146)

Channel	Var.	Description of channel in survey	% respondents ranking each channel as 1st or 2nd most important	% respondents ranking each channel as 1st or 2nd whose PROPER rating improved
Consumers	g_1	Bad PROPER ratings make our firm less competitive in international markets	6	38
	g_2	Bad PROPER ratings make our firm less competitive in domestic markets	1	0
	g_3	Good PROPER ratings help to differentiate our product from our competitors	7	20
	g_4	Good PROPER ratings will help in obtaining ISO 14001 certification	11	63***
Information	t_1	PROPER ratings provide clear information about how to improve environmental performance	22	28
	t_2	PROPER ratings make owners and senior managers aware of the environmental performance of the factory	38	29
Financial capital	k_1	Bad PROPER ratings increase pressure from the shareholders	8	73***
	k_2	Bad PROPER ratings make it difficult to obtain credit from banks	2	0
	k_3	Bad PROPER ratings make it harder to get capital from the International Finance Corporation	0	—
	k_4	Bad PROPER ratings reduce the market value of the company	4	67**
Human capital	k_5	Bad PROPER ratings increase pressure from our firm's employees	7	30
Regulators	r_1	Good PROPER ratings improve our firm's relationship with BAPEDAL	4	67**
	r_2	Good PROPER ratings will make it easier to comply with future regulations, which will be more strict	8	27
Communities	c	Bad PROPER ratings increase pressure from communities living around the factories	36	30
NGOs	n	Bad PROPER ratings increase pressure from non-governmental organizations	10	27
News Media	m	Bad PROPER ratings increase pressure from the news media	25	27
Industry Assns.	a	Bad PROPER ratings increase pressure from industry associations	2	33
Courts	j	Bad PROPER ratings increase the chances of court action by the government	8	42

***significantly different from sample proportion (34%) at 1% level
**significantly different from sample proportion (34%) at 5% level

ratings provide clear information about how to improve environmental performance) or channel t_2 (PROPER ratings make owners and senior managers aware of the environmental performance of the factory) as most important or second most important. Thus, in the eyes of most of our survey respondents, PROPER ratings first and foremost serve as an environmental audit.

This is not to say that our survey respondents did not perceive factors external to the firm to be important as well. Channels ranked as first or second most important by more than 10% of the respondents included: c (bad PROPER ratings increase pressure from communities living around the factories) which was ranked as first or second most important by 36% of the respondents; m (PROPER ratings increase pressure from the news media) which was ranked as first or second most important by a quarter of the respondents; and g_4 (good PROPER ratings will help in obtaining ISO 14001 certification) which was ranked as first or second most important by 11% of the respondents. The last channel concerns certification of the plant's environmental management system by the International Standards Organization (ISO), an endorsement that is highly valued by firms that participate in international markets or that are seeking to do so (Dasgupta, Hettige and Wheeler 2000).[11]

While these data indicate which channels PROPER participants as a group perceive to be important, they do not tell us whether these channels actually drove a third of the plants in our sample to improve their environmental performance. Did these plants reduce their emissions because they obtained better information about their emissions and abatement opportunities via PROPER reports? Or did they reduce their emissions because of external factors such as community pressure? Ideally, multiple regression analysis could be used to address this question. But such analysis would require plant-specific measures of changes in the intensity of each of the 18 channels due to public disclosure, i.e., for each plant, measures of the intensity of each channel before public disclosure and after it. Unfortunately, such data do not exist and our survey data are an inadequate proxy.[12]

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[11] ISO 14001 certification requires the following: (i) initial review of plant conditions to identify environmental issues of concern, (ii) establishment of priorities for action, (iii) establishment of an environmental policy statement signed by the chief executive officer, (iii) development of performance targets based on the policy statement, (iv) implementation of the environmental management system with defined procedures and responsibilities, and (v) implementation reviews, performance measurement, and management audits.

[12] Plants' survey responses are not suitable proxies because they may not be exogenous to the plant's environmental performance. For example, a plant's choice of channel c as most important does not necessarily indicate that as a result of the disclosure of PROPER ratings, this plant was subjected to particularly intense pressure from the surrounding community independent of it's environmental performance. Rather, plants with continued poor

However, when combined with regulatory data on changes in PROPER ratings over time, our survey responses can provide some clues as to which channels drove improvements in environmental performance. Using these two types of data, we calculate the percentage of plants that chose each channel as first or second most important whose PROPER rating improved during the course or their participation (see the last column in Table 3). We then test whether this percentage is significantly greater than the percentage of improvers in the entire sample—34%. A statistically significant difference indicates a simple correlation between the channel and improved environmental performance. We would note that like all tests for simple correlations, this one does not control for correlations with other potential explanatory variables such as the type and size of the plant. Nor does it imply anything about the direction of causality.

We find statistically significant differences for four channels: g_4, k_1, k_4 and r_1. However, for three of these channels—k_1, k_4 and r_1—the percentage of the sample that chose each as first or second most important is so small—9%, 4% and 4% respectively—as to cast doubt on the import of this finding.[13] Eleven percent of the sample chose the remaining channel, g_4 (good PROPER ratings will help in obtaining ISO 14001 certification), as first or second most important. Almost two-thirds of these respondents were improvers. This suggests that there may be some synergy between public disclosure and international certification programs. Note that there is not a significant correlation between improved environmental performance and choosing either of the two information channels (t_1 and t_2).

But our analysis of the correlation between our respondents' survey responses and their environmental performance may be biased by the fact that the sample contains both plants initially rated blue and green as well as plants initially rated black and red. As discussed above, fewer than 10% of the plants in the first group improved while almost half of the plants in the second group did. Both the marginal costs of improvement and the expected marginal benefits of improvement (the MAC and MAB schedules) may be different for these two groups of plants, and therefore, the drivers of improved environmental performance may also be different. To control for this, we split the sample into plants initially rated red or black (n = 92) and those

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performance after public disclosure may have been subjected to more intense community pressure, and as a result, may have been more likely to choose this channel as most important.

[13] Of the 146 plants in the sample, 11 choose k_1 as first or second most important eight of which were improvers, six plants chose k_4 as first or second most important four of which were improvers, and six plants chose r_1 as first or second most important four of which were improvers.

Table 4. How do PROPER ratings create incentives for improved environmental performance? Survey responses and environmental performance for split sample

Channel	Var.	Description of channel in survey	**A:** % respondents ranking each channel as 1st or 2nd most important **B:** % respondents ranking each channel as or 2nd whose PROPER rating improved			
			initial rating = red + black (n = 92)		**initial rating = blue** (n = 47)	
			A	**B**	**A**	**B**
Consumers	g_1	Bad PROPER ratings make our firm less competitive in international markets	5	40	6	33
	g_2	Bad PROPER ratings make our firm less competitive in domestic markets	1	0	0	—
	g_3	Good PROPER ratings help to differentiate our product from our competitors	7	33	6	0
	g_4	Good PROPER ratings will help in obtaining ISO 14001 certification	13	75**	6	33
Information	t_1	PROPER ratings provide clear information about how to improve environmental performance	23	38	19	0
	t_2	PROPER ratings make owners and senior managers aware of the environmental performance of the factory	44	40	32	0*
Financial capital	k_1	Bad PROPER ratings increase pressure from the shareholders	5	80*	13	67***
	k_2	Bad PROPER ratings make it difficult to obtain credit from banks	2	0*	0	—
	k_3	Bad PROPER ratings make it harder to get capital from the International Finance Corporation	0	—	0	—
	k_4	Bad PROPER ratings reduce the market value of the company	3	33	6	100***
Human capital	k_5	Bad PROPER ratings increase pressure from our firm's employees	4	75	13	0
Regulators	r_1	Good PROPER ratings improve our firm's relationship with BAPEDAL	3	100**	9	—
	r_2	Good PROPER ratings will make it easier to comply with future regulations, which will be more strict	7	50	6	0
Communities	c	Bad PROPER ratings increase pressure from communities living around the factories	39	42	34	6
NGOs	n	Bad PROPER ratings increase pressure from non-governmental organizations	10	44	11	0
News Media	m	Bad PROPER ratings increase pressure from the news media	25	43	21	0
Industry Assns.	a	Bad PROPER ratings increase pressure from industry associations	3	33	0	—
Courts	j	Bad PROPER ratings increase the chances of court action by the government	5	100***	15	0

***significantly different from sample proportion at 1% level
**significantly different from sample proportion at 5% level
*significantly different from sample proportion at 10% level

initially rated blue (n = 47). We omit from the sample plants initially rated green since no plants have ever improved from green to gold.

For the sample of 92 plants initially rated red or black, the results are qualitatively the same as those for the full sample: the lion's share of plants chose as first or second most important those channels having to do with information, community pressure, the media and ISO 14001 certification, and (discounting channels selected by fewer than 6% of the sample) there clearly is a simple correlation between environmental performance and concern about ISO 14001 certification. For the sample of 47 plants initially rated blue, the survey results are slightly different. Most notably, there is not a significant correlation between improved environmental performance and concern about ISO 14001 certification, but there is a significant correlation between improved environmental performance and concern about shareholders. In neither subsample is there a significant correlation between improved environmental performance and choosing either of the two information channels (t_1 and t_2).

In summary, our survey results show that in the eyes of the majority of the plants in our sample, the most important means by which PROPER encourages emissions reductions is enhancing factory owners' and managers' information about their plant's emissions and abatement opportunities—the environmental audit effect. But the perception that this effect is critical is not correlated with improved environmental performance: non-improvers are more or less just as likely to have this view as improvers. Rather, for plants not in compliance with regulatory standards, improved environmental performance is correlated with concern about ISO-14001 certification, and for firms that are in compliance, it is correlated with concern about shareholders. These results suggest that although the environmental audit effect may be an important component of the explanation for PROPER's success, it is only one component. This effect probably has an impact by operating in concert with external pressures heightened by public disclosure.

7. Conclusion

This paper reviewed the literature to develop a list of channels through which public disclosure may motivate emissions reductions, developed a simple analytical model to demonstrate how these channels may operate, and presented data that suggest which of these channels are important. Although it runs counter to the focus of the economics literature on channels external to the firm, our finding that program participants perceive PROPER's environmental audit role to be a critical driver of improved environmental performance seems quite logical. Firms in industrialized countries typically pay consultants to perform

environmental audits, a practice that implies it is costly to collect environmental performance data. Therefore, in countries like Indonesia where formal regulatory pressure is virtually nonexistent and factories have little incentive to pay these costs, one would expect public disclosure programs to provide new information about environmental performance to ill-informed polluters as well as to the public. What are the policy implications of this finding?

Tietenberg (1998) points out that public disclosure programs entail four elements: (i) detecting environmental risks, (ii) assuring reliable information, (iii) disseminating the information to those at risk from the pollution, and (iv) allowing public- and private-sector agents to act on the information to create pressures for pollution control. Our survey data suggest that a fifth element—disseminating the information to polluters—also plays an important role in generating emissions reductions and should be deliberately fostered by program administrators. Should this be done at the expense of disseminating information to those at risk from pollution and encouraging them to act on it? This would have the distinct advantage of reducing industry resistance to information-based programs. But our results do not unambiguously support the conclusion that simply collecting reliable information on environmental performance and providing it in confidence to polluters would spur significant emissions reductions. As noted above, we hypothesize that the environmental audit effect has an impact on environmental performance by operating in concert with external pressures heightened by public disclosure.

Further research is needed to gauge the relative importance of the environmental audit effect and external pressures in public disclosure programs. As more plants join existing public disclosure programs and as new programs are set up, researchers have an opportunity to collect the data that might best address this question—*ex ante* and *ex post* firm-specific data on the intensity of various pressures to abate.

Finally, we note that our finding that ISO 14001 certification bodies and shareholders may have exerted significant pressures to cut emissions suggests that public disclosure programs may be particularly effective when targeted at firms that seek to participate in international certification programs as well as those that are publicly owned.

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