Structuring Disclosure As Environmental Regulation

Shakeb Afsah, International Resources Group, Washington DC
Mary Graham, Georgetown University Law Center and Kennedy School of Government, Harvard University
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INTRODUCTION

Seen less than two decades ago as a distraction from the government's regulatory agenda, mandatory disclosure is now viewed as a primary means of improving environmental protection in the United States. Traditionally, environmental information collected from private sector entities or public authorities by government was viewed primarily as an underpinning for regulatory decisions. In the 1970s and 1980s, access to environmental information held by the government became seen also as a right and many "right to know" laws were enacted. In the last decade, the systematic disclosure of environmental information has become seen also as an independent regulatory instrument. The government's authority to require the collection and disclosure of private sector information has taken a legitimate place beside its authority to set standards and to influence market mechanisms as a means of furthering environmental objectives.

Environmental disclosure strategies raise unique political, economic and communication issues. Disclosure creates conflicts among fundamental political values that are different from those raised by government use of pollution control standards or market mechanisms. Its economic features are also distinctive. Unlike command and control or economic instruments where regulators determine the quantitative standards or fees, public disclosure relies on communities and markets to determine environmental performance standards. Disclosure systems also raise novel communication issues because they employ communication of information about risks as a central mechanism. Cognitive distortions complicate effective communication with the general public about the magnitude and character of risks and about uncertainty of scientific knowledge, discussions which previously took place mainly among experts.

Improving understanding of environmental disclosure strategies is important for three reasons . First, such requirements are now more frequently employed to reduce environmental risks than they were in the past. Second, mandatory disclosure is currently viewed as a particularly successful form of environmental regulation. Third, environmental disclosure regimes are being widely copied. In the United States, they are

viewed as models for strategies to reduce other kinds of health and safety risks. In both industrialized and developing countries, U.S. experience with such regimes increasingly serves as one basis for new regulatory strategies to reduce a variety of social risks.

The purpose of this paper is to provide an interdisciplinary framework for analysis of environmental disclosure strategies and for future research. This paper is at an early stage of development and we particularly welcome feedback. We focus primarily on disclosure systems that are free-standing (i.e. not linked to a parallel compliance-based system) and performance-oriented and we focus on applications within the United States. However, several aspects of the analysis may be applicable more broadly. In Part 1 we examine the historical context for the employment of disclosure strategies and some reasons for their increasing use. Part 2 analyzes how such requirements are shaped by the political process with emphasis on identifying conflicts among fundamental values that affect the essential elements of disclosure requirements. Part 3 examines the economic incentives created by disclosure, the channels through which those incentives operate and the cost-effectiveness of disclosure requirements. In Part 4 we summarize unique communication issues raised by disclosure requirements. Finally, Part 5 suggests implications of this analysis for the design of future systems of environmental disclosure.

PART 1: BACKGROUND

Government requirements that businesses or public authorities disclose specific information relating to environmental protection in a systematic way for the purpose of reducing risks to human health or to ecosystems are emerging as a newly prominent regulatory tool. So far, however, there has been relatively little analysis of the use of such strategies to improve environmental protection.

In the United States, mandatory disclosure of information has been employed as a national approach to address a variety of environmental problems. The federal Toxics Release Inventory has required disclosure of some toxic releases since 1987 and has been associated with a reduction of 45 percent in reported releases of listed chemicals. In October, 1999, 55,000 local water authorities began reporting to their customers on contaminants in drinking water in response to a provision of the Safe Drinking Water Act

of 1996 intended to improve their vigilance. The largest systems are required to place reports on the Internet. Federal law requires chemical manufacturers are required to disclose their risk management plans, including worst case accident scenarios, to help reduce risks in the event of mishaps. Employers are required to label hazardous substances and make available to employees detailed explanations of health problems associated with them under a hazard communication standard promulgated by the Occupational Safety and Health Administration. Federal law also requires public labeling of hazardous substances such as asbestos and pcbs to reduce risks to public health. It is important to note that the use of environmental disclosure requirements is newly prominent but it is not new. The first major environmental law of the modern era employed information disclosure as a means of improving environmental protection. The National Environmental Policy Act required reporting by federal agencies of the anticipated environmental consequences of major decisions.

States also use informational approaches to reduce environmental risks. Most states have enacted their own requirements that government agencies disclose expected environmental consequences of major actions. California has created a different kind of incentive system by requiring companies to give "clear and reasonable warning" whenever they expose people to reproductive toxins or cancer-causing chemicals in amounts above a minimal level under an initiative approved by voters in 1986. A number of state laws require broader disclosure of toxic chemicals than does federal law. For example, manufacturers in New Jersey and Massachusetts are required to report not only releases of toxic chemicals into the environment but also their use.

Recently, disclosure strategies have been hailed as a particularly effective means of reducing pollution. In its annual TRI report for 1997, the federal Environmental Protection Agency (EPA) suggested that: "[A]ccording to many, the TRI program is one of the most effective environmental programs ever legislated by Congress and administered by EPA." In his 1996 State of the Union address President Clinton made environmental disclosure a priority by stating that “[p]utting environmental and public health information into the hands of the American people is one of the most effective ways to reduce pollution and prevent it from occurring in the future.”

Internationally, public disclosure programs are gaining acceptance. Among developing countries, the Indonesian government was the first to launch a public disclosure program. It launched PROPER in 1995. Under PROPER, industrial enterprises are rated for their environmental performance against compliance benchmarks. Ratings are based on a five-color scheme and are publicly disclosed through a formal press conference. Following PROPER's rating methodology, the Philippines' government introduced its own version called EcoWatch. Interestingly, in these countries public disclosure was seen as a substitute for their dysfunctional command and control systems and not a product of any organized "right to know" movement. Several countries have introduced disclosure programs for toxic chemicals that are modeled after TRI. The OECD has developed a prototype disclosure program called Pollution Release and Transfer Registries (PRTR).

In the United States, mandatory disclosure is also becoming a common national approach to reducing other kinds of risks to health or safety. The Institute of Medicine of the National Academy of Sciences reported in November, 1999 that between 44,000 and 98,000 people die each year as a result of medical errors and recommended a new national system to require disclosure of errors that cause death or serious injury for the purpose of reducing those risks. Both Democrats and Republicans have endorsed the idea (though their legislative proposals differ in important ways) and General Motors, General Electric and six other large employers have said that they would change their practices based on the results of disclosure by steering employees to hospitals that made the fewest mistakes. Other prominent examples include national requirements that food processing companies disclose the nutritional content of their products in standardized form as a means of reducing health risks, that commercial airlines disclosure their safety records and that auto manufacturers to reveal the results of crash testing for each of their new models.

Disclosure has long been employed as a regulatory tool to further other kinds of national objectives as well. Banks and other lending institutions are required to disclose the geographical distribution of their loans as a means of discouraging "red-lining." In

securities regulation, disclosure provisions that require publicly traded companies to reveal financial information have been in operation for nearly 50 years.

Disclosure requirements are remarkably varied. As employed in environmental protection in the United States, they refer to a cluster of strategies that use governmental authority to require systematic collection of and broad access to private sector (or public authority) information for the purpose of reducing pollution or improving ecological conditions. Within this general rubric, however, who discloses, what kind of information is disclosed, and how it is disclosed can vary widely. Information may be collected from a class of companies or government agencies. Disclosure may focus on the contents, means of production, or environmental consequences of specific products. It may focus on specific characteristics of services. Or it may focus on the intended or unintended environmental implications of broader activities of companies or public agencies. Disclosure may relate to environmental consequences that have already taken place or to those that are anticipated. Information may be disclosed in government or business reports, included on product labels, posted in work places, broadcast in public announcements or made available over the Internet.

In practice, in the United States informational strategies have generally been used to complement, not replace, other regulatory tools. Toxic chemical releases and drinking water quality, for example, subject to systematic disclosure requirements, are also regulated separately under a number of federal and state laws. EPA's Science Advisory Board suggests a typology of regulatory instruments that places informational strategies on a par with standard-setting, market mechanisms, liability provisions and other policy tools. A broad-based analysis led by former EPA administrator William Ruckelshaus also concluded two years ago that disclosure constitutes an emerging regulatory tool that complements other kinds of environmental regulation. However, some commentators have also suggested the use of informational strategies as a replacement for more conventional regulation. [Karkkanien]

Informational strategies also present policy-makers with a familiar conundrum in an unusual guise. On the one hand, mandatory disclosure provisions, like other regulatory

regimes, are products of the political process. The political process is designed to resolve conflicts among competing values and interests. On the other hand, the ultimate justification of government regulatory action is the effective reduction of environmental risks. Effective reduction of risks suggests the need for efficient use of public and private resources to maximize benefits to the public. The conundrum: How can the need for action that is accountable to the public's will and the need for action that effectively reduces risks be reconciled?

PART 2: POLITICS OF ENVIRONMENTAL DISCLOSURE

In this section we suggest underlying reasons for the growing prominence of mandatory disclosure as a means of reducing environmental risks. We then propose a framework for understanding unique conflicts among competing values that are posed by disclosure requirements. We suggest ways in which the resolution of these conflicts can influence the essential characteristics of disclosure requirements. Finally, we highlight a number of paradoxes associated with environmental disclosure that emerge from this analysis.

Roots of Disclosure as Environmental Regulation

Growing interest in mandatory disclosure as a means of improving environmental protection has roots in three broad trends. First, a convergence of political and economic forces has intensified the search for more effective and less costly means of reducing environmental risks. Instances of regulatory failure, increasingly unmanageable agency workloads, decreases in federal grant funds for social programs and the growth of international commerce have pointed to limitations associated with conventional regulation. At the same time, national efforts to tackle more problems that are locally unique or commercially variable have prompted a search for more flexible, de-centralized approaches to regulation.

Second, disclosure requirements derive their current prominence from the continuing evolution of the "right to know" movement. Most major U.S. environmental laws enacted beginning in the 1960s included reporting requirements for targeted

industries. A great deal of private-sector information about environmental practices and performance was collected as a result of those requirements. In general, though, government agencies used that data to inform public decisions about new regulations and about enforcement. Reported information was not released to the public in any systematic way. But growing demands by organized labor that workers be told about hazardous substances they might be exposed to led to the enactment of a number of state and local worker right-to-know laws by the mid-1970s. Drawing on common law principles that require manufacturers to disclose hidden product hazards and on evidence from consumer boycotts that the power of disclosure could bring environmental improvement to company practices, the demand for broader community right-to-know gained ground in the 1980s. These political pressures resulted in the enactment of a variety of federal and state laws that required disclosure of information held by government to the general public. It is important to note, however, that such laws had limitations.Despite their broad purposes, disclosure remained fragmentary. Information generally had to be requested piece by piece, requiring foreknowledge of its existence and location.

Third, computer power and the Internet increase the potential influence of disclosure. Advances in information technology are producing new means of communication in public as well as commercial life. At their best, these advances make it possible to aggregate environmental information from many sources at lower cost than in the past and to make comparisons among facilities, companies, industries and public agencies that would have been cumbersome or impossible even a few years ago. They can also facilitate layering of environmental information in readily accessible form. And, because they facilitate interactive communication, they allow diverse users to customize information for their particular needs. These characteristics create the potential for members of the public to understand and act on complex information previously available mainly to experts. At a time when national authority is challenged by complex political and economic forces, the government's unique ability to command the collection and disclosure of information appears to be an increasing strength.

Mandatory disclosure has gained approval as a regulatory tool when these underlying forces have combined with more immediate political concerns. For example,

the Toxics Release Inventory (TRI), currently viewed as one of the nation's most successful environmental disclosure requirements, gained credence from the convergence of economic and political forces, growing pressures to expand the public's right-to-know, and the promise of information technology. But it was also a result of a tragic incident, a newly perceived risk, strong Congressional leadership, the example of innovative state laws, linkage with unrelated legislative priorities and a certain amount of political serendipity.

Specifically, the TRI was part of a response to an accidental release of methyl isocyanate at a Union Carbide pesticide-manufacturing plant in Bhopal, India in 1984 that left 2,000 people dead and 100,000 injured. Congressional leaders (as well as the media and environmental groups) linked that accident to risks from mishaps in the United States involving toxic chemicals and urged action. New Jersey's industrial survey demonstrated that it was feasible to collect basic information about toxic releases from manufacturers. In 1986, Congress tacked onto a Superfund re-authorization bill the requirement that companies report annual release levels of toxic chemicals, facility by facility and chemical by chemical. To most people this inventory looked like just another reporting requirement. But the law required that information about toxic releases had to be made available to the public and distributed "by computer telecommunications." The power of this simple requirement became clear on June 30, 1988, on the eve of the first reporting deadline, when Richard J. Mahoney, then head of the Monsanto Corporation, called a press conference to express his surprise at the amount of air toxins (374 pounds a year) that the company was releasing into the environment and to pledge a 90 percent reduction within four years.

Unique Conflicts Created by Mandatory Disclosure

Experience to date indicates that disclosure requirements aimed at improving environmental protection produce a unique set of conflicts among competing values. The purpose of the political process is to resolve such conflicts and to come up with workable compromises. Disclosure requirements further several values that are widely viewed as fundamental to American democracy. However, they also conflict with a number of other

enduring values and with powerful political interests. Legislation and regulatory actions have been successful in producing disclosure requirements that are workable compromises. But there is a possibility that those compromises will distort requirements in ways that limit their effectiveness.

Values Promoting Disclosure

Regulation by means of disclosure can further fundamental democratic principles widely viewed as essential to the political system. Foremost among these is the idea that a well-informed public is essential to the creation of sound public policy. In particular, disclosure requirements are seen as one means of improving effective public participation in decisions about environmental protection at the national, state and local levels. Public participation in such decisions has long been a prominent policy goal but has proven problematic in practice.

Second, disclosure requirements are often seen as furthering the fundamental value of minimizing government intrusion in private affairs. Disclosure requirements generally allow companies (or agencies) that are the targets of their mandates broad choices in whether, how, and how much to change their practices or products. They therefore are viewed as less restrictive than other common regulatory approaches such as technology standards, performance standards and market mechanisms.

Third, disclosure requirements are often viewed as less contentious than other regulatory programs. They may therefore be seen as producing fewer of the prolonged political and legal battles that have plagued some environmental standard-setting. Unlike standards and economic incentives based on price or quantity, disclosure requirements do not necessarily depend on political agreement about appropriate benchmarks for environmental protection. Instead of agreement on the amount of pollution to be allowed or the appropriate size of a tax, legislators need only agree on what information the public should have about practices that may not violate any law.

Fourth, disclosure requirements are thought to be more adaptable to changing circumstances than regulations that are based on fixed quantities or prices. They are

therefore seen as less likely to become outdated as technology, industry, or scientific knowledge progress.

Fifth, information requirements have drawn a broad following partly because they are seen as avoiding the complex regulatory framework and enforcement efforts that inevitably accompany government standards. Proponents argue that information requirements are largely self-enforcing, with publicity about polluters and decisions by consumers and investors taking the place of squads of government inspectors.

Because of these characteristics, mandatory disclosure sometimes has particularly broad political appeal compared to other regulatory proposals. Liberals tend to see disclosure as a supplement to established environmental regulation that also fosters public involvement in environmental decisions. Conservatives tend to see disclosure as an alternative to expensive and burdensome federal regulation. Both may see information requirements as likely to be less costly to government and business than regulations that set specific environmental standards. It is important to note, however, that much of this apparent common ground often collapses as specific provisions are debated because liberal and conservative support is based on widely divergent assumptions.

Values Discouraging Disclosure

If mandatory disclosure promotes some fundamental values, it often conflicts with others. In particular, environmental disclosure requirements may interfere with one or more of three broadly accepted values: protection of confidential business information, protection of personal privacy and safeguard of national security.

Protection of Confidential Business Information

Both common law and statutory law recognize the importance of protecting corporate trade secrets from public scrutiny. The rationale for such protection is that proprietary information is central to encouraging business innovation and healthy competition. Even in well-established regulatory regimes, continuing disputes over the precise scope, means and burden of proof for the protection of trade secrets are not uncommon. Therefore it is not surprising that new measures designed to employ

disclosure as an instrument of environmental regulation have been accompanied by political battles over the scope of protection for trade secrets.

While the general principles involved are well understood, disclosure requirements have varied in their approaches to protection of trade secrets. TRI, for example, provides relatively narrow protection. After much debate, TRI was framed to require companies to substantiate trade secrets at the time they were claimed, release protected information to federal and state officials and abide by a final decision made by EPA. In the aftermath of the Bhopal incident, members of Congress were explicit in limiting protection of trade secrets because of what was viewed as a compelling public need to provide the public with better information about toxic chemicals released in their communities. At other times and in other political circumstances, the need to protect trade secrets has been a higher priority. For example, OSHA's Hazard Communication Standard, finalized only a year before TRI was enacted, provided for much broader protection of trade secrets. And in 1996 industry groups lobbied successfully against broadening disclosure of toxic releases to include both inputs and outputs of toxic chemicals, arguing in part that expanded disclosure might reveal trade secrets.

Understandably, industry demands for secrecy have increased in the "information age." A coalition of trade associations representing chemical companies, auto manufacturers, oil companies and other major sectors of the economy have argued recently that business information needs more legal protection in the electronic age than in the past because companies face new threats from the growing use of computer technology and other sophisticated techniques in intelligence-gathering by competitors. They argue that computer power can easily combine company information from a variety of public sources to produce composite clues about new products, manufacturing processes and expansion plans. Such electronic capability, they argue, creates a "mosaic effect." In fact, environmental information may be a relatively minor part of such intelligence work compared to more general information gleaned from company employees or consultants. A recent survey of security specialists noted that the greatest risks of damaging revelations are from individuals who have a close relationship to the company. New Jersey and Massachusetts, states that require companies to publicly report

not only releases of toxic chemicals (as the Federal government does) but also inputs and use of such chemicals have found that fewer than two percent of facilities have asked for protection of confidential information. Nonetheless, the Senate Appropriations Committee directed EPA in 1999 to find ways to improve protection of confidential business information.

Safeguard of National Security

Concern about national security can also clash with disclosure of environmental information or limit it. In 1999, national security arguments led Congress to bar disclosure of chemical companies' worst-case scenarios in the event of accidents. Such scenarios were required by the 1990 Clean AirAct. Both the FBI and the Central Intelligence Agency added the weight of their support to industry lobbyists who claimed that such information (much of which was already available in public reports) could make it easier for terrorists to plan attacks on vulnerable targets.

More broadly, concern about national security has blocked public disclosure of the nation's most complete storehouse of spatial information concerning the environment – the U.S. military's records gleaned from spy satellites and other advanced instruments. Despite five years of efforts by the Clinton administration to place more of such information in the public record, most remains classified.

Protection of Privacy

The enduring societal value of protecting personal privacy and private property also clashes with some disclosure requirements aimed at improving environmental protection. In one often cited example, in 1993 Secretary of the Interior Bruce Babbitt proposed a National Biological Survey to provide a baseline for protection of ecological resources, including endangered species. Private property advocates attacked the plan and convinced Congress to forbid the spending of federal funds on gathering such basic information about distribution of plant and animal species.

The growing use of satellite imagery, aerial photography and sophisticated remote sensing to gather environmental information will raises more privacy issues. Satellite imagery is currently used to track commercial practices such as logging and farming. In

some cities, it is also used to check on residents who may be building homes or additions on their land without required permits. Both the resolution and the technological capabilities of commercial remote sensing are increasing. Following the end of the Cold War the federal government issued new rules permitting commercial satellites to record and distribute images of one meter resolution. While the character and extent of the market for such images remains uncertain, several commercial firms have projects underway to deliver one-meter images on demand via the Internet.

Political Interests and Disclosure

In addition to conflicts among fundamental values, disclosure of environmental information favors or threatens more immediate political interests. Regulatory decisions intentionally increase the costs of some commercial activities and decrease the costs of others in order to serve a public purpose. Particularly when disclosure is used as a means of regulation, information that is power to some inevitably is threatening to others. Disclosure of environmental information can improve the competitive position of some firms while making competition harder for others. It can make some cities look like desirable places to live and suggest that others have more contaminants in drinking water, air pollution or beach closings. The character of each disclosure requirement is framed in part by the relative strength of conflicting interests that stand to gain or lose from disclosure.

As the power of government's informational strategies to influence private sector practices becomes increasingly evident, political battles become more heated. In 1999, for example, a coalition of auto manufacturers, oil companies, chemical companies, and other major manufacturers circulated a white paper justifying erecting new procedural barriers to disclosure of "information products." (The term was not defined.) The Senate Committee report then directed EPA to consider new procedures for the release of environmental information to provide for advance notice, opportunity to comment, an annual agenda and judicial review as well as better protection of confidential business information.

Influence of Political Conflicts on Disclosure Requirements

We suggest that the interplay of these values and interests influences the design of essential aspects of environmental disclosure systems. The resulting architecture of disclosure requirements in turn influences the strength and character of incentives created for businesses or public agencies to improve environmental protection. We suggest that disclosure requirements, though varied in purpose, operation and effects, share a number of essential characteristics, each of which may be influenced by the interplay of political forces. Specifically, each disclosure requirement is characterized by particular purposes, targets, scope, structure, vehicle and means of enforcement. We illustrate how design can be affected by summarizing the influence of such conflicts on the framing of the TRI, one of the earliest and often considered one of the most successful disclosure requirements to improve environmental protection.

TRI was a groundbreaking requirement in the use of public disclosure but its purposes were expanded by Congress until they satisfied a wide variety of constituencies but also confused its design. TRI was expected to aid Congress and government agencies in framing new regulations, to encourage businesses to decrease toxic pollution, to help researchers better understand such pollution, to help communities plan responses to such pollution, and, of course, to inform the general public.

Its targets, however, were so severely truncated that it reported on only a small portion of the sources of toxic pollution. Congress excluded from obligations to report toxic pollution small businesses, agriculture, mobile sources as well as many large businesses including mining operations, power plants and firms that manufactured or used limited amounts of chemicals.

Similarly, Congress limited the scope of disclosure. TRI included a partial list of toxic chemicals and reflected outdated thinking about events for which disclosure was required. To secure rapid congressional approval, its sponsors created a national list of toxic chemicals by combining lists assembled by New Jersey and Maryland for state purposes. They also narrowed the initial proposal to require disclosure only of end-of-

Characteristics of Information-Based Environmental Regulations

Purpose*: Why is disclosure required?*
Eg. To reduce risks to health or environment by lowering amount of pollutant or class of pollutants, improving certain ecological conditions.

Policy issue: Is purpose clear and specific and is disclosure an appropriate regulatory tool to reduce the risk in question?

Target: Who is required to disclose?
Eg. categories of firms, public agencies, utilities, individuals.

Policy issue: Does disclosure approximate entities that are sources of risk?

Scope*: What is required to be disclosed?*
Eg. Substances (inputs/outputs with environmental consequences), processes or practices (logging, mining, farming, etc.), intended or unintended environmental consequences (past or projected).

Policy issue*: Does disclosure reveal known causes of risk?*

Structure*: How is disclosure framed?*
Eg. Timeliness, accuracy, character of measure and level (facility, firm, sector, etc.) of disclosure.

Policy issue*: Does disclosure produce a reasonably complete indicator of risk that allows fair comparisons among sources and over time?*

Vehicle*: How is disclosure communicated?*
Eg. Raw data and/or interpreted data; government report, firm or agency self-reporting, product label, Internet.

Policy issue*: Does vehicle of disclosure maximize effectiveness of communication?*

Audience*: To whom is disclosure required?*
Eg. General public, specialized groups (researchers, community residents, auditors, environmental accountants, etc.), government officials (emergency personnel, regulators, etc.), other firms, CEO or other portions of reporting company.

Policy issue: Is audience appropriate for risk reduction?

Enforcement: How is disclosure enforced?
Eg. Penalties, citizen suits, government/private audits, industry self-policing.

Policy issue: Does disclosure produce reliable information?

Context/Consequences*: How does disclosure relate to other efforts reduce risk in question and other national priorities?*
Eg. Interaction with federal/state pollution-control limits, land-use rules, market incentives, other risk regulation, and policies that reflect competing priorities.

Policy issue*: How does disclosure re-enforce or counter existing incentives for risk reduction and for other national priorities? On balance, is disclosure an effective approach to risk reduction, taking into consideration likely costs and unintended consequences?*

the-pipe releases of chemicals at a time when national policy was turning toward pollution prevention.

In addition, Congress framed a disclosure structure that prevented TRI from serving as a source of information about risk and that limited the timeliness and accuracy of disclosure. Chemical releases were reported only in total pounds per facility per year without information about toxicity and exposure that are essential to judgments about risk. Reports were not due until six months after the close of the calendar year and, in practice, EPA processing of data generally took nearly another year, producing information that was seriously out of date. Also, responding to industry concerns about reporting burdens, Congress allowed disclosure to be based on estimates so that no new monitoring would be required and allowed each company to choose its own estimating techniques. Thus the politics of Congressional approval distorted both the picture of toxic pollution that reached the public and the incentives for industrial change.

The vehicle and audience of disclosure, however, were strengths of the requirement. They required electronic disclosure just as the power of computer technology and the Internet were about to transform communication and they required disclosed to the general public at a time when interest in risks related to toxic chemicals was high. Enforcement did not produce compliance, however, especially in the early years. The law provided penalties for failure to report but an overburdened and under-funded EPA did not initially frame a national enforcement strategy. EPA delegated responsibility to regional offices and to states, and reported that as many as a third of facilities required to report initially had not done so. Thus the politics of congressional approval distorted both the picture of toxic pollution that reached the public as well as incentives for industrial change.

Paradoxes Associated with Disclosure Requirements

We conclude this section by suggesting a number of paradoxes that emerge from this analysis.

1. Workable compromise v. effective risk reduction

When disclosure is used as a tool of environmental regulation, its overarching purpose is to contribute to reduction of environmental risks. However, public accountability requires that such regulation be framed by the political process. The political process is designed to resolve conflicts by achieving workable compromises. Such compromises may diverge from characteristics of information-based regulation that are essential to effective risk reduction.

Possible approaches: Particular attention to structuring political v. technical decisions.

2. Increased appropriateness of disclosure when risks are uncertain v. increased likelihood of distortions in disclosure when risks are uncertain

In a choice among regulatory tools (standard-setting, market incentives, product bans, liability provisions, etc.), disclosure requirements may appear to be particularly appropriate when risks are relatively uncertain. Standard-setting (which usually requires decisions about the quantity of allowable pollution or ecological damage) and market incentives (which usually require decisions about appropriate price or quantity of pollution or ecological damage that is acceptable) call for a degree of certainty. Providing the public with information may appear to be a politically benign way of taking action to reduce environmental risks about which relatively little is known. However, disclosure regimes may also be more likely to create distortions when risks are relatively uncertain. Uncertainty exacerbates difficulties in setting the appropriate targets, scope, vehicles and other characteristics of disclosure and in communicating effectively. And uncertainty makes it more difficult to evaluate the effectiveness of information-based measures after they are in operation.

Possible approaches: Particular attention to communicating the character and degree of uncertainty and to building into disclosure systems mechanisms for adaptation to new knowledge.

3. Complexity needed for accuracy v. simplicity needed for effective communication

In the case of conventional environmental regulation, emphasis is placed on delineating the complexity of environmental risks with as much precision as possible. When disclosure as chosen as a regulatory instrument, however, effective communication with the non-expert public is a central goal. Research by cognitive psychologists and economists has shown the people inevitably simplify complex information to make sense of it.

Possible approaches: Include release of raw data in disclosure. Use information technology to layer/customize data to maintain richness of information while communication with a broad audience.

4. Requiring corporate accountability for environmental consequences of past actions via disclosure v. fostering uninhibited sharing of information to encourage future actions to minimize risks

There is sometimes a hidden duality of purpose in disclosure regimes. One goal is often accountability. The idea is that firms or public authorities should be held responsible for actions that have serious environmental consequences. The public has a legitimate interest in knowing the character of those consequences. Another goal, however, may be to increase the flow of information in order to minimize future risks. That goal might be served by candid communication among companies, or between companies and researchers or other experts, about near misses, minor environmental problems with common patterns, etc. Because public disclosure associated with accountability creates incentives for targeted entities to hide information or distort accuracy, pursuit of that purpose may conflict with efforts to minimize future risks.

Possible approaches: Assure that purpose(s) of disclosure is clear. Consider stratified disclosure.

5. Broad availability of information under "right to know" principles v. limited disclosure with a regulatory purpose

"Right to know" laws establish the important principle that information obtained from private sector entities by the federal government should be generally available to the public unless there is a good reason for withholding it. But when information is obtained from private sector entities for the purpose of disclosure-based regulation, its availability to the public is structured to serve the purpose at hand and may be subject to procedural impediments (consultation with stakeholders, for example) that do not apply in the "right to know" context.

Possible approaches: Draw a clear distinction between right-to-know and regulatory regimes based on disclosure.

PART3: ECONOMICS OF ENVIRONMENTAL DISCLOSURE

How does public disclosure work?

Typically, environmental disclosure is geared towards five target groups: consumers, NGOs and communities[1], corporations (including managers and employees), regulators and investors. Depending on the responses of these groups, public information can motivate companies to change their environmental behavior in several ways. But fundamentally, public disclosure will work only if it can create some direct financial incentives for pollution abatement or strengthen corporate norms regarding environmental management. In our view, financial incentives are created by external agents like markets forces or communities while corporate norms work through internal agents within an organization. Thus, public information operates through external as well as internal agents of change.

Financial Incentive Framework: The financial incentive framework is rooted in the most commonly used analytical model in environmental economics. Within this framework, public disclosure must impose a credible level of cost on industries that

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[1] *NGOs and communities are clubbed together because both these groups drive informal regulation or civic environmentalism*

release pollution without adequate control. As shown in Figure 1a, firms control pollution up to the point where the marginal penalty for pollution released is equal to the marginal cost of pollution abated. For unregulated pollutants, industries have little incentive to invest in pollution control, as represented by the point A_1 in Figure 1b. If public disclosure works, industries will move up the abatement curve to some point A_2. There are two fundamental ways in which this change can take place. First, the penalty function can shift upwards as shown by the curve MEP_2, so that it intersects the marginal cost curve at A_2. The second possibility for this change is through a shift of the marginal abatement cost curve to MAC_2, which occurs primarily through technological improvements. The intermediate situation that can lead to the same level of abatement occurs by the simultaneous movement of penalty and cost curves. We call these "carrot and stick" effects of public disclosure.

In our view public disclosure increases the marginal expected penalty ("stick" effect) either by adversely affecting the reputation of industries or by strengthening informal regulation[2] or both. The "carrot" effect, by contrast, works through positive reputation and informational incentives[3]. These are the four primary mechanisms through public disclosure can influence the environmental behavior of industries. The specific channels through which public disclosure operates are illustrated in Figure 2.

There are four channels through which bad reputation can harm the competitive position of businesses. First, market demand can be adversely affected by product boycott by environmentally sensitive consumers. Similarly, the cost of production can increase because of the likelihood of increased cost of capital and difficulty in hiring skilled workers. Finally, poor performance on unregulated pollutants may reveal poor performance on regulated pollutants as well. Consequently, public disclosure can identify businesses that require closer regulatory oversight, thereby leading to increased investment in compliance management. Clearly, negative environmental reputation can

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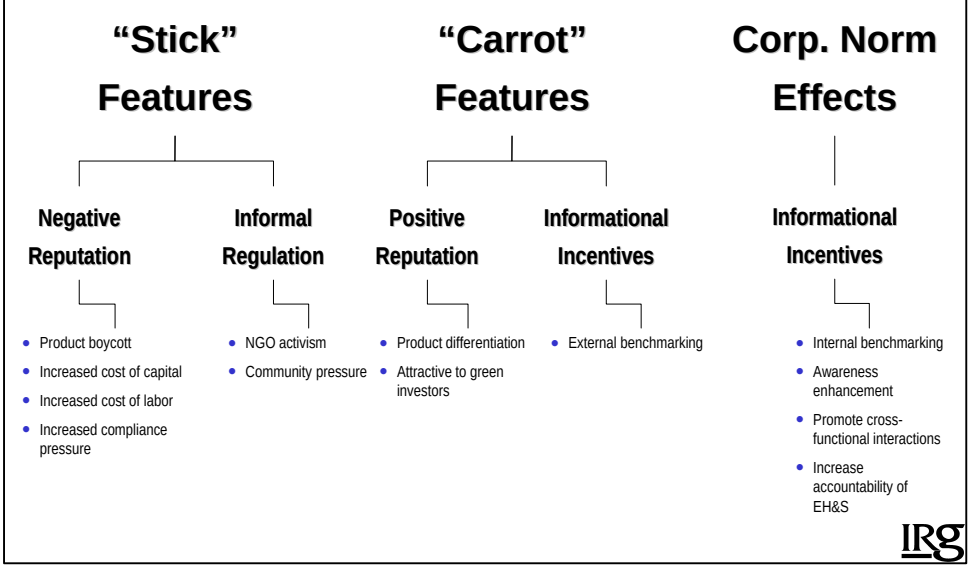
[2] *Informal regulation refers to pressure from NGOs or communities to improve performance.*
[3] *Informational incentive refers motivation for change created by the arrival of new information.*

Figure 2:Public Disclosure and its Incentive Structure



hurt profitability by increasing production costs. In short, businesses may have to pay a heavy price for bad reputation created by their poor environmental performance.

The second dimension of the "stick" effect works through civic environmentalism or informal regulation. Public information can empower NGOs and citizens groups with information that enables these groups to increase pressure on companies to reduce pollution.

The "carrot" effects of public disclosure are generated through positive reputation and informational incentives. Companies recognized for environmental stewardship can benefit from recognition in the product market, are attractive for green investors in the capital market and are trusted by regulators and thereby subjected to reduced regulatory scrutiny. Similarly, benefits from information incentives come through comparative benchmarking. Public information enables corporations to compare themselves with their competitors and in the process discover the potential for improvements.

Corporate Norm Framework: Public disclosure affects corporate norms in several ways through informational incentives. First, public disclosure helps to bring the

understanding of environmental performance to a common level throughout the organization. Such understanding otherwise resides primarily with the environmental, health and safety (EH&S) staff. This form of organization-wide information dissemination increases the awareness level of senior managers in ways that may strengthen the corporate commitment to environment. Second, public disclosure provides data in structured and standardized form that enables environmental managers to analyze their performance systematically, thereby increasing the likelihood of investment in environmental improvement. We call this the internal benchmarking effect. Third, publicly provided information may catalyze interaction between the environmental and production staffs in ways that may lead to innovative solutions by discovering unrealized opportunities for environmental improvements. Finally, public disclosure puts the head of the EH&S operations in the spotlight. Just as the stock price is used as the indicator of the CEO's performance, environmental disclosure creates a similar system for scrutinizing the performance of EH&S operations in the organization.

In the following section, we discuss these channels in more detail.

1. Environmental Reputation and Market Demand

Consumers may internalize environmental information to revise their opinions about environmental performance of companies, particularly those that supply brand name products. Depending on the environmental preference of consumers, market demand can be adversely affected by negative reputation. Environmental awareness of some consumers has reached the critical level where their purchasing behavior has become sensitive to the environmental characteristics of the products and services they purchase. More specifically, consumers tend to notice three types of characteristics. First, consumers may be concerned about the private health and safety impacts from products or services they use. Such impacts have parallels in other areas of risk regulation such as automobile or consumer product safety. Second, consumers may be concerned about the environmental impacts from post-consumption product disposal. For example, a product may be packaged in a form that increases household waste and therefore the overall demand for landfills or other less-environmentally friendly forms of waste management. Environmentally conscious consumers may find such products relatively

undesirable. And finally, consumers may be concerned about the environmental characteristics of the production process through which a product or a service is provided. Thus, even when a product may not have any of the first two environmental characteristics, consumers may decide against a particular brand of product if they believe that the product was manufactured through a dirty technology or inadequate waste management.

On the positive side, high standards of environmental performance may help companies differentiate their products on the basis of environmental characteristics. But a high level of performance comes at a cost, and therefore companies may charge more for these products compared to their substitutes that do not have any differentiable environmental feature. Clearly, companies will adopt green marketing strategies only if the there is a sizeable mass of environmentally sensitive consumers.

2. Public disclosure and the financial market

Several studies have analyzed the impact of environmental disclosure on the market value of firms. Most of these studies find that poor environmental performance is associated with loss in market value of firms. Through such empirical observations, several authors have argued that the financial market creates incentive for firms to improve their environmental performance. Because of this relationship, a public disclosure program becomes an important channel for informing investors about the environmental performance of firms.

In our view most of these empirical studies merely show an association between change in market value and good or bad environmental news. This association simply implies that the financial market is efficient about internalizing market risks contained in the environmental performance data on firms. To conclude that the financial market creates incentives for improving environmental behavior is a gross misinterpretation. Incentives for improving environmental behavior through public disclosure still come from market demand effects, informal regulation, benchmarking and increased organizational capacity — the other channels discussed in this paper. If anything, the

changes in the market value only reaffirm that some combination of the channels discussed here creates measurable costs or benefits for organizations.

So, how can the financial market influence environmental behavior of publicly traded firms? We argue that the financial market can create incentives for environmental improvement in two ways. First, it has to be established that good environmental performance increases the likelihood of profitability. The underlying theory is that superior environmental performance reflects more efficient use of raw materials, energy and other resources or superior organizational, technological and management capacity compared to firms that do not have as good a performance. This comparative efficiency will then translate into marginally higher profit for firms with good environmental performance. To the best of our knowledge, there is no study that offers a clear answer to this question.

The second possibility through which the financial market may create incentives for improving environmental behavior depends on whether or not the average investor has strong environmental preference. Investors with strong environmental preferences may first want to screen companies for high standards in environmental performance as they develop their investment strategy. This process may eliminate several firms with good profitability from the portfolio. In comparison, firms with moderate but acceptable profitability but with good environmental performance will be attractive for environmentally responsible investors. In some sense, good environmental performance will compensate for somewhat lower profitability. If this is the case then clearly the financial market can create incentives for firms to improve performance. But the impact of the financial market on the environmental behavior of publicly traded corporations is heavily dependant on the market power of environmentally responsible investors.

To understand this effect of the capital markets, we evaluate investors' reaction to environmental performance information. As shown in Table 1, after disclosure, companies are slotted in one of the four broad categories marked as Box 1-4. Companies in Box 1 will be best positioned for favorable rating by all types of investors and so the marginal impact of public information will be minimal. Companies in Box 2 are likely to

be attractive for green investors and therefore corporations in this box will benefit from public disclosure. However, the extent of this impact is dependant on the relative share of environmentally sensitive investors. If the public's commitment to environmental values continues to strengthen, the share of environmentally responsible investors is expected to grow and firms in Box 2 will be rewarded for their exemplary environmental behavior even if their financial performance is moderate.

Table 1

	Profitability: High	Profitability: Moderate but acceptable
Environmental Performance: Good	Box 1: Ideal for all investors; preferred stock for green investors	Box 2: May be preferred by green investors
Environmental Performance: Bad	Box 3: Preferred by all, except the green investors	Box 4: Moderately attractive for all but the green investors

For firms in Box 3, the impact of environmental disclosure is somewhat complex. First, some investors will revise their assessment of profitability when they learn about a firm's under-investment in environmental management. Second, investors will evaluate the extent to which profitability of these firms is sensitive to environmental reputation. If the cost of poor environmental performance is high, these firms may be pushed into Box-4. However, if the impact on profitability is not large, it may be optimal for these firms to remain in Box-3. On the contrary, if the green investors are influential in the market, firms in Box-3 may consider undertaking the necessary investment to move to Box-2. Firms in Box-4 will be largely unaffected by public disclosure unless there is critical mass of environmentally responsible investors to adversely affect the market value. Clearly, firms will converge into Box-2 only if there are enough environmentally responsible investors.

3. Information strengthens informal regulation

Informal regulation operates through direct pressure by communities and NGOs on industries to reduce pollution. Informal regulation can change environmental behavior if industries consider it cheaper to comply with the demands of communities and NGOs than to maintain the status quo. Industries take informal pressure seriously because

communities and NGOs can impose costs directly through citizen's lawsuits[4] or indirectly through the market by damaging corporate reputation. Therefore, public disclosure can be a crucial informational resource for empowering communities and NGOs.

People prefer to live in neighborhoods with low health risks unless employment, access to housing and environmental quality are inextricably linked. In such cases, environmental risks from industrial production are internalized in the residential location decision. In other situations, communities may be under-informed about environmental risks from industrial activities in their vicinity. Through public disclosure, these community residents may revise their assessments of health risk and may pressure industries to adopt stricter performance standards that will lower health hazards.

In some cases, communities may be well aware of environmental risks but may not have adequate information to identify the precise pollution sources, pollutants, their health effects or levels of exposure. In such situations, public disclosure will fill an important gap and may catalyze community action.

However, the probability of community action depends on the level of information as well as on a wide range of community characteristics. In locations where community characteristics are not conducive to informal pressure, public disclosure may have little impact.

Additionally, community action is a credible force even for instances where corporations are considering expansion or relocation of production activities. For corporations that are associated with negative environmental reputation, such community actions can impose serious transaction costs (e.g. Disney trying to move to Virginia). Public disclosure of environmental information strengthens this kind of informal regulation since it is an important determinant of environmental reputation.

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[4] *This may include boycotts and state/local decisions about zoning, infrastructure (roads, sewers) tax policies.*

4. Information as compliance tool

Though it is not always obvious, public disclosure strengthens formal regulation in several ways. There are at least three types of interactions between public disclosure and formal regulation depending on whether or not the disclosed information relates to regulated or unregulated pollutants. First, if disclosure is based on regulated pollutants, information on non-compliance behavior of firms can often be reputationally very damaging because compliance with regulation is a well-accepted social norm. In several cases, reputational incentives may be sufficient to motivate polluters to comply with environmental regulation. In the absence of reputational pressure, compliance is completely dependent on the threat of formal enforcement through legal channels which can be an expensive and a time consuming process. If some non-compliant firms can be influenced by reputation then the limited inspection and enforcement budget of environmental agencies can be applied towards the remainder of non-compliant polluters, thereby increasing the expected cost of non-compliance through increased probability of inspection and enforcement. Thus, public disclosure expands the incentive base of the regulatory system, thereby increasing the compliance level among the regulated facilities.

The second interaction emerges from the informational effects through the disclosure of unregulated pollutants (e.g. TRI). Because of the high likelihood of scrutiny by diverse and independent users, environmental information meant for public disclosure are often well structured and associated with superior quality compared to the information that is not designed for organized disclosure. The information on these unregulated substances has value for regulators for two reasons. Firstly, the high volume of unregulated pollution may convey some information about the quality of the environmental management system (EMS) in the firm. If the EMS has limitations and regulatory compliance is also managed through the same EMS then it is likely to associate this firm with high risk of violation. Secondly, unregulated and regulated pollutants may be correlated. For example, if a polluter has a high level of an unregulated toxin in the wastewater, it is likely that this polluter could be a violator for some regulated pollutant in the same waste stream. If such associations exist, public disclosure of information on unregulated pollutants may be a good predictor of the compliance

behavior of polluters and regulators can target their inspection and monitoring resources more effectively.

The third dimension of the interaction between public information and regulation has its roots in the politics that public information creates. Public disclosure produces transparency that is highly valued in a democratic environment, creating favorable political conditions for environmental agencies to undertake stricter regulatory actions. Empowered with good information, regulators can introduce new standards.

5. Environmental audit effect of information

Environmental reporting requirements, even if they are for unregulated pollutants, have compelled industries to review their production processes and environmental management systems in unprecedented ways. Often these efforts have led to the discovery of opportunities for pollution prevention or savings in materials that are cost neutral or cost saving. Such opportunities would have gone unnoticed without mandatory reporting requirements. The existence of such win-win opportunities remains debatable but if there is some probability that such possibilities exist, data collection needs imposed by public disclosure programs can be potentially beneficial. We can think of this environmental audit effect as an investment that helps firms identify a distribution of pollution control options ranging from cost-saving or cost-neutral to cost-increasing possibilities. Once a firm accumulates such information or knowledge, it will be well positioned to undertake cost-effective strategies for controlling regulated as well as unregulated pollutants.

Firm level audit of environmentally hazardous substances can also promote exchange between production managers and environmental specialists, creating opportunities for discussions and solutions that may go well beyond just the end-of-the-pipe approaches. Unfortunately, a strong compliance-focused environmental management system established over the past thirty years has segregated environmental management from mainstream production operations. This disconnect has severely limited the possibilities for cost-effective environmental management. Public disclosure can contribute significantly to deconstructing the environmental divide within the existing

organizational structure of industrial units. This way, public disclosure helps to break the alienation of the EH&S group within an organization.

6. Benchmarking effect of public information

In the new millennium, compliance objectives are not the only drivers of environmental initiatives by industries. As information on environmental performance of industries becomes publicly available through regulatory or voluntary disclosure, comparative analysis and environmental benchmarking are feasible (e.g. UNEP report on corporate environmental reports). Public disclosure bridges the information gap, and makes it easier for a firm to compare itself against its competitors. Since corporations compete for public image and reputation, public disclosure creates dynamic incentives for environmental improvement. In the process, public disclosure establishes new industry norms for environmental performance.

Public disclosure also works through internal benchmarking because it requires data collection and reporting in standardized formats on a regular basis. Because diverse groups scrutinize the environmental data, public disclosure strengthens the culture as well as disciplines the system of environmental data collection within an organization. Consequently, it becomes possible for an organization to observe the rates of environmental improvements relative to its historical baseline and undertake appropriate measure for continual improvement.

Cost-Effectiveness of Public Disclosure

We develop our analysis of cost effectiveness in three steps. First, we explain the primary environmental objective polluters attempt to pursue under a public disclosure program. Then we describe the basic principles of cost effectiveness that can be applied to evaluate public disclosure. Finally, we apply these principles to evaluate the cost effectiveness of public disclosure. We use some empirical results from TRI to illustrate our arguments.

Environmental objectives created by public disclosure

Compared to command and control regulation or economic instruments, public disclosure creates a unique environmental objective for waste reduction by industries.

Under command and control regulation, polluters aim to minimize the cost of pollution control subject to the pollutant-specific emission standard and, in some instances, mandatory technology. In the case of pollution charges, a polluter aims to minimize the cost of pollution control subject to the emission charge fixed by regulator. And under emissions trading a firm minimizes the cost of pollution control subject to the market-clearing price for fixed quantity of emission permits established by regulator.

It is clear that even for economic instruments, the price of pollution requires some form of quantity control or price-fixing by regulators. In this respect, Cole (1999) has correctly characterized economic instruments as a system of command without control. We extend this characterization one step further and describe public disclosure approach as a no-command and no-control system—in some sense a truly liberated system for environment management.

So how do firms determine the waste reduction target under a public disclosure program like TRI? Alternatively stated, what determines the price of pollution when there is neither an emissions target nor an emissions fee? We show that communities and various market players determine the price of pollution in a public disclosure program. Like regulated price or quantity, which reflect regulators' assessment of the implicit environmental health risks, public disclosure embodies the public's understanding of environmental risks. The question for cost-effectiveness is whether or not the decentralized process through which the price of pollution is determined will lead to superior economic efficiency compared to the use of conventional instruments. In other words, when there is neither command nor control, how will pollution control deviate from the optimal level?

To develop our analysis of cost-effectiveness, we first highlight an interesting feature of public disclosure programs. This pertains to the issue of the implicit performance standard.

Performance standards hidden in public disclosure programs

Since industries have always complained about the interventionist disposition of the conventional approaches, they should prefer public disclosure to the other policies.

This may not be true in practice, however, because public disclosure has its own way of imposing environmental performance standards on industries, and therefore fixing the price of pollution in some unique ways. We explain how the concept of a dynamic emissions standard is disguised within a public disclosure program and its cost implications for industries. Industries will accept or resist public disclosure depending on the implicit price of pollution that emerges from this no-command and no-control mechanism.

In our view, in a public disclosure program the main objective of a firm is to make sure that it is not among the top generators, whether it is at the national, sectoral, county, state or other geographical levels. In other words, a firm aims to be out of the list of top polluters in any identifiable category. We call this environmental behavior the "list effect." The environmental standard in effect is some cutoff point based on the firm's rank. Therefore, public disclosure applies a rank-based standard for pollution control which is distinctively different from the traditional standards based on technology, emissions levels, permits or fees. A polluter's primary intent is to reduce waste to stay out of the "list" at least cost. As illustrated in Figure 3, the price of pollution or marginal expected penalty for firms in any category of "list" is likely to be high.

There are two distinctive features of the "list effect" that differentiate public disclosure from the conventional approaches. First, the "list" in any category is a moving target because it keeps shifting as firms get off it by reducing the pollution they generate. As the threshold level for inclusion in the "list" decreases overtime while the price of pollution remains constant, firms with lower pollution in the first period start to progressively inch towards the threshold level of the "list". Consequently a firm's core strategy under a disclosure system is to get off of the "list" if it is on one and to continue to reduce pollution that will keep it off of the "list." This way public disclosure creates an incentive for firms to continually improve their performance. In the environmental sense, it is a superior outcome compared to command and control and under some conditions could be more effective than economic instruments also. While economic instruments create incentives for continual improvement through the regulated price of

pollution, public disclosure operates through the dynamic performance standards created by the downward movement of the threshold level for inclusion in the "list".

Second, unlike command and control and economic instruments that are pollutant specific, public disclosure under systems like TRI is pollutant-neutral because it is based on the combined volume of all types of wastes. Under TRI firms simply report on the total toxic releases without differentiating for the marginal health risks of different chemicals that constitute the total volume. Consequently, industries tend to reduce waste without taking into consideration the relative toxicity of individual chemicals. This feature makes public disclosure a no-command type of policy tool—that is, neither the choice of pollutant nor their minimum limits is mandated by regulation.

Given these features, we now evaluate if the incentives created by "list effect" will maximize the reduction in health hazard per dollar of effort. In this analysis we will focus on the TRI-type public disclosure program[5].

Case 1: Unambiguous Conditions

The analysis of cost effectiveness of a public disclosure program like TRI is a challenging proposition because the empirical data are very limited. To be precise, we have data on the toxic release trends, its constituent chemicals, a moderately good idea of relative toxicity and some indicators of firm characteristics. Unfortunately, there are no data on cost of pollution control and cost of health impacts. Therefore, it is not possible to conduct a quantitative benefit-cost analysis of public disclosure. However, it is possible to combine the trend analysis of waste released with waste characteristics to see whether or not the reduction is in the direction that signals cost effectiveness. To evaluate the directions of change that are consistent with cost effective reduction, we apply the framework that is most frequently used in environmental economics. The basic elements of this approach are shown in Figure 4a.

[5] *TRI model is only one of many possibilities for public disclosure.*

First, we evaluate the conditions of change that are unambiguously associated with improvement in cost effectiveness. Here there are two clear situations where the reduction in pollution will always be cost effective. The first condition applies to those chemicals that are known to be very dangerous to humans and the general ecology. Such pollutants will have a marginal damage function shown by MD_2 in Figure 4b. On the continuum of substances with varying degrees of risk, it is likely that even a small amount of highly toxic chemicals released into the environment can be fatal. For such pollutants, near zero emissions is optimal because the marginal benefit of no pollution may still be higher than the excessive marginal cost of abating the last unit. Thus, every unit of reduction of such chemicals is an adequate indicator of cost effectiveness, and the higher the reduction more cost effective it is. It is only at a very high level of pollution control that the trade-off between economic benefits and environmental damage becomes an issue. Since TRI includes several such chemicals whose releases have declined significantly over time, it has clearly been an economically efficient tool from this perspective. For example, carcinogens, at one broad level, represent such a category and, as shown in Figure 5, the generation of carcinogens has declined by more than 40% since 1989.

Another condition that is unambiguously cost effective occurs when the marginal control cost declines due to some form of technological improvement. As described in the previous section, public disclosure leads to reductions in waste through informational incentives that work through internal and external benchmarking (Krakkainen 2000). Through benchmarking firms discover efficient ways of carrying out pollution control. As shown in Figure 1b, public disclosure through benchmarking shifts the marginal control costs to the right (MC_1 to MC_2). Such a change is always cost effective because it makes pollution control cheaper. There are enough anecdotes that indicate that benchmarking may be an important factor behind the reduction in TRI releases. Additionally, a feedback survey from Indonesia from factories that participate in the PROPER environmental disclosure program shows that nearly 50% of factories ranked benchmarking and awareness impacts as the most important benefits of PROPER (Afsah and Blackman, forthcoming).

Case 2: Fuzzy Situations

There are at least three situations when the cost effectiveness of public disclosure program like the TRI is less clear. First, under a public disclosure program like TRI firms reduce total volume of waste releases regardless of the differences in environmental impacts per unit pollution of different pollutants—a result of its no-command feature. Secondly, firms adopt multiple combinations of technologies or processes to reduce the waste released. Some of these processes may not eliminate environmental hazards but simply shift problems to another medium or location—a result of the no-control feature of public disclosure. Finally, the volume-based approach is biased against large generators and therefore at high abatement levels that are often very costly, large generators may still get poorer rank compared to smaller emitters at far lower level of abatement—an effect caused by volume-based ranking rather than pollution-intensity-based ranking. In remainder of this section, we explain these cost effectiveness concerns in more detail.

Concern #1--Disregard for Toxicity

The lack of differentiation by pollutants can lead to significant distortions in the economic properties of public disclosure programs. The economic framework to analyze this feature is illustrated in Figure 5. The middle graph shows the firm-level total marginal abatement cost function generated by the summation of marginal abatement costs of individual pollutants. The marginal abatement costs of individual pollutants are shown in the left and right graphs. A firm chooses a level of abatement A* to stay out of the "list". As shown in Figure 6, at A* abatement level the least cost strategy will require A_1 and A_2 level of abatement for the two pollutants. However, the optimal level of abatement should have been A^*_1 and A^*_2, and the level of distortion caused by not incorporating the pollutant characteristics is shown by the size of the shaded area. It is clear that for any given level of abatement, the size of the total distortion will be proportional to the level of difference in the marginal damage functions across pollutants. The more variation we observe, the higher will be the economic cost. One way to get some insight into the extent of this problem within the TRI program is to look at the variance in the toxicity levels of the TRI chemicals. According to Horvath (1995), the

most harmful of SARA chemical is 1,000,000 times more toxic than the least harmful. Given this observation, cost-effectiveness is a potent concern for TRI.

The economic cost will be further exacerbated if it is indeed cheaper to control less-toxic pollutants compared to the more toxic chemicals. In such a case, we will observe that the rate of decline of highly toxic chemicals is slower than of the less-toxic chemicals. A simple trend analysis of total TRI releases disaggregated by non-carcinogens and carcinogens shows a lower rate of decline for carcinogens (Figure 7). Horvath (1995) also found a similar trend when they analyzed the change in waste reduced weighted by toxicity. These observations in combination provide some indication that it may be cheaper to abate less toxic substances compared to the high toxicity chemicals, and therefore there are real concerns about the cost effectiveness of public disclosure programs that treat all pollutants to be equal in terms of their environmental impacts.

Concern #2 --Risk of pollution manipulation

Public disclosure program like the TRI offers considerable flexibility to industries regarding the choice of technique for reducing pollution. But flexibility can be without any consideration for the inherent environmental features of each method. Often pollution prevention is the most desirable technique for waste management because it eliminates waste at the production stage. End-of-the-pipe treatment and recycling are other commonly used methods for pollution control but these are post-production pollution control processes. Other pollution control techniques that reduce waste releases without eliminating them from the environment include off-site storage and cross-media transfers. Under public disclosure, firms may choose any of these techniques and earn equal credit for every unit of waste reduced. Firm's best strategy is to choose a combination of technologies based on the principle of equal marginal control across all techniques, as illustrated in Figure 8. From policy perspective, however, continual environmental improvement through pollution prevention is the most desirable objective. Pollution prevention can be the most widely used method for waste reduction under

public disclosure only if it is the least expensive technique. At best, such an outcome will only be a matter of coincidence rather than a systematic result because public disclosure is not geared to differentially recognize sustainable means of toxic management.

We get some indication of this concern when we analyze the trend for waste reduction through off-site transfers in TRI. As shown in Figure 7b, it appears that there is an increased reliance on off-site transfers per unit waste generated. TRI facilities tend to cut the quantity of toxics released into the environment dominantly by a less desirable technique like off-site transfers. Because performance under TRI is based solely on the total volume of waste releases irrespective of the how the waste is reduced, facilities have no incentive to prefer *an* environmentally superior method unless the cost considerations permit it. Therefore, in TRI there may be under-investment in pollution prevention based reduction techniques. If the command and control system is criticized for its rigidity regarding technology-based standards, public disclosure may also *create a* bias against desirable technologies because of over-flexibility.

Concern #3—Over-burdening large generators

Both theoretical and empirical analyses show that public disclosure is most effective in reducing waste from large and well-known facilities or firms because they are most likely to attract public scrutiny and attention. Comparatively, small or medium-scale waste producers often go unnoticed. As a result, even when large enterprises are at a fairly high level of pollution abatement levels, they may still face pressure to further reduce their waste compared to small producers operating at much lower abatement levels. Since the incremental pollution control can be excessive at high abatement levels, reduction in waste will be achieved at high cost. On the contrary, smaller polluters can reduce the same amount of waste at lesser cost because their baseline abatement is comparatively lower. This scenario is illustrated in Figure 9. Let there be two waste generators, A and B, and let A be a significantly larger generator than B. For simplicity, we assume that their marginal abatement cost curves are identical. Because A is large, it will generate more waste than B for any given level of abatement. Let the cut-off point

for getting out of the “list” be Q*, such that smaller polluter is not in the “list” but the larger polluter is. A is currently at abatement level A_1 and needs to increase the abatement level to A_2 to get out of the list. Facility B has little incentive to abate, therefore is at a low abatement level shown as B_1. For facility A, the total cost for the incremental abatement will be the area A. However, if facility B were to reduce by the same quantity, as shown by the distance (Q_A-Q*) in the graph, the total cost will be the area B, which could be lower than the cost for facility A. This discrepancy is caused by unbalanced incentive created on large and small waste generators in a public disclosure program, and is potentially a significant source of economic distortion. The main reason for this problem lies in the use of a volume-based indicator for performance measurement which is not a good indicator of environmental management effort. This problem can be corrected by using an indicator like toxic intensity (quantity of toxics released per unit output). However, some large waste generators may end up producing dangerous levels of toxics even when they are at a very high level of abatement. In such cases, a toxic-intensity based indicator will rank this facility favorably, when in fact its waste can cause significant environmental damage. In short, there is no single magic indicator that will be a sufficient indicator of environmental performance. Public disclosure therefore needs to incorporate such challenges in its design. Reliance on single indicators like total volume or toxic intensity alone will make the program highly susceptible to economic distortions.

PART 4: COMMUNICATING INFORMATION ABOUT RISKS

In this section, we explore unique communication issues raised by disclosure when it is used as a means of environmental regulation. We analyze why communication issues are different and more critical for regulatory systems based on disclosure than they are for conventional regulatory systems and why communication about uncertainties is particularly important. We discuss how the cognitive short cuts which help people to make sense of complex data can also distort understanding of information concerning environmental risks. We suggest ways in which improving knowledge about such shortcuts can help government officials and private groups provide effective guidance to

the public about the significance of environmental risks. Finally, we raise some difficult issues that call for further analysis.

Regulatory efforts to reduce environmental risks by means of information disclosure raise communication issues that are different from those presented by the use of pollution standards or market mechanisms. Pollution standards rely primarily on the threat of sanctions for their effectiveness. Communication plays a role in their success. Regulated industries must understand the nature of the government requirement and the consequences of company actions. But communication of complex information by government authorities is essential only to that narrow and relatively expert audience. Market mechanisms rely primarily on economic incentives for their effectiveness. Again, communication matters. Firms must comprehend the way the requirement works and the consequences of their decisions. But, again, communication of complex information is essential only for a relatively narrow and knowledgeable audience.

The role of communication in regulatory systems based on disclosure, however, differs in three ways. First, such regulation relies on communication as the central mechanism on which its effectiveness depends. As discussed in the previous section, company responses to disclosure depend on a variety of factors. All responses, however, ultimately hinge on effective communication. If the character and degree of risks are not accurately understood, incentives are skewed and trust in the public process is undermined. Second, regulation by disclosure requires communication of complex information to a broad, non-expert audience rather than to a narrow, relatively expert one. Ultimately, it is the understanding and responses of consumers and voters that matter. Third, accurate communication to the public about what is unknown about risks becomes at least as important as communication about what is known. When conventional regulation is employed, discussions about uncertainty take place mainly among government and private experts in the context of standard-setting or design of market mechanisms or in the context of evaluation or of judicial review. Often, statements released to the public focus mainly on what is known and convey an inflated sense of certainty. But the use of disclosure requires that the public understand not only the nature of the risk at issue but also the complex contours of uncertainty. For pollutants, those

contours may include what is not known about their sources, behavior and interaction; air and water flows; dose-response relationships; disease mechanisms; adequacy of monitoring and exposure information and so on.

Contrary to classical economic theory which assumed that people react to events in a rational way, recent research by cognitive psychologists and economists suggests that reactions to risk may diverge from the traditional understanding of rationality in predictable ways. These shortcuts, called heuristics (from the Greek word heuriskein, to find), are helpful to individuals in preventing information overload but can exaggerate reactions to environmental risks. Without claiming expertise in this literature, we summarize some of the recognized heuristics that have particular bearing on public understanding of environmental risks. In general, researchers have found that people tend to:

- Overestimate some low probability risks (like tornados) and underestimate high probability events (like accidents in the home);
- Assign disproportionate importance to risks of events that are easily brought to mind by frequent reminders – by accidents involving toxic chemicals or spills from oil tankers, for example;
- Ignore evidence that contradicts current beliefs;
- Overrate less visible, less understood risks;
- Overrate high risk assessments when faced with conflicting sources of information.

These cognitive distortions may make consumers and voters vulnerable to manipulation by advertisers, political partisans and others who wish to further particular objectives. But they also create opportunities for responsible guidance.

Understanding cognitive short cuts and devising strategies to minimize them is essential to the effective use of disclosure to improve environmental protection. If people inevitably simplify, public and private intermediaries can provide heuristics that approximate the true character and degree of risk, in so far as it is known, and that

accurately characterize uncertainty. Examples of such shortcuts include rankings, endorsements, and hierarchies of risk or of scientific uncertainty.

Three problems persist, however. One is that there are as yet no accepted ground rules for determining the appropriate government role in such interpretive tasks. Should the government provide a standardized vocabulary, ground rules for benchmarking, or itself rank polluters or grant endorsements? Another problem is that such shortcuts, especially when employed by public authorities, are likely to be politically controversial precisely because of the high degree of uncertainty to surrounds many environmental risks. A third and related problem is that there is inevitable tension between the need to provide credible simplification and the need to communicate information about risks in all of its complexity, especially in a legal system that creates pressures toward precision. Information technology may be one tool that is helpful in resolving this last tension. At its best, computer power and the Internet can combine fragmented environmental information from many sources, integrate it and make it meaningful for non-expert members of the public. They can customize information by answering each individual's questions. They can also layer information to maintain the richness of data while increasing its reach to non-expert audiences. Nonetheless, problems associated with the central role of communication in mandatory disclosure systems have received little attention and remain formidable.

PART 5: IMPLICATIONS FOR DESIGN OF DISCLOSURE REQUIREMENTS

Recognizing that disclosure requirements are inevitably the products of a political process and that economic incentives associated with them can be foreseen, how can their effectiveness be maximized? As a starting point, we suggest five questions the answers to which are central to designing effective instruments.

Is Disclosure the most effective regulatory approach to the problem?

In practice, disclosure is complementary to – rather than a substitute for – the use of standard-setting, market mechanisms and other regulatory tools to improve

environmental protection. In some circumstances, systematic disclosure effectively expands the incentive base that motivates firms to improve their practices. Disclosure regulations allow firms flexibility in the means by which they improve performance. They also do not pre-determine results in pollution reduction or ecological improvement. There are many situations, however, in which the use of mandatory disclosure is not sufficient or effective, including when there is an immediate risk to public health that may call for a product ban or when no significant information gaps exist. As a starting point for further analysis, we suggest that informational strategies may be most useful in minimizing environmental risks when (1) information gaps are significant, (2) relevant information can be obtained at reasonable cost, (3) information is likely to make a difference in consumer choices or company decisions and (4) variable outcomes are acceptable.

Are Purposes of Disclosure Clear?

It is important to distinguish government use of disclosure as a means of regulation from the long and important history of "right to know" efforts. The purpose of "right to know" provisions such as those embodied in the Freedom of Information Act is to generally inform the public. They are therefore founded on the premise that the public should have access to any information held by the government, unless there is a compelling reason to withhold it. Information is released in whatever form it happens to exist in government files. Completeness, accuracy, and clarity of format are not at issue. By contrast, when disclosure provisions are employed to reduce risks to health, safety, or the environment, specificity of purpose is essential to their success. Disclosure must then be structured to achieve that purpose.

Mandatory disclosure should not be viewed as an on-off switch but as a continuum of choices of expanding audiences. Multiple purposes may call for stratified disclosure. When the primary purpose of disclosure is to improve accountability for significant environmental damage, the public has a legitimate interest in the source and magnitude of those risks and companies should expect to provide that information. However, when the primary purpose of disclosure is to identify and correct emerging problems before significant damage occurs or when interests in maintaining

confidentiality are compelling, then limited disclosure may be more effective. In such circumstances the dominant public interest may be in complete reporting and full discussion among interested parties, unhampered by the fear of liability or risk to reputation that full public access brings. Disclosure among firms, to experts, to government agencies (without public release) or to third party monitoring organizations may produce more effective corrective measures.

Can Disclosure Metrics be Designed to Reflect the Dimensions of the Targeted Risk in Order to Produce Cost Effective Results?

As discussed in our political and economic analyses, disclosure requirements employed to date have been characterized by significant strengths but have also exhibited a number of weaknesses in their architecture. If disclosure in practice has sometimes operated as a blunt instrument, future instruments can be further refined. To be effective in reducing risks, disclosure requirements should be designed to reflect four dimensions of the risk in question. First, the disclosure metric should be calibrated to reflect relative toxicity or other measures of environmental harm. Second, it should reflect the quality of the techniques that firms apply, creating incentives for firms to choose pollution prevention over waste management, for example. Third, the requirement should be calibrated to reflect level of effort by firms rather than simply the total volume of pollutants reduced. Volume-based measures tend to bias the system against large firms. Finally, the requirement should reflect the level of impact on the environment. Here there are legitimately greater pressures directed at larger firms. Even with relatively advanced pollution controls, activities of large firms may cause substantially greater environmental impacts than those of smaller firms. Requirements that create incentives for large firms to make further reductions are appropriate, however, both to serve the public purpose of reducing environmental damage and to reflect the more substantial resources available to those firms for environmental controls.

Do Targets, Scope, and Structure of Disclosure Create a Complete, Accurate and Timely Picture of Risks That Government Aims to Reduce?

In addition to the four dimensions discussed above which are directed toward creating appropriate incentives for targeted firms, disclosure requirements are effective only if their choice of targets includes the important sources of the risk, if their scope includes the relevant pollutants or other agents of environmental damage, and if their structure and enforcement promotes timely and accurate disclosure.

Do Terminology and Methodology Facilitate Comparison with other Health, Safety and Environmental Risks?

In the U.S. system of government, disclosure requirements will continue to be adopted in piecemeal fashion to address unique problems as they arise. But in approving terminology and methodology for new disclosure requirements, Congress and the executive branch could construct an evolutionary web of common assumptions to be used by agencies in risk disclosure requirements in order to facilitate benchmarking and to improve effective communication. Where appropriate, for example, legal definitions should be consistent from one requirement to another. Consistent treatment of confidential business information and other competing values would improve predictability for companies and regulators. Uniform indicators to aid in comparisons of risks and standardized categories reflecting degrees of scientific uncertainty could evolve over time.

Figures

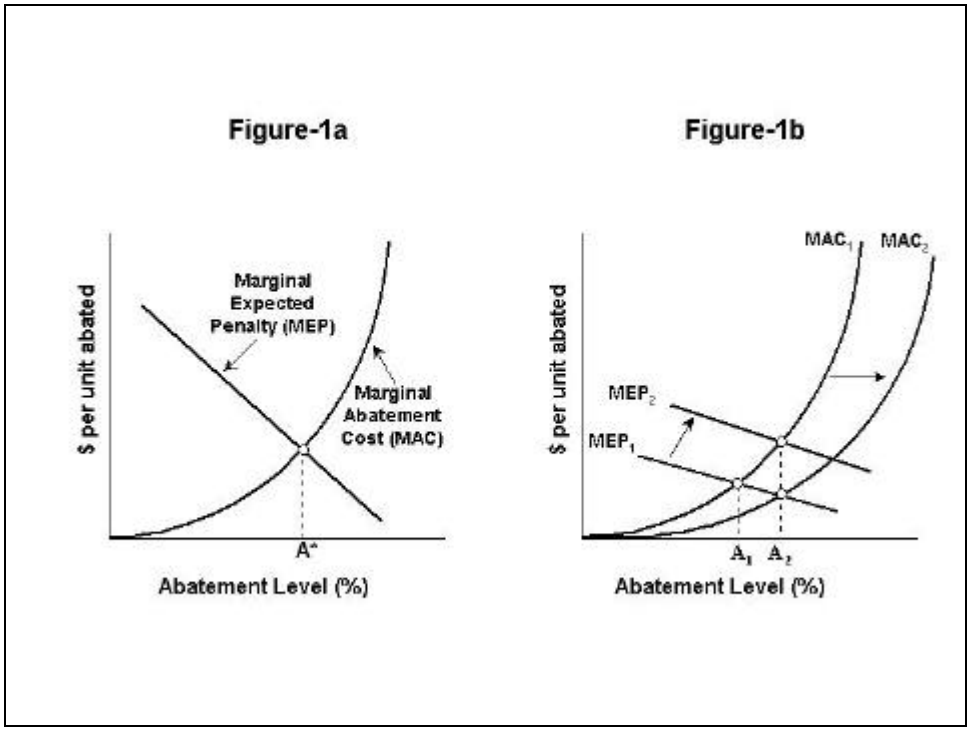


Figure-1a
$ per unit abated
Marginal Expected Penalty (MEP)
Marginal Abatement Cost (MAC)
A*
Abatement Level (%)
Figure-1b
$ per unit abated
MAC1
MAC2
MEP2
MEP1
A1 A2
Abatement Level (%)

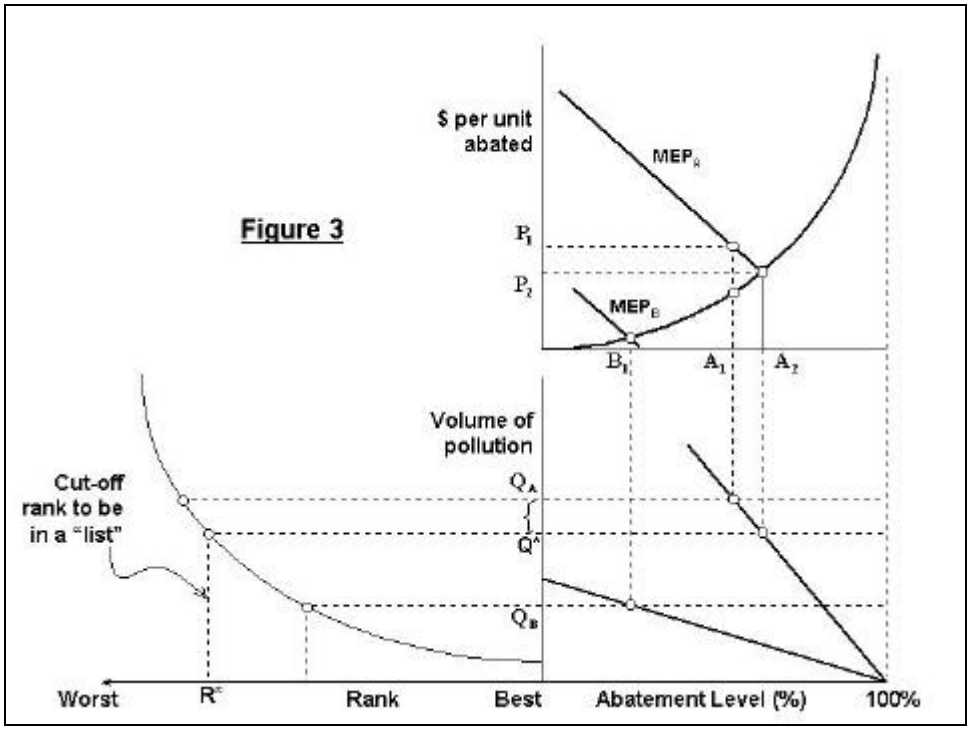


Figure 3
$ per unit abated
MEPA
P1
P2
MEPB
B1
A1
A2
Volume of pollution
Cut-off rank to be in a "list"
QA
Q*
QB
Worst
R*
Rank
Best
Abatement Level (%)
100%

Figure-4a

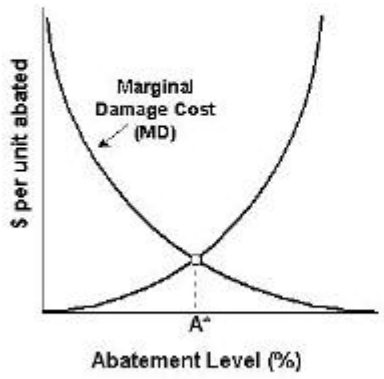


Figure-4b

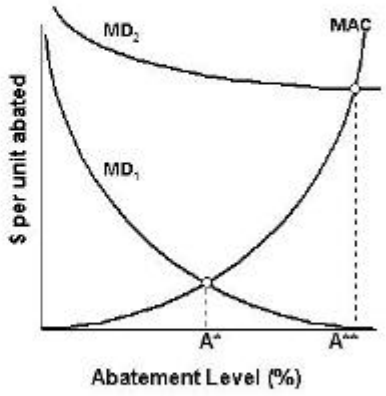
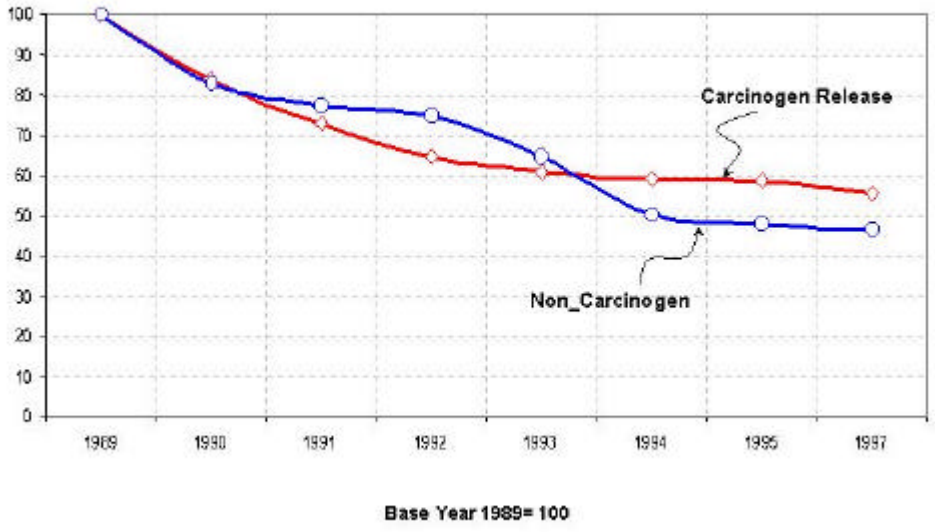


Figure 5: Reduction Trends by Toxicity



Base Year 1989= 100

Figure 6: Distortions Caused by Differences in Toxicity

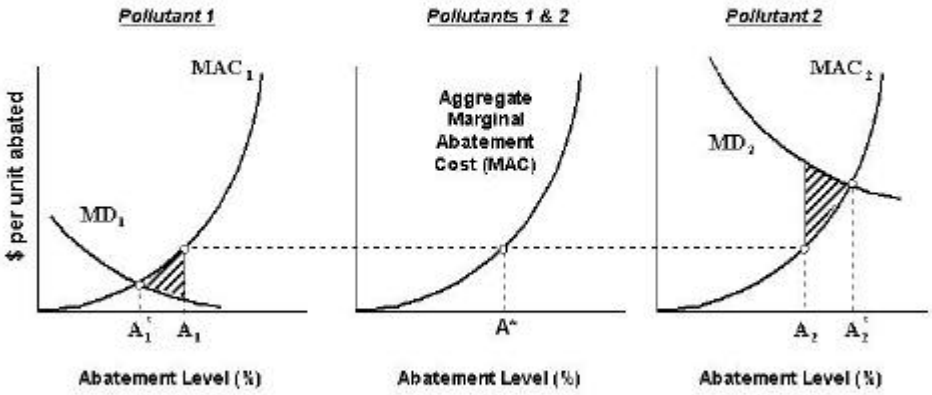


Figure 7a: Share of Toxics Released

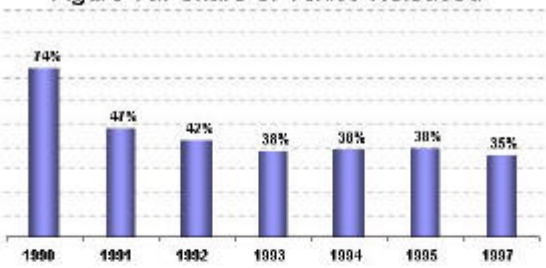


Figure 7b: Share of Toxics Transferred Off-site

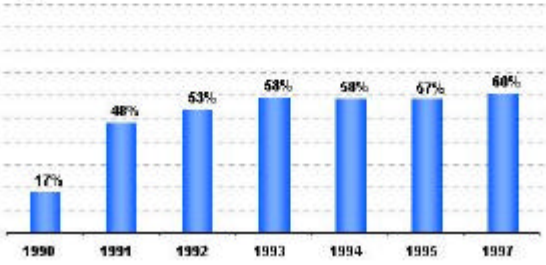


Figure 8: Choice of Pollution Control Technology

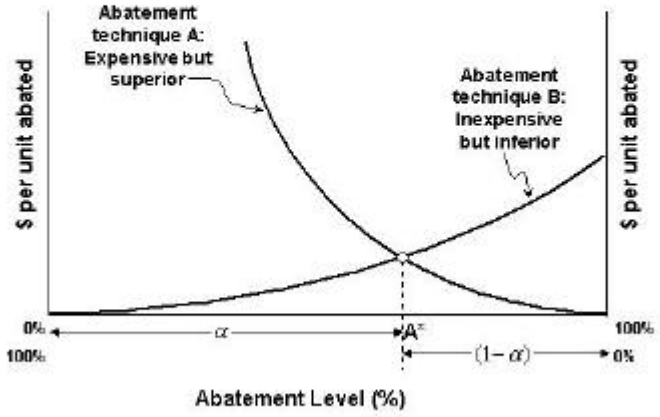


Figure 9: Bias Against Large Polluters