

# Voluntary and Information-Based Air Quality Policies

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Market-based solutions to promote environmental quality and achieve sustainable conservation goals have received attention for their potential capacity to improve incentives for environmental stewardship. Market approaches rely heavily on information. This paper develops voluntary and information-based policies that hold great promise for feasible, substantial, and sustainable conservation gains by supporting a limited role for government, catalyzing and guiding entrepreneurial energies, and enhancing personal (and corporate) accountability for environmental impacts. To address air quality challenges, voluntary and information-based policies can simultaneously promote sustainably prosperous and cleaner cities. Recent decades have provided many chances to learn how voluntary and information-based environmental policies can spark conservation behavior. Lessons from the peer-reviewed scholarly literature can inform the design of these policies, specifically for reducing air pollution and its harms. Well-designed voluntary and information-based policies will enable entrepreneurial firms to take advantage of air quality improvements, be rewarded for emissions reductions, and develop nonprofit institutions to voluntarily reduce emissions where and when it matters most. They inform consumers to enable markets for greener products and investments, to adapt to avoid dangerous exposure, and to pressure businesses to voluntarily clean up dirtier industries. Without informed consumers and investors, markets will fail to deliver their potential for prosperity and environmental gains. Facilitating better information and lowering transaction costs, on the other hand, should inform consumers, investors, and firms to unleash entrepreneurial enterprises to coordinate between residents who want cleaner air and the various and creative ways of achieving it. The guiding voluntary and information-based principle is to help provide public good of information rather than promulgate more mandates. These voluntary and information-based policies are relatively low-cost and locally implementable solutions that would facilitate more market-based approaches, allow a reduction in costly regulations to achieve the same or better environmental improvements (in all cases), and fully replace traditional command-and-control approaches (in some cases). This paper applies voluntary and information-based solutions to air quality, but its ideas can extend to other arenas as well.

A suite of voluntary and information-based policies might include several elements. Some examples of these policies include:

- Publishing real-time appropriate air pollution metrics to make transparent firms' uses of public airsheds and enable greener marketing to be rewarded in the marketplace (both by consumers/supply chain and by investors).
- Providing appropriate data for public air quality forecasting, akin to the National Weather Service, to allow individuals to avoid exposure during peak pollution episodes. It would also guide firms' and individuals' efforts to optimally (i.e., during peak periods) reduce emissions, a necessary condition for any local air quality market to achieve its potential.
- Better dissemination of local and regional pollution levels can inform improved voluntary "sorting" responses by households and firms, providing stronger price signals to reward regions with better environmental performance and reduce excessive exposure to pollutants and regulation. This dissemination, combined with institutions to facilitate voluntary local coordination of emissions reduction, will encourage greater inter-region competition and cleaner air without imposing one-size-fits-all command-and-control solutions.
- Greater information for households about their goods' emissions and their home's air quality, coupled with enhanced vehicle-specific emissions information, would enable greener and healthier consumption choices and make other emissions market mechanisms (e.g., tradeable driving permits) possible.

## Introduction to voluntary and information-based environmental policies

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Urban air pollution remains a serious concern in the United States and internationally despite major improvements made in the past half century. From a policy perspective, the problem is not that the air is dirty or that economic activity pollutes. The problem is, rather, twofold: how clean ought our air quality be, and what institutions and policies best achieve that? Once framed that way, the trade-offs and implementation realities become more apparent.

Recognizing that "perfect" or idealized solutions, such as a competitive market for air quality or a cost-free regulated world, are infeasible even if desirable, this essay focuses on a suite of policies to incrementally improve matters. The solutions here are not silver bullets, nor are they comprehensive solutions to air quality challenges. They are, instead, feasible policy tools with the promise to promote better quality of life and environmental conditions. Aside from their more immediate impacts on human well-being and air quality, voluntary and information-based policies are distinguished by several additional attributes: (1) compatibility with other market-oriented approaches,

(2) feasibility amidst policy gridlock, and (3) applicability to other conservation domains.

- Voluntary and information-based policies outlined here are sympathetic to and compatible with market-based environmental policies. They offer more information and ample freedom for individuals to do with that information as they will. Voluntary and information-based policies are consistent with “libertarian paternalism” or “nudges” to help firms and individuals achieve their own goals (Sunstein and Thaler 2008). Arguably, better information gives people more freedom to pursue their interests. Further, well-functioning markets generally need symmetric buyer-seller information to be efficient. However, providing that information often takes on costly public goods characteristics, and thus information-based policies establish critical foundations for *any* market-based solutions. Successful approaches like “cap and trade” (e.g., the RECLAIM market in Southern California or the former national SO<sub>2</sub> market) depend on good information underpinning the market.
- Voluntary and information-based environmental programs can circumvent existing policy gridlock (Prakash and Potoski 2012). They are not free, but they are scalable and broadly relevant. Plus, they can adapt to fit a wide range of policy agendas.
- These solutions need not be confined to air quality issues. While there is a good deal of experience with voluntary and information-based policies for air pollution, the lessons learned here are not intrinsically related to air and air pollution. These solutions could readily be adapted to address water pollution, toxic contamination, species conservation, carbon mitigation, climate change adaptation, and so on. In fact, they have been applied for these other purposes (e.g., Shimshack et al. 2007, Delmas et al. 2010).

## Pendulum of failures

A short history of air pollution problems demonstrates an inefficient and frustrating-yet-effective political and economic system. The fundamentals of air pollution as a policy problem were present in ancient times and have become far more prevalent and severe. At its essence, air pollution represents a classic example of negative externalities, where firms and individuals undertake actions (via factories, automobiles, power plants, etc.) that create emissions that pollute the air and, ultimately, harm other, third-party individuals without their consent or compensation. Because the

polluting firms and individuals do not take into account those external costs when deciding what to do, we expect to see “too much” of that polluting activity to occur, and the air quality would be worse than it optimally ought to be. The economic heart of air pollution problems becomes a rather simple pollution story with no market or liability rules to discipline polluters to take their harmful actions into account.

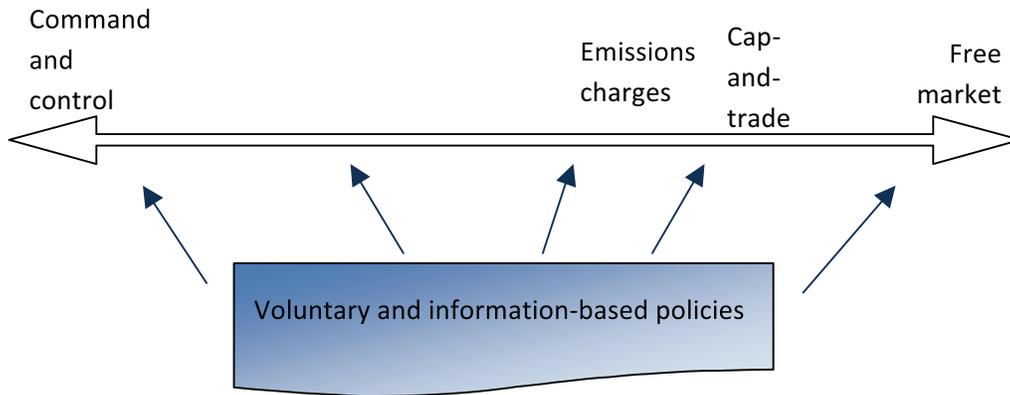
### Swing to regulation

As the scale of the polluting activities grew rapidly after the Industrial Revolution, the scale of the harms grew to the point they demanded policy response. This story is told over and over across the world and at various stages of economic development. The Environmental Kuznets Curve (EKC) literature has unearthed a few simple truths. As economies develop, their air pollution problems worsen. It is hard to expect otherwise, given the nature of the air pollution problem, as the growth in polluting activities is not naturally accompanied by any concern by polluters for their externalities. Also, as incomes rise, the number of air pollution regulations in the economy rises proportionally (Dasgupta et al. 2002). The U.S. experience has shown rapidly improving air quality as regulations have expanded in scope and tightened their grip (Greenstone 2004, Auffhammer et al. 2009). The policy response to the growing air pollution problem became the textbook for “command and control” regulation. Such regulations dictated technologies, performance standards, and other rules restricting how firms and individuals could operate. These regulations have determined which firms operated where and with what technologies, which technologies go into automobiles, and maximal ambient air pollution levels for cities. In a nutshell, the response to the air pollution externality problem has generally been command and control market regulatory interventions, and thus the pendulum swung away from markets to policy interventions.

### Swing to markets

The inefficiency of the command and control regulatory approaches is well-rehearsed elsewhere (e.g., Tietenberg and Lewis 2012, Portney and Stavins 2000). Such regulations for air quality certainly had widespread impacts on many things, like costs (Burtraw 1996), firm behavior (Becker and Henderson 2000, Greenstone 2002), human health (Chay and Greenstone 2003), and air quality (Auffhammer et al. 2009). Even when they passed cost-benefit tests, the consensus was that they amounted to a classic case of “government failure” in that they were typically wasteful, far too costly, and inferior to other policies that could accomplish more for less. These growing costs and frustration with cumbersome federal regulation pushed the

## An environmental policy continuum



pendulum to swing back toward market reliance.<sup>1</sup> The SO<sub>2</sub> emissions allowance market established in the Clean Air Act Amendments of 1990 to address acid rain problems became a grand testament to the efficiency properties of market-based approaches (Schmalensee and Stavins 2012). The RECLAIM project in Southern California also operates and demonstrates success in applying market-based solutions to environmental problems (Fowlie et al. 2012).

### Swing back to where?

The pendulum of air pollution policy has swung back again away from market-based approaches. The U.S. experiment was limited in its scope and, recently, has been effectively dismantled. A 2008 court ruling and several subsequent rulings and legal action against the national SO<sub>2</sub> market are based on a concern that one state's pollution affects air quality in a downwind state, imposing costs on it.<sup>2</sup> Thus, we return to a concern about markets that fail in light of these externalities. The RECLAIM program notwithstanding, the broader field of air pollution policy in the United States is still one that is dominated by command-and-control regulatory approaches. These approaches have even been favored over market-based approaches to greenhouse gas emissions. Although the momentum of the pendulum is swinging away from market-based approaches, the well-worn command-and-control alternatives threaten steep cost curves. The next phase in the history of air pollution policy remains to be written. The polarization and stalemate in Washington, D.C. do not bode well for efficient solutions to the policy problems outlined above. What is the optimal air quality, and how do we best achieve it? Neither

command-and-control nor market-based solutions satisfy important constituencies. Herein is an opportunity to revisit the nature of the problem and find another path forward.

### A continuum of policy alternatives

Consider a continuum of policy regimes to address air pollution challenges. At one extreme is the “free market environmentalist” stance, wherein property rights and unencumbered markets reign in air pollution via common law mechanisms. At the other extreme is the regulatory approach that supplants torts and private negotiations with command-and-control mandates on economic activity. Somewhere in the middle sits the market-based policies of emissions taxes<sup>3</sup> and cap-and-trade schemes, ones that leverage the incentives of the market orientation with the centralized authority of the interventionist approach through the setting of nationally prescribed standards. While much of the debate over air pollution policies and institutions rages along this continuum, the voluntary and information-based policies presented here powerfully contribute to good policy *everywhere* along this continuum. These approaches mitigate the shortcomings of each of these archetypal policy regimes. All of these approaches—whether market-based or regulatory—face huge information problems, especially in the air pollution context. The voluntary and information-based policies become necessary (but not sufficient) policies underpinning a good approach to controlling air pollution *regardless of that approach*. In that regard, voluntary and information-based policies offer a particularly compelling (albeit incomplete) “solution” to some of our most vexing environmental challenges of the 21st century.

<sup>1</sup> See Fred Smith's (1995) article for a quick example of voicing this “backlash” against failing government intervention.

<sup>2</sup> See *EME Homer City Generation LP v. Environmental Protection Agency* (11-1302, 2012); Order, No. 11-1302, slip op. at 2 (D.C. Cir. Dec. 30, 2011); *North Carolina v. EPA*, 531 F.3d 896, 908 (D.C. Cir. 2008); *North Carolina v. EPA*, 550 F.3d 1176 (D.C. Cir. 2008).

<sup>3</sup> By “emissions taxes,” throughout the essay I refer specifically to Pigouvian taxes: an efficient tax scheme where polluting activities face a marginal tax (subsidy) rate exactly equal to the marginal external damage (benefit) they cause (Pigou 1920). This “polluter pays” approach has the actor thus fully internalize their costs.

## Information as a solution

Better information holds a key to finding new solutions for urban air quality problem. The essence of the air pollution problem – the externality where decision-makers can dump waste into the air without a care—is not entirely about information. Hence, information alone will not be a comprehensive solution because it does not encompass the root of the problem. Information does play critical roles in both the problem and in remedying it. On their own, voluntary and information-based policies can bring modest or incremental improvements. Together with other more radical reforms, information-based policies are necessary but not sufficient components of ideal or optimal policy design.

### Air pollution as market failure

To revisit the nature of the air pollution problem, recall the basics of the market failures for air quality—where free and competitive markets fail to produce efficient outcomes. When markets are unable to optimize the allocation of scarce resources and maximize net benefits, government intervention can be justified. For air quality problems, market inefficiencies arise in three ways:

**Externalities:** unpriced output of harmful airborne emissions. Economic activities (e.g., electricity generation, driving a car) can emit chemicals and other substances into the air, which ultimately can harm downwind individuals, their property, and other interests. The producers of air emissions do not face prices for this output and pay no compensation for the harm, thus they overproduce them insofar as convenient (in light of whatever regulations they also face). In the sense that markets use prices to convey information about social costs and benefits, the externality of air pollution marks a departure from this, as the zero price for emissions misleadingly conveys that the activity has no downwind or other third-party impacts.

**Public goods:** information can be consumed by all. Markets tend to underproduce public goods, which are characterized by their nonexcludability (i.e., it is impractical to prevent anyone from enjoying the good) and their non-rivalrous nature (i.e., one person's enjoyment of a good doesn't reduce another's ability to enjoy it). Information often has these two properties. Knowledge, like gossip, can spread nearly without cost. And, unlike hamburgers, one person enjoying some information does not diminish another's ability to enjoy the same morsel of information. That anyone can enjoy public goods and that charging for them is problematic at best makes profit-maximizing firms ill-suited to produce them in light of everyone's tendency

to free-ride. This situation applies to knowledge about air pollution risks that could better enable individuals and firms to protect themselves. Knowledge production offers, thus, a textbook case for government intervention to promote overall social welfare.

**Information asymmetry:** one side of a transaction knows more about product quality than the other. Air pollution, either as an attribute of a product (e.g., emissions from a car or cleaning service, or ambient pollution concentrations in a home) or an attribute of a firm (e.g., toxic releases associated with production), is often known to the seller but difficult or impossible for a buyer to discern. Such information asymmetries lead to a “market for lemons,” effectively limiting markets for high-quality, greener products, and making contracting for better environmental performance subject to severe principal-agent problems.

### Using markets and courts to remedy market failures

Many have appealed to common law as the source for remedies to the externalities or spillovers endemic to air pollution. A free-market approach would rely on well-defined property rights forcing agents to internalize the external harms from their air pollution as victims either received compensation through the courts or negotiated efficient compromises.<sup>4</sup> The challenges of using conventional common law approaches and the “free market” to address problems like air pollution have been well rehearsed elsewhere, perhaps most recently by Jonathan Adler (2012). Air pollution possesses several characteristics that undermine the effectiveness—and ultimately the efficiency—of common law and the simple competitive-entrepreneur remedy. First among them is likely the “many/many problem”—where many actors cause the externality that harms many parties. Whereas the interdependence of many buyers and many sellers is a *strength* in competitive markets, the many/many problem unravels traditional common law remedies because of problems associated with proving harm, assigning liability, and overcoming cost barriers to coordinating, litigating, and negotiating resolutions. At least some of the evolution of institutions, based on property rights and common law, that environmental policy analyst Fred Smith (1995) imagined for air pollution relied heavily on information provision and the development of new information

<sup>4</sup> Ronald Coase (1960) famously argued that well-defined property rights and minimal transaction costs would lead to private actors using market negotiations to achieve an efficient allocation of pollution as the market for polluting activities would impose a cost on polluters or an opportunity cost on those who would prevent polluting activity, depending on who was endowed with the rights to pollute.

technologies.<sup>5</sup> Some regulatory critics (Meiners and Yandle 1998) envision a non-regulatory remedy for the speculative harms of air pollution (e.g., cancer cases in the future) that might evolve in the courts, one which relies on “special masters” who are expert in environmental science, to define liability and decide on incentives to deter excessive pollution. This alternative approach nonetheless shifts the information burden to the courts (which now must be well-informed about the sources, consequences, costs, and benefits of polluting activities) or to the parties preemptively negotiating. The informational deficit remains.

That this common-law approach has struggled to handle a growing air pollution problem is often blamed for the shift to command-and-control regulation. Information deficits (i.e., too difficult to link harms to causes) and coordination problems (i.e., many polluters, many victims) limit the courts’ ability to get polluters to internalize costs.<sup>6</sup> A “third wave” (Tietenberg 1998) of environmental policy—information-based regulation—has been seen as not just a response to diminishing returns to command-and-control regulations but also as a way to make the impractical common-law approach *less* impractical.<sup>7</sup> Several analysts (Kleindorfer and Orts 1998) argue that informational regulation could hold the key to shrinking bargaining costs (i.e., reducing information asymmetry, mitigating coordination problems) and addressing information deficit about which activities caused what harm. To them, the free-market ideal of optimal or efficient pollution is advanced by reducing these informational barriers to trade. Daniel Esty (1999) goes further in noting that voluntary information-based programs are a *precondition* for any of those to work – and they would benefit other policy regimes as well.

### Information outside of markets

The deleterious effects of air pollution result from a complex combination of factors that include decisions by the “*victims*” of pollution. Who moves to or away from the downwind

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<sup>5</sup> Smith asks “How do we ‘fence’ the airshed”? (p.71). He notes that privatizing the airshed would be prohibitively expensive, although voluntary actions evolved institutions to define and protect property rights – and technological innovation can lower the costs of establishing property rights. Specifically, Smith pointed to several “free market” approaches to remedying air pollution problems (contrasted, in his argument, to politically managed approaches that included CAC and market-based approaches). First, in likening airsheds to the Western frontier, he calls for a technological breakthrough to mark property boundaries at lower cost. Such a breakthrough amounts to lower-cost monitoring and more information about who impacts whom. He suggests regional atmospheric monitoring to track pollution flows and *requiring* emitters to label their outputs to facilitate tracing back the originators of harm. He also suggests market consolidation and establishing more localized governments to negotiate on behalf of residents.

<sup>6</sup> For the near term at least, air pollution of the sort caused by automobile emissions, for instance, will not be effectively addressed through common law courts (Meiners and Yandle 1998).

<sup>7</sup> Making it actually practical would likely require additional fundamental changes in how the courts handle suits over air pollution nuisances.

destination of air pollution will directly affect whether (and how much) the emissions actually harm others in society. Just as Nobel laureate economist Ronald Coase (1960) discussed the culpability of victims in the externality story, good policy need also recognize that the optimal amount of pollution (and location, timing, etc.) is jointly determined with the optimal behavioral responses by would-be victims.<sup>8</sup> The relevant air pollution information is not just data on emitters and chemicals or other substances emitted. It vitally includes information on the victims and their circumstances.

For whatever air pollution is created and whatever air quality exists, there is an optimal behavioral response from residents. This concerns urban residents’ “live, work, and play” choices. Avoiding exposure has benefits, but it also has costs, and these must be balanced in order to determine the optimal avoidance. More nuanced optimization of responses takes into account *who* is being exposed and their sensitivity to the air quality. These considerations may include characteristics of the individual (e.g., their health) and their activity. For instance, rigorous cardiovascular exercise on smoggy days has more harmful health effects than other activities. Putting asthmatics, elementary schools, or sports fields in pollution hotspots, like nearby highways, brings along more costs than locating less sensitive populations or activities there.

There are many things that could be done to reduce exposure. Not all of them should be done. There are complex trade-offs that depend on a vast array of different factors. (Obviously, regulating this optimally imposes impossibly high information burdens on a regulator.) Yet these trade-offs do get made, and whether they are the optimal ones even for the individuals in question depends on the information at their disposal. Making informed decisions to protect one’s own health may be extremely difficult if key information is costly to obtain and digest. Here, there is room for policymakers to help with voluntary and information-based environmental programs.

### Unintended consequences

Interestingly, it is not assumed that more or better information about the risk trade-offs associated with optimal exposure avoidance will result in reduced exposure. For instance, it may well be that indoor air quality is worse than the outdoor alternative. Telling people that the air is cleaner or dirtier than they thought could lead to behavioral responses that increase or decrease their exposure. See interesting examples of how perceptions poorly align with reality for air pollution. (Johnson 2012).

Care should also be taken to account for the emissions effects of tweaking the information provided. My own work

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<sup>8</sup> Optimal response, of course, is conditioned on constraints like wealth, the availability of other options, and the cost of changing behavior.

(Noonan 2011) shows how telling people about “code red” smog days can actually increase the amount of driving people undertake (as they avoid exposure by walking, biking, or waiting for public transit). Increasing driving, and thus emitting, behavior is a tricky consequence of using information to empower more optimal avoidance responses because it (marginally) exacerbates the pollution problem. If residents were better informed about where dirtier air clusters in a city, they might move farther away and increase the length of their commutes. In so doing, they would add to and disperse the air pollution problem.<sup>9</sup> Informing avoidance behavior may help reduce the costs of pollution, but it might also affect pollution itself and introduce a complex feedback loop into any framework for dealing with air pollution.

This information is not an intrinsically neutral, benign, or easy fix. Information is costly and scarce. It is costly to produce and obtain; it is costly to filter and to process. And it is not neutral. Asymmetric information can advantage one party in a transaction. Firms contributing pollution to a hotspot may not want their consumers, neighbors, or regulators to know. Publishing that information could harm the firm, just as homeowners might not want would-be buyers to know about the hotspot their home sits in (Smith and Huang 1995), drivers might not want others to know how extra dirty their clunker is, and so on. While releasing more information may not be a win-win situation—some will likely lose—it has the potential to bring large net gains to society. There is no guarantee that gains from better information will also bring environmental improvements. Many of the voluntary and incentive-based programs suggested below will bring cleaner air, although this is not a necessary consequence of better information. Some research (Owen et al. 2012) offers a fascinating demonstration of how more information might undermine the provision of environmental quality. The same might hold here, and those implementing these policies ought to be aware of that possibility.

### Government failures for information

Any policy intervention is subject to government failure, where net benefits of the policy are negative. Although government interventions likely (or necessarily) involve inefficiencies, interventions to address market failures make the relevant comparison the inefficiency of the market failure with the inefficiency of the government

<sup>9</sup> In a Tiebout (1956) sense, we might still expect some people to opt to live in the pollution hotspot, just at a discounted rental price to reflect the lower quality of life there. Optimal land use, however, might go a step further and see land uses less sensitive to air pollution (e.g., industrial) bid up prices and opt to locate there—thus pushing the residential density farther away.

failure. There is no inherent reason that one source of failure is greater than the other—policies should be examined on a case-by-case basis. All good voluntary and information-based policies respect the likelihood of government failure and design the policy to mitigate them.

## Some lessons learned?

### Public information can be very influential and valuable

Information as a public good can be enormously valuable to society. Research on innovation, R&D, and patenting has repeatedly shown the profound impact that new ideas and novel information can have for the public or economy as a whole. Patenting policies go a long way to encouraging the knowledge transmission and realizing the value of public information. On a smaller scale and closer to air quality, programs like the National Weather Service (NWS) generate substantial social value in helping to overcome some market failures in the provision of the public good of weather forecast information (Stewart et al. 1984). While directly providing inputs into farmers’ production, for instance, NWS forecast information also spurs industries in packaging and repackaging that information in other forms (e.g., nightly news broadcasts).

Publicly provided environmental information has been shown to influence behavior elsewhere. Matt Neidell (2009) shows how daily air quality forecasts in the Los Angeles area impact the kinds of activities and exposures people have. They use this information to undertake costly avoidance behavior and thereby reduce visits to the ER for respiratory problems.

The federal Toxic Release Inventory (TRI) program resembles a public information program, except that, in practice, it works like an information disclosure or labeling program because the information being disseminated publicly is not some general condition (e.g., weather, ambient air quality) but rather the behavior or characteristics of private facilities. Economist Mark Cohen (2001) recounts many of the lessons learned from the initial wave of studies looking at the behavioral and market impacts of information disclosure programs like TRI. One such lesson is that capital markets react to this kind of information, sending signals to firms, even if the firm does not change its behavior in light of the disclosure program. Several studies have detected responsiveness in firms’ stock prices when their large toxic releases or emissions are reported (e.g., Hamilton 1995, 2005; Khanna et al. 1998; Konar and Cohen 1997; Shapiro 2005). One researcher (Grant 1997) even shows that firms’ emissions have fallen in response to information disclosure programs.

Firms might voluntarily disclose information for a variety of reasons, including responding to investor or employee pressure, improving shareholder value, and improving terms of trade with suppliers and consumers (Matisoff 2012). Yet there are other reasons for information disclosure that hinge more directly on public policy. Firms strive for transparency and disclosure if such efforts reduce regulatory pressure (Barry et al. 2012, Lev 1992, Walker and Salt 2006) or are in response to legal liabilities (Skinner 1994). Yet firms have no intrinsic tendency toward transparency. Witness their resistance to mandatory disclosure and labeling rules—even participants in the Carbon Disclosure Project (CDP) have increasingly opted to keep their disclosures private (i.e., only available on a paid subscription basis) (Matisoff et al. forthcoming). Requiring some disclosure may be needed.

### Information disclosure as “civil regulation”

A primary role of information disclosure is to enable a sort of “civil regulation” (Murphy and Bendell 1999). This lets stakeholders demand accountability and reward strong performers (Fiorino 2006). Some pressure manifests through stock markets and investments made. Product labeling (green labels, eco-labels, etc.) can inform consumers and influence market actors through consumption choices, accordingly. Here, the impacts of these policies are particularly hard to detect, in part because they should generate multiple interdependent impacts. Green labels might affect

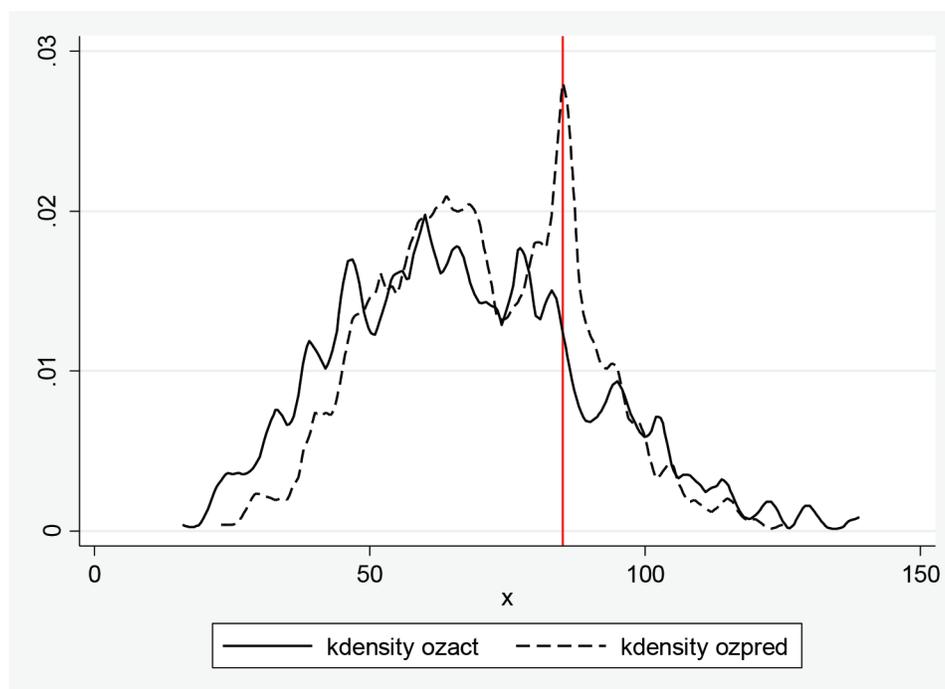
environmental performance of firms, but they might just affect marketing—influence market share, confer market/monopoly power, deter entry, affect reputation, etc. (Prakash 2002). Still, recent research (Delmas et al. 2010) shows how green labels can affect the fuel mix used in the electricity industry. Economists Paul Portney and Robert Stavins (2000) discuss how product labels can shift demand for more energy efficiency and spur innovation in that regard.

Other recent research (Sartzetakis et al. 2012) also shows how coupling a public information campaign about environmental quality of goods can reduce the scope or magnitude of the government intervention (via pollution taxes, say) needed to achieve the optimum. Voluntary and information-based programs, either via civil regulation and just smarter consumers, stand to reduce the demand for regulatory intervention in air quality.

### Incentives matter for government information provision, too

Governments can easily fail to implement information-based programs well or efficiently. Bad incentives for government information handlers will lead to predictably bad results. Government agencies’ ability to generate and disseminate information has often shown shortcomings (Matisoff 2012, Cohen 2001), biases (Noonan 2012), and market distortions (Shimshack et al. 2007). They may exhibit bias in the collection or dissemination of the information.

## Density of observed (ozact) and forecasted (ozpred) daily ozone levels, 1999-2003



Or they might just not collect it in the first place or disseminate it afterward. Some research (Bae et al. 2009) offers evidence that how states process the TRI data in releasing it to the public can make all the difference between useless “information overload” and useful information. Yet not all state environmental agencies face appropriate incentives to produce useful information. Often, it is just a matter of states complying with federal mandates.

An interesting example of bias in public information can be found in the fairly innocuous case of air quality forecasting in the city of Atlanta. Daily forecasts of ozone are performed by a team of atmospheric scientists.<sup>10</sup> The daily ozone forecasts from 1999 – 2003 were compiled and their frequencies graphed alongside the actual observed daily ozone levels. The solid line, actual ozone levels, shows roughly a “bell shaped” distribution, with most days experiencing between 40ppb and 90ppb and a few days at the extreme high and low ranges. Nature produces a fairly smooth distribution of ozone values for Atlanta. The forecasters, on the other hand, exhibit a peculiar pattern. The dotted line (frequencies of forecasted levels) closely matches the actual observed frequencies for the most part. In general, the forecasts take on a “bell shape” where the forecasters predict just about as many 50ppb days as nature provides. The glaring exception occurs at the 85ppb level. Immediately around that 85ppb level, the frequency of forecasts spikes dramatically. Forecasters are several times more likely to call for an 85ppb day than nature is to produce it.

Why favor 85ppb days so dramatically? The straightforward reason is that 85ppb represents a threshold, where forecasts at that level or above trigger an “ozone alert day.” The 85ppb level is the National Ambient Air Quality Standard limit for ozone, and when ozone reaches that level the Department of Natural Resources issues advisories to the public to reduce exposure and emissions. Of course, this kind of “crying wolf” forecasting leads to many false positives and unnecessary alerts. When I asked the team about this bias, they were unaware of it. When faced with the data, they admitted that they face asymmetric incentives regarding forecast errors: they pay no price for false alarms, yet failing to issue alerts when they should have brings unwanted pressure and scrutiny. Also, at least one team member suggested that the purpose of the forecasts was to help citizens reduce exposure, so inflating forecasts was only helping them. As I will recommend below, good voluntary and information-based policies will avoid this situation by clearly establishing incentives to produce

<sup>10</sup> The team is led by scientists at Georgia Tech. Although some members work for the state Department of Natural Resources (DNR), they all have graduate degrees from Georgia Tech during the time studied. They ultimately report to the DNR, which funds and broadcasts the forecasts.

accurate, unbiased information with the goal of helping citizens make better or more informed decisions (not to favor any particular decision).<sup>11</sup> When incentives reward bias, expect bias. If allowed, agents within the government may also pursue their own agendas via their information provision.

### Information can affect behavior, sometimes not as expected

Often the lesson from voluntary and information-based programs is that information can affect behavior, and often in unintended or unexpected ways. The ozone alert program provides a fine example of this (Noonan 2011). Most programs broadcast forecast information for two reasons: to let citizens take precaution to reduce exposure to air pollution, and to encourage voluntary emissions reductions on that day (“spare the air”). Yet the altruistic aim of emissions reduction might conflict with private avoidance behavior. Commuters seeking to reduce exposure might opt to drive rather than wait outside at a train or bus stop. In San Francisco, when the BART system offered fare reductions on alert days, a reverse problem arose as ridership increased—but so did car trips and their attendant pollution (Sexton 2011). Some researchers (Zivin and Neidell 2009) find evidence of ozone forecast fatigue, where the first day of smog alerts might affect behavior but the alerts’ impact fades on subsequent, consecutive days. As people “rebound” back to their usual behavior after the first day of a multi-day bad air quality episode, this phenomenon poses an interesting challenge to forecasters. If the goal is to reduce exposure on the worst days, the better strategy might be to delay the alert until later days in the multi-day episode. Or perhaps longer-term forecasts might be published, but that again invites peculiar (or no) responses if citizens face information overload.

Information disclosure and product labeling policies exhibit similarly unexpected results at times (Barry et al. 2012). Sometimes this is a difficulty in communicating relevant information with relevant audiences, and not giving irrelevant information or reaching unintended recipients. For instance, in one study (Shimshack et al. 2007), researchers examined mercury advisories for fish consumption and suspect that the overall effect of the policy is likely negative for public health. This is because, although sensitive populations avoided fish in response to the advisories, so did the non-sensitive populations, who lost the health

<sup>11</sup> The forecast team also revealed that they use a variety of heuristics in generating daily forecasts. For instance, individual members produce their own forecast and then they discuss these results to find a single consensus forecast. In practice, they regularly ride a “hot hand” (a common gambler’s fallacy) of a particular forecaster who recently performed well. After discussing some of these issues with the forecast team in 2008, they might have changed their practices. Recent years do not exhibit the irregularity at 85ppb.

benefits of fish consumption. Sometimes the voluntary and information-based approach can work too well.

Sometimes voluntary and information-based programs fail to influence behavior as an implementation matter. There are many factors other than simple accessibility that influence information programs' impacts (Cohen 2001, Tietenberg 1998). The speed and accuracy of disclosed information have direct bearing on its relevance and value to decision-makers. The format and "processing" of the information can surely matter (Bae et al. 2009). Ultimately, in many cases, the information itself is not pivotal, and decision-makers are not on a margin where additional information might alter their choice. This can be seen in the minimal reaction of Atlanta commuters to smog alerts (Noonan 2011), likely due mostly to the dearth of alternative commute modes, and in San Francisco commuters who already take BART simply getting that decision reinforced with new smog alert information (Cutter and Neidell 2009). Effective information must not be irrelevant or too complex or costly to understand.

Finally, information programs can very indirectly affect behavior. The "Hawthorne Effect," where the act of observing subjects may affect the subjects and thus the outcome, applies in a sense to monitoring programs. Tracking environmental performance heightens awareness of it and might lead to better performance even in the absence of incentives or disclosure of the information. Much of the lengthy literature on firms adopting "Environmental Management Systems" like ISO-14001 purports to find this sort of effect: better tracking and monitoring reduces pollution. The robustness and generalizability of some of these lessons is a bit more suspect (Koehler 2007).

Yet unexpected or unintended effects of voluntary and information-based environmental programs may not be a bad thing. Moreover, people can learn new information systems over time. Even though heuristics complicate matters, the fundamentals of information communication might not be all that problematic at heart and over the long run. Some biases are second-order problems. A bigger problem facing policymakers using these approaches is when the naïve model of environmental policy—"just educate people more and they will make the 'right' choice"—breaks down. At that point, the temptation is to skew the information until it translates into the "right" behavioral change. A better approach appreciates that better information might garner unexpected results. And that might be a good thing.

### **Information alone may be insufficient to affect behavior**

Research showing that information disclosure rules do little to affect firm behavior is not hard to find (see, e.g.,

Grant and Jones 2004, O'Toole et al. 1997). But, lest we think that information about firm behavior or product quality is meaningless, a more nuanced read of this literature is merited. First, ample evidence of the importance of information disclosure in affecting firm behavior does exist (e.g., Barry et al. 2012, Cohen 2001). Similar criticisms have been levied at purely voluntary programs – many of which are informational and many of which are privately sponsored – where their effectiveness in altering firms' performance or their environmental impacts are suspect (Prakash and Potoski 2012, Lyon and Maxwell 2007, Darnall and Sides 2008). Second, it is the very mixed nature of the research findings that give credence and import to the results: information is no universal panacea but rather a component to the complex array of factors influencing behavior, and the way and context in which information transmits are critical.

Third, studies showing the impotence of information disclosure hint at the power of information *in conjunction* with other mechanisms. For instance, information disclosure via the Carbon Disclosure Project (Matisoff 2012) does little to affect behavior. This might be because it is a private-sector-led and purely voluntary program, with non-random participants opting in and thus diluting any independent effect of the program. Further, this null effect involves disclosure in a context (carbon and climate change for U.S. firms) lacking likely or imminent restrictions on carbon emissions. Information without incentives may prove toothless and more entertaining than actionable. Moreover, though some relevant research (Matisoff 2012) also showed no effect from state-mandated disclosure programs, that information was not well reported to stakeholders. Information disclosed to nobody likely has the same effect of it falling on deaf ears, namely no behavioral impact. Coincident regulation may be required for voluntary and information-based programs to work well (Cohen 2001; Kim and Lyon 2011). Alternatively, stronger legal liability for harms or other common law mechanisms may serve the same role in a market setting. Monitoring and enforcement activities by the government have shown consistent and significant effects at deterring violations *and* emissions by targeted firms and by other firms (Gray and Shimshack 2011). Monitoring alone, with no prospect of punishments for nonperformance, may not have such strong results. In short, information must be coupled with incentives to induce the desired responsibility or deterrence effect (Bui 2005).

Fourth, information programs' effectiveness might depend on the audience or the community as much as anything. Better education, more social engagement and activism, and other demographics may be necessary ingredients in the recipe for information-based program effectiveness (Hamilton 2005)

# Principles for good voluntary and information-based programs

In the abstract, good voluntary and information-based programs should adhere to two main principles:

- (1) produce information as a public good (that others will use as inputs to make better decisions), and
- (2) produce information to support new markets (lower transaction costs, calibrate market-based mechanisms).

Additional general guidelines include the following:

## Use information to empower the market, not to restrict or guide it

More information and education does seem to promote demand for environmental quality (Somanathan 2008). Suppliers through market mechanisms will meet this demand and environmental quality should improve. This should work for air quality as well. Implementing a voluntary and information-based program should be divorced from the provision of environmental quality—a responsibility for market or other actors.

Likewise, policymakers should be mindful of the mechanisms through which any particular voluntary and information-based program operates—which will likely necessitate costly efforts to evaluate the program. A primary concern here is with more pernicious voluntary and information-based programs. This might be programs that promote “greenwashing” or effectively introduce bad signals that crowd out the good ones (and thus the good behavior) and exacerbate information asymmetries. This might also be programs that erect ‘barriers to entry’ and offer branding advantages or monopoly power, thereby reducing social welfare.<sup>12</sup> Information-based programs ought to expand and free up markets, not help a firm gain a stranglehold on it.

Well-designed voluntary and information-based programs should avoid crowding-out private provision or private dissemination of information. If the market can produce or distribute the information, competition or redundancy from the government should be avoided. Again, these policies should address strictly informational public goods problems and not pursue other agendas. “Mission creep” should be guarded against.

<sup>12</sup> From some perspectives, especially those who have economic contraction or emissions reduction as a goal, this might be seen as an advantage also. Yet there are more cost-effective ways to achieve those ends.

## Leverage competitive forces

In a similar vein, voluntary and information-based programs should be implemented in ways to leverage powerful competitive and market forces outside of government. Mandatory disclosures of details of emissions or trespasses against the common airshed should free consumers and investors to express their air quality values in the hitherto incomplete market. Funding basic research into the epidemiology of air pollution and pathways of health effects should foster innovative adaptations in the markets. Data retrieval and processing tools, such as air quality models, should be developed as open-source code projects with development supported by public funds. This fosters a level playing field for information access and manipulation, and it invites entrepreneurs to market new information tools to the public. Similarly, to seed competition and encourage new markets to develop, a role for voluntary and information-based policies would be to provide experts to small-scale information users (who otherwise could not afford to retain expertise). Low- or no-cost access (especially in the courts) to expertise in air quality modeling, public health, and even negotiations can reduce transaction costs, information complexity, and market failures at the heart of local air pollution problems.

Tactics such as competitive grants and prizes like the “X Prize” should be used to encourage the private sector to produce informational public goods. Beware of some earlier lessons learned in environmental policy: making the caretakers pay for producing the public good is a great way to damage the public good.<sup>13</sup> Those generating and sharing the relevant information—regardless of its moral content—should be rewarded, not made to bear extra costs. (Good policy should aim to separate the provision/dissemination of information from the forces that might reward or punish agents based on it.) This means subsidizing firms and others for disclosing information (Lyon and Maxwell 2007). It also means including bounties for watchdogs to enforce disclosure rules—on both public and private agencies (Sunstein 1999). Compensation for costs to produce the informational public good may take other forms, but the key here is policymakers should acknowledge that information is costly to produce and distribute, and their policies should align its production costs with its beneficiaries.

## Mind the costs

Good voluntary and information-based programs promote transparency in government. This makes it all the more important that such programs honestly and transparently recognize the implementation and compliance costs. Mandating disclosure imposes costs on market actors, and

<sup>13</sup> The Endangered Species Act teaches us this.

these should be appropriately measured and weighed in policymaking.

Public agencies can be high-cost producers of any good or service—this may apply even more so to information. Voluntary and information-based policies would do well to outsource and contract out to obtain cost savings. Government ought not to monopolize information provision or distribution. It ought to focus on overcoming collective action problems to spur private actors to produce and share the information innovatively. To that end, targeting information programs to “upstream” agents should be considered as there are fewer entities involved. This is especially important as calibrating information and communicating to smaller (and more homogenous) audiences may have cost and complexity advantages.

### Minimize political provision

Voluntary and information-based programs risk politicization like anything else, and good approaches deliberately set out to minimize the role of politics in information provision. Some analysts (Lyon and Maxwell 2008) emphasize how easily something like “corporate social responsibility” can become “greenwashing” or, more perniciously, a form of informational lobbying to advance their interests in government. Voluntary and information-based programs should be designed to withstand corporate manipulations to the extent possible, and they should avoid being dragged into green marketing schemes that reduce competition or that the market can provide on its own. As economist Mark Cohen (2001) puts it, private ratings organizations provide more valuable or relevant information than most government disclosure programs, and the Environmental Defense Fund’s Scorecard (in contrast to the unwieldy raw TRI data) offers another example of the private-sector’s skill in providing information. A good information-based approach takes a backseat to these private-led initiatives and resists “capture” by industry or other political interests.

Voluntary and information-based programs should be localized and devolved, unless there are compelling economies of scale at work. The scale might occur because of technologies and the costs of data archival or processing (i.e., high fixed costs and minimal per-unit costs for IT). It might also occur for analytical expertise—as the smallest scales (individuals, hamlets) will find it too costly to invest in expertise to interpret/forecast using the complex data, but larger organizations and scales might have an advantage here. Programs that employ economies of scale should enable local organizations to opt into the larger-scale system. As providing an information network resembles a commons subject to “tragedies,” voluntary and information-based systems would do well to adhere to Nobel laureate Elinor Ostrom’s design principles for robust institutions by

leveraging local information and by using “nested institutions” (Ostrom 1990). Better coordination across scales and jurisdictions can help in achieving cost-savings and increased effectiveness – and good policies need to actually incentivize this coordination.

### Learn from policy evaluations

The final set of guiding principles is to learn from our past. Be mindful of perverse consequences and the human element—employ some economists and psychologists. Research into the “needs and knowledge of stakeholders” (Cohen 2001) is vital here, as we still have much to learn about which and how people value information. This condition is likely to persist for a long time. Advancing the science in this regard is itself an informational public good likely to be underprovided by the market and worthy of explicit government support. Moreover, and in these contexts it hardly can be emphasized enough, the information to be collected and disseminated is more than just quantities, times, and places for chemical flows. Information about people—their behavior especially, but also other characteristics—is an essential part of the equation. Too easily these programs develop tunnel-vision and only track technology and chemicals. Yet environmental risk depends crucially on the human element as well, and generally speaking, optimal responses depend on human factors as well. Of course, how to best “package” the information also requires understanding those people as well.

The emerging work from behavioral economists is instructive here. As the book *Nudge* (Sunstein and Thaler 2008) popularized, subtle decisions in structuring information and choices can play significant roles. Effective voluntary and information-based approaches will take care with *how* the information gets disclosed. Who receives it and how it is packaged is vital (Weil et al. 2005). The age of “cheap information” should not be confused with an age of *good* information. Abundance in information puts the onus on filtering (witness the rise of Google) and can make it seem like no information at all (Sunstein 1999). Keeping information user-friendly, accurate, and relevant is key (Dranove et al. 2003). So is experimentation with information-based approaches, especially in light of our limited understanding of how they function (Stephan 2002). Experiment more.

## Practical voluntary and information-based suggestions

Building on those guiding principles for voluntary and information-based solutions to air pollution problems,

I offer the following more practical suggestions for conservation policies. There are many small and large reforms proposed here, only some of which might be applicable or appropriate in certain contexts. They are organized by their major theme, although many of these ideas overlap across multiple themes.

### Enhanced monitoring, processing

The first order of business is to generate much more of the informational public good regarding air quality.

#### More, better monitors

First of all, more monitors are needed. The use of remote-sensing devices and monitoring stations need to be expanded rather than contracted. This partly means removing the unfunded portion of the CAA mandate to states to monitor their own air quality – at least monitors contributing to interstate pollution and trade should be financed at the federal level. It also means investing in monitoring more wisely. Politics guides monitoring effort now, and this should be shifted to monitoring to support (market, public) demand for information. Optimize the placement of monitors, allowing for flexibility over time, to collect information relevant to other tasks below (rather than compliance with national ambient air quality standards). Encourage private actors contribute to the network of remote-sensing devices (RSDs).

Monitors should be required for major and cost-effective sources of air pollutants—including criteria pollutants, airborne toxics, and even allergens. Both Bruce Yandle (1997) and Fred Smith (1995) call for more emissions monitoring using new technologies. Not everything ought to be tracked; costs and benefits should be weighed. But a precondition for dumping known and serious pollutants into the common airshed should be an obligation to track and report those emissions. Ideal enforcement here is as upstream as possible, such as installing monitors on-board automobiles at the assembly line. Encourage innovation here, too, with subsidized R&D. Nearly two decades ago, Fred Smith (1995) called for chemical or isotopic “labeling” of large polluters’ wasteful output. We should innovate and implement technologies to better track emissions.

For instance, emerging nanotechnologies hold promise for ubiquitous deployment of self-powered remote sensors. Next generations of devices like automobiles’ OBDII (on-board diagnostic computers) can do more than track performance of emissions control systems (e.g., more information to estimate actual emissions) and reduce the cost of reporting (e.g., wireless transmission). While attaching monitors to specific emitting technologies can gather detailed information, high costs should limit this approach. Thus, the network of RSDs should be greatly expanded to

allow better estimates of variation in local air quality and environmental performance of other sources (e.g., vehicles, smaller facilities) and real, on-the-street measures of ambient air quality where it matters most. This means the RSD network should be more than just the monitoring stations needed for compliance with the CAA’s NAAQS for criteria pollutants. It should also include monitors of air quality, including air toxics, in areas most helpful to interpolating the air quality “landscape” for a region and where the most sensitive receptors or population lies. In addition to measuring ambient levels, the RSD network should also include devices to detect emissions of major sources (e.g., roadside monitors that “sniff” tailpipes). The government need not be the ones to install and maintain these RSDs. Subsidies can encourage the private sector to do this (e.g., support for school projects, grants to local environmental nonprofits). These RSDs and monitors should be wirelessly connected to the data network insofar as efficient to bring real-time data online.

#### More, better modeling

Just collecting the data is important but insufficient. Another aspect of the informational public good is the processing of that data. To that end, more and better modeling of air quality phenomenon should be supported vigorously by policy. Modeling the fate-and-transport of air emissions, for instance, provides crucial information in establishing causal connections between pollution sources and downwind harms. Effort should be made to overcome the ‘informational deficit’, as this knowledge is likely to be underproduced in the market. This modeling can be done by agency staff or, better yet (as discussed below), contracted out to the private sector via competitive grants. The goal is to generate usable and relevant information to empower better averting or sorting behavior on the part of households and firms (and even public agencies). The information should guide daily operations (e.g., whether to play or work outside on a particular day, whether to bike to work) and more-long term decisions (e.g., which air filtration system to buy, where to relocate).

#### Link the information to other policies

The better monitoring and processing of air pollution information recommended above aims to produce informational public goods. This will support better decision-making, markets less encumbered by asymmetric information, and lower transaction costs for agents to coordinate. Ideally, however, the information generated would be linked to other policies to enhance its impact. In the CAC-dominated status quo, better-informed regulators can act with more nuance as their fundamental information problem has been lessened. For example, some economists (Harrington and

McConnell 1999) discuss how better RSDs might help save substantial costs by using them to screen for dirty cars in implementing inspection and maintenance programs.

More promisingly, however, the information should provide an essential foundation to any market-based policy approach. The information is vital to both emissions taxes and to cap-and-trade systems where actual emissions must be tracked and their impact on social welfare better measured in order to optimize the tax or overall cap. Other changes, like assigning liability for emissions control further upstream (per Harrington and McConnell 1999) and away from owners of small sources, would need RSD measures to assess their performance but can also benefit greatly from being able to target specific sources for cost-effective reduction. Going further, this better information would become extremely valuable in an evolved common-law regime that addressed air pollution via market forces, voluntary bargaining, and compensation for nuisances. Even Fred Smith's (1995) free market would *require* large emitters to monitor and report where their airborne waste goes. Agents would rely on that information about harms and causes to trade (and relocate) efficiently.

### **Remember to monitor and model the behavioral side as well**

The information products generated here are repackaging of the raw data (which should also be freely available to the public) with value-added from domain expertise. The obvious domain is atmospheric chemistry, but good air quality voluntary and information-based policies should not be so limited to just the “hard science” and engineering components. The monitoring and modeling should be designed to incorporate the relevant behavioral, social, and psychological aspects as well. De-funding the American Community Survey (ACS) and shrinking the work of the Census Bureau without funding a superior substitute, for instance, is opposite to what good voluntary and information-based policy recommends.<sup>14</sup> Optimal monitor placement, for instance, depends on how people will respond to the monitors if and how they see them. What data products are ultimately relevant, of course, depends on understanding the psychological and economic considerations of the decision-makers. And, perhaps most importantly, the location of mobile-source emissions is critical to understanding how these emissions contribute to downwind harm, so monitors and models should take into account the human dimension to emissions. Advantages of using electronic and wireless technologies to reduce transaction costs for road tolls are well known—these technologies can piggyback at least pollution tracking and at

best pollution charges. Readily available and non-intrusive information technology can let us track and estimate tailpipe emissions on an individual basis while also protecting privacy (Harrington and McConnell 2003).

### **Augmented disclosure programs**

The second order of business is to reduce information asymmetries and expand markets regarding air quality.

#### **Improve disclosure programs**

Disclosure programs have a mixed record, at best. Nonetheless, we can do better and, in some places, do more. Disclosure programs of a sort should be added for the sources or products that pose the greatest environmental harms or risks. For major sources, this disclosure is effectively covered in the previous section: their emissions monitored, reported, and made publicly available. Investors, consumers, and neighbors associated with that source then can have that facility's environmental performance information at-hand. Similarly, products that have significant air quality impacts should also face mandated disclosure. For impacts that pose health risks to the consumer (especially for indoor air quality), this disclosure will likely spur a sharp response from the market. Importantly, this disclosure is not a regulation that prohibits or taxes products – it merely informs the consumer while retaining their free choice to select their own risk level. For products that harm non-consumers, like automobiles, the mandated disclosure follows from the monitoring requirements discussed in the previous section. Another class of public information campaigns includes disclosing information about ambient air quality and risks. Relevant information about neighborhood air quality, indoor air quality in major public buildings (e.g., schools), and air pollution episodes should be disclosed to appropriate decision-makers.

Disclosure program reforms should include criteria pollutants, not just airborne toxics like the TRI covers. It should also report information on emissions, not just “releases”, and report or disclose the information in more user-friendly ways. The reporting should account for lifecycle emissions to prevent strategic responses by firms attempt to hide emissions upstream in their production process. This likely involves combining multiple data sources on multiple firms and facilities, and making the data useful also demands supplementing the raw data with complex knowledge about relative risks and exposed populations. Disclosure programs, in short, should get more sophisticated and include incentives to get agencies to take their mandate (to offer relevant information and spur entrepreneurial responses) seriously. Accordingly, outsourcing much of the information processing and reporting to third-party private agents is recommended.

<sup>14</sup> The fate of the ACS's funding hangs in doubt at the time of writing.

For disclosure programs to work well, however, they should be linked to genuine information asymmetries<sup>15</sup> or informing averting behavior by individuals. Disclosure programs should be eliminated or curtailed if they turn into an arena for powerful interests or firms to capture either the market (reducing competition via a branding barrier to entry) or policy (by steering regulations in their favor). They should also be avoided and eliminated when benefits cannot justify their compliance costs.

### **More basic research on information programs**

The spotty record of voluntary information-based programs is routinely accompanied by calls for more research into decision sciences to better understand how we use information. Good voluntary and information-based programs will put substantial resources to this. More research into effective “nudges”, behavioral economics, and what makes for more effective information programs is very much needed. The results, even if they have little benefit for the voluntary and information-based programs themselves, will be informational public goods that will benefit information producers and users throughout the economy. More research into the basic science behind air pollution’s impacts on social welfare is also a priority. The history of the Clean Air Act begins with regulation that, in many ways, was far out ahead of the science. We still have many major gaps in knowledge about human health and other effects of air pollution. Better understanding these health effects, moderating factors, and cross-chemical effects is another form of “information disclosure” to society. Perhaps the single most valuable voluntary and information-based policy would be to advance the science of understanding the social causes and impacts of air pollution. Advancing knowledge about the behavioral and psychological aspects of information use in this arena should also have positive spillovers.

### **Foster private efforts**

The key to disclosure programs is to use them to catalyze the private, market responses. The success of these programs likely follows from how much of the programs exist *outside* of the government’s direct control. Disclosure programs like product labeling need not be run by the government (e.g., EnergyStar). Many product certification schemes struggle due to costs associated with certification. To that end, the recommended voluntary and information-based programs will offer subsidies to agents for pursuing certification. The third-party certifier is also producing a public good and will tend to struggle to stay profitable. Rather than resort to government as the certifier, they

should subsidize third-party certifiers to stay afloat. A good voluntary and information-based program strikes a balance between standardization and economies of scale in having one or a few certifier and the advantages that come from variety in the marketplace (of certification). Again, this should be research driven on the agency’s part, and the overarching principle is to foster, not restrict, market activity here. To foster private-sector led labeling initiatives, government should allow and even encourage “precompetitive” round-table discussions among industry for standard-setting purposes.

To help foster private efforts, the disclosure programs especially should encourage private agents to help provide the information. Private efforts will be keys to capturing entrepreneurial energy needed to find the best ways to communicate the information. This obviously includes subsidizing those seeking certification, those disclosing, and those running the certification or disclosure program. It also includes outsourcing as much of the program duties as possible to private agents. Matching subsidies to the expected benefits of the program should help avoid wasteful disclosure efforts (as profit-seeking firms avoid the program). Bounties should be placed on failures by private *and* public agencies to disclose. Policy reforms should give legal standing to watchdog groups who make sure that both private actors and government agencies are doing their duties in disclosing information appropriately. This is especially important for public agencies properly disclosing (and protecting privacy of) data and for third-party certifiers whose effectiveness relies on their credibility.

Government should use its purchasing power to support certification or labeling schemes (when cost-neutral). This can help establish these signals in the marketplace. Similarly, the government should use information brokers like [ecoScorecard.org](http://ecoScorecard.org) to help process the complex eco-information in making purchases. It is the success of these kinds of information brokers that voluntary and information-based programs should catalyze (without favoring any particular firm).

### **New competition, markets**

The third order of business is using informational public goods to support more competition and new markets.

### **Encourage new products using public data products**

The public informational products created (largely discussed in the first theme) should always include the raw data (rendered anonymous as needed) for data collected and the analytical models published in an open-source fashion. Transparency is paramount here, including the raw data and source code for any processing done to produce useful data. Accessibility should also be maximized. This

<sup>15</sup> Where one side of a transaction knows something about the good or service that the other side doesn’t, but wishes they did.

includes archiving information from multiple jurisdictions (if possible) in one or a few “one-stop shopping” clearing-houses. Economies of scale should be sought to reduce costs, but incentives for the archivists to maintain transparency and accessibility suggest that bidding out contracts to operate the archives is worth considering.

Exciting new information technology, such as “apps” for handheld devices, can greatly expand on the sort of service provided by Environmental Defense Fund’s Scorecard.org. Apps for portraying information to different sorts of users at different locations and times (updated in real-time) are already possible with current technology. Apps to foster the collection of relevant data on air pollution risks are being developed as part of “crowdsourcing” processes. Public voluntary and information-based policies should foster this and more—and when market barriers hold back entrepreneurs, such programs should circumvent those barriers. The government should seed new IT like websites, apps, and social media platforms that disseminate real-time data on air risks. Again, governments are likely better off putting contracts to deliver those services out to bid. Seed funds should promote *competition* in providing these information tools. Open-source code requirements can help achieve enormous cost savings across multiple jurisdictions, pointing to a role for federal seed funds.

Consider an example of an air quality prediction market. Every day, government agencies make local air quality forecasts for hundreds of U.S. cities. Every day, these forecasts are used by households, firms, and agencies in making some decisions. Their use is limited at best, but this is partly due to their limited information content. Better information products, in other words “more relevant predictions,” could change all of that. Some households care about air quality in certain places or times in order to plan their commutes, their after-work jog, or their mid-day stroll with their newborn. Some firms care about air quality in certain places or times to decide where to assign workers,

where to put customers (e.g., daycares keep children indoors), or when to allow workers to telework. Some agents don’t care about daily air quality levels, but rather want to know long-term projections. These might be projections about ambient levels or about national ambient air quality standards compliance (and ensuing regulatory stringency). Good voluntary and information-based programs should identify the relevant forecast products and seed efforts to produce them. In small markets or for low-consequence forecasts, public agencies should make the forecasts themselves with clear guidelines to incentivize unbiased forecasts. Where possible, voluntary and information-based programs should establish prediction markets and invite the private sector to make, and profit from, better forecasts. These markets can also allow agents to insure against uncertainty in air quality.

**Produce data to reduce transaction costs, overcome bargaining costs**

The information generated should support new markets. Better information about ambient air quality and environmental risks across space and time should be valuable in a variety of current markets (e.g., housing, labor). Yet accessing and customizing the information for those markets requires some value-added work done by specialists, and providing the data in accessible ways should spur entrepreneurs to fill market gaps and meet the demand for information. Packaging and repackaging public data may be well suited to competitive markets, with countless examples across sectors. The high fixed costs associated with generalizable knowledge about air pollution (e.g., fate-and-transport modeling) warrants government investment to produce the “basic knowledge” that underlies the private information services. Public agencies need not do this role themselves. Competitive grants to analysts to generate modeling “results”—always fully transparent—should be offered.

## Summary of suggested voluntary and information-based policies

<b>Enhanced monitoring, processing</b>	More, better monitors More, better modeling Link the information to other policies Monitor and model the behavioral side as well
<b>Augmented disclosure programs</b>	Improve disclosure programs More basic research on information programs Foster private efforts
<b>New competition, markets</b>	Encourage new products using public data products Produce data to reduce transaction costs, overcome bargaining costs
<b>Foster coordination</b>	Share more information, expertise Offer and improve forums for coordinating, bargaining Remove barriers to coordinated responses

Providing relevant and valid air quality information can indirectly improve other market-based efforts to efficiently provide environmental quality. Better information enables firms to better benchmark their performance against others, allowing consumers and investors to reveal their green preferences through the market. As some research has shown (Brouhle and Khanna 2007), disclosure of (verified) information can facilitate product differentiation, thus allowing consumers and investors to reward high quality/high cost firms that opt for greener operations and products. Already shown to work in the electricity generation sector for greener fuel mixes (Delmas et al. 2010), this might readily extend to household products that affect indoor air quality, automobiles' emissions, and other producers with polluting production processes. This sort of effect might be limited where concurrent real (or threat of) liability associated with poor performance is absent. But watchdog groups or other third-parties could benefit immensely from the availability of information to help verify product quality, certifications, or other “green” claims. In addition, this information can help nonprofits – or others with lower bargaining costs—to help identify “hotspot” victims and coordinate their efforts to lobby or otherwise seek redress. Similarly, this information can help profit-seeking firms identify markets and target marketing efforts for products that help people (or firms) reduce exposure or mitigate harm from air pollution. Again, this kind of market research obviously has private value to those firms, but its public good nature prevents firms from fully capturing its value and thus invites some subsidized provision. Private “club good” re-packagers of the public information that firms can provide evidence of the effectiveness of the voluntary and information-based policies.

### **Foster coordination**

The fourth order of business is helping overcome collective action problems that prevent private solutions.

### **Share more information, expertise**

Efforts to promote the flow of information and expertise should be made. This includes reducing the red-tape and other bureaucratic costs, vigilantly. It also includes making investments by public agencies to share information directly about how to coordinate well. These kinds of “guidebooks,” “smart practices,” and directories to available resources can help lower coordination costs for groups. This is especially true for costs for initially forming groups. Information sharing should also attempt to identify “latent” groups and make information available to members of those classes.

### **Offer and improve forums for coordination, bargaining**

Expanding markets and property rights—and legal liabilities—associated with air pollution will certainly

increase the burden on the court system. More resources must get dedicated to the courts. This includes the supply of “special experts” (Smith 1995) that can help adjudicate the science. These experts, whether drawn from the ranks of government employees or not, are part of the informational public good. They can be provided outside of courts, too, in other forums where their expertise can foster coordination.

Voluntary and information-based programs should reduce friction in bargaining and coordination by subsidizing workshops, working groups, summits, etc. Information disclosure programs have frequently been seen to promote more cooperation and reduce antagonism between firms and regulators. Offering facilities, experts, facilitators, seed funding, and other resources can help bring affected parties to the table and promote voluntary agreements. Enforcing contracts and assisting with arbitration can also help.

### **Remove barriers to coordinated responses**

Barriers to bargaining and coordination vary widely across contexts. In general, policy reforms should remove those barriers and enable meaningful coordination. This might be, in some instances, setting the standard when multiple competing standards are proposed. Multiple standards currently complicate voluntary carbon emissions reporting (Matisoff et al. forthcoming). It might be altering rules to make it easier for local organizations (e.g., nonprofits, neighborhood associations) to represent the interests a local community or a class or affected parties in binding negotiations with polluters. Ideally, legal action can be brought in a low-cost way by groups or classes of harmed parties and the interests of polluters—or even groups of polluters—can be represented in a similarly low-cost fashion. Enabling meaningful negotiations will likely require a radical departure from the centralized, command-and-control regulatory approach that limits polluter liability for harms. Even without shifts to more efficient policy regimes, lubricating coordination where there are many polluters and many victims may yield surprising “race to the top” outcomes in at least some areas.

## **Conclusion**

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Policies to promote better information should be feasible—i.e., find considerable political support—from a wide base of support along the ideological continuum. Again, while information policies likely will not be win-win, and surely some parties stand to wilt under the sunlight these policies bring, the voluntary and information-based policies do nicely to complement air pollution policy

frameworks espoused by many on the left, the right, and moderates.<sup>16</sup>

At one extreme, a “free market” approach that shunned political involvement in regulation or even setting Emissions taxes or tradeable caps is not immune from improvements via voluntary and information-based policies. Even the more ardent free market advocates acknowledge that, in light of the practical limitations of common law and property rights, their system can benefit from better information. As legal scholars Richard Posner and Cass Sunstein (2005) write:

*In the context of air pollution, for example, chains of causation are exceedingly difficult to trace, and those who fall prey to life-threatening or fatal diseases are unlikely to know that pollution is responsible. Because of collective action problems and informational deficits, tort law will not provide adequate incentives even if it is optimally tailored.*  
(p.24)

The market system will tend to under-produce quality information in the air pollution context as actors free-ride on information provision by others or strategically reveal or disclose private information to prevent efficient bargaining. There is a role, even in this extreme stance, for better information to track pollution, to better understand its impacts, and inform appropriate parties of relevant information. In some cases, providing this information will unleash the competitive-entrepreneurial forces to conserve our airsheds in new ways. In other cases, when the institutions are tweaked to facilitate the private production of the information in the first place, the competitive-entrepreneurial forces will be pioneer new and affordable technologies to provide valuable information.

At another extreme, one might hope that the conventional regulatory approach would be greatly improved with the availability of more information from these voluntary incentive-based programs. That regulators’ reach would be as wide and as deep as it is *without* the benefit of enhanced information is troubling. Surely the command-and-control approaches could be further refined when informed by these voluntary and information-based approaches.

<sup>16</sup> This broad political support is not sufficient to prove its feasibility. What likely holds back their implementation is a combination of factors like (a) general gridlock over air quality policies in Congress, (b) their orthogonality to the rhetoric and polarizing debate of big vs. small government, (c) technical complexity for regional governments, (d) voluntary and information-based policies can frustrate both those who dislike disciplining agency intervention and those who dislike allowing new government involvement, and (e) the lack of obvious and predictable outcomes in terms that translate well into sound-bites.

And, perhaps most especially (and most feasibly), the market-based instruments for addressing air pollution rely heavily on voluntary and information-based approaches. Voluntary and market-based solutions to improve air quality *depend* on the provision of (the public good) information. They rely on better information about the causes and impacts of polluting behavior. They rely on more informed “victims” and more symmetry in the information about air quality and polluting activities. Appropriate emissions taxes depend entirely on information allowing the estimation of external harms, and how it varies across the time and place (and other conditions) of emissions. A proper cap-and-trade approach would also incorporate conversion factors to standardize the unit of trade—so that each emissions allowance is a homogenous commodity. This requires information to weight some emissions more and some less. And both the cap-and-trade and the emissions taxes approaches require verification or monitoring of emissions. Optimized avoidance behavior by residents, workers, and firms also depends heavily on the availability of information about air quality. Likewise, green marketing and labeling efforts to enable market forces to spur voluntary air quality improvements also depend on making available reliable information about air quality and emissions.

In short, voluntary and information-based policies are more than just a complement to a core policy approach – be it “free” markets, market-based policies, or conventional regulation. They are at the heart of each of these approaches. In a sense, the voluntary and information-based approaches are the common elements that remain after you strip away the other aspects of these core policy frameworks.

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