Resources for the Future
1616 P Street NW
Washington, DC 20036–1400
USA
www.rff.org

EDITORS:
Ian W.H. Parry, series editor
Felicia Day, managing editor
Adrienne Foerster, assistant editor

CONTRIBUTING EDITORS:
John Anderson
Sally Atwater

COVER AND BOOK DESIGN:
Ellen A. Davey

Distributed by RFF Press, an imprint of Earthscan

978-1-933115-89-4 (hardback)
978-1-933115-87-0 (paperback)

PART 3

National Environmental Policies

In the United States, air and water quality has improved considerably over the past 40 years due, at least in part, to the introduction and progressive tightening of regulations on automobile and industrial sources of particulates, sulfur dioxide, lead, and other pollutants. At the same time, there has been increasing recognition of the drawbacks of traditional forms of regulation, such as mandates stipulating technologies that must be used to control pollution. The key attractiveness of market-based approaches, like cap-and-trade and emissions taxes, is that they allow firms the flexibility to choose the lowest cost means of reducing pollution.

As the most serious national environmental challenges have, in part, been addressed, and disenchantment with traditional forms of regulation has generated interest in more novel approaches, national environmental policy issues of the day have diversified in many directions. These are discussed in the collection of commentaries in this section.

More attention is now being paid to other environmental problems, such as hazardous chemicals that are difficult to monitor and regulate, the generation of household waste and its disposal in landfills, agricultural pollution, and pollutants like nitrogen that require a portfolio of control measures. Policymakers have also become interested in to what extent voluntary programs, or businesses acting on their own to become green, may complement, or substitute, for mandatory environmental programs.

Other policy options that are evaluated in this section include how successful programs like the cap-and-trade system to regulate sulfur dioxide might be reformed going forward, to what extent cost/benefit assessments might be used in the design of environmental regulations, and how measures of gross domestic product might account for environmental trends.

Finally, there is greater interest in the distributional impacts of environmental hazards, across different racial and income groups, and how this might be factored into policy reform.

35. WHAT ARE THE BIGGEST ENVIRONMENTAL CHALLENGES FACING THE U.S.?

Paul R. Portney

is the dean of Eller College of Management, University of Arizona. He served on the RFF research staff for more than 30 years and as the president of Resources for the Future from 1995 to 2005.

A broad-brush evaluation of EPA'S role in regulating pollution since its inception in 1970 leads into a discussion of the key challenges facing environmental policymakers in coming decades.

We can pick 1970 to conveniently mark the beginning of the modern environmental era in the United States. After all, that was the year that EPA was created, and with it came significant federalization of environmental protection efforts that had until then been the province of individual states. And that same year saw the passage of amendments to the Clean Air Act, the first really dramatic assertion of power by the federal government in the environmental arena. Two years later, Congress passed what we now refer to as the Clean Water Act, and, in the decade or so to follow, a handful of other federal laws were passed dealing with pesticides, solid and hazardous wastes, and drinking water.

So, where do we stand 30 years later? It's simply beyond dispute that air and water quality have improved in virtually every part of the United States, no matter which pollutants we consider or how we choose to measure them. Moreover, in most parts of the United States today, we treat solid waste—garbage, that is—with about as much care as we handled nuclear wastes back then—a pretty low bar, I realize, though progress has been great. Not only are truly hazardous wastes today treated with even greater care, but their use has been significantly reduced, in part because of the expense of dealing with them in the modern regulatory system. This progress is all the more remarkable because our population has exactly doubled since 1970, and real GDP has tripled.

I know, I know, air quality was improving in at least some U.S. metropolitan areas before 1970, the result of state and city regulations like banning the open burning of leaves and burning household garbage in basement incinerators. And well before 1970, California took on the auto industry and required cars sold there to meet the first vehicle emissions standards in the country. Some analysts have used this to argue that we would have made the same environmental progress had we left matters to the states and not created EPA, nor passed the statutes of the 1970s.

Baloney. It strains credulity to suggest that individual metropolitan areas, or even states, could have mounted as effective a campaign to control air and water pollution from industrial facilities like electric power plants, petroleum refineries, steel mills, paper mills, and cement kilns, among others, as the new EPA did. And it's painful to imagine 50 different sets of standards governing tailpipe emissions from new cars, trucks, and SUVs. Detroit's carmakers would be in even graver condition by now had they been forced to cope with such Balkanization.

Before we bruise our backs patting ourselves too hard, let's remember two things. First, while we have made terrific environmental progress in the United States, we could have accomplished as much, if not more, at much less cost (in the tens of billions annually) had we built our initial federal regulatory apparatus using the kinds of incentive-based approaches that have become the default approach to environmental regulation today. No one likes to hear "I told you so." But economists in the late 1960s and early 1970s, like Allen Kneese, Cliff Russell, and Walter Spofford at RFF, as well as Charles Schultze at Brookings, were pointing out how much more efficient pollution taxes or tradable emissions permits would be than the clumsy command-and-control apparatus EPA was erecting at Congress's behest. The success of the sulfur dioxide

emissions trading program established in the 1990 amendments to the Clean Air Act has proved they were right on the money.

Second, while we've done an exceptionally good (if also overly expensive) job of dealing with the environmental problems at which the laws of the 1970s were aimed, we neglected two problems that ought to concern us the most as we look forward in this new century. First, no federal law or regulation has required emissions reductions for carbon dioxide (CO_2) or other greenhouse gases (with the exception of chlorofluorocarbons, or CFCs, which were controlled out of concern for their ozone-depleting potential). While I think there is more uncertainty about the causes and likely consequences of global warming than most scientists suggest, we're nuts not to have instituted gradually increasing controls on CO_2 and other greenhouse gases. The worst-case scenario, especially for future generations, is too scary not to be taking some preventative measures now.

The second environmental problem we face lends itself less to federal control and is not the province of EPA, namely the steady conversion of wilderness and open space to developed uses as our population grows and spreads out. In many respects, we're lucky we're a growing country, both demographically and economically. But as we expand, the wilderness areas and open spaces we enjoy, which are home to a host of species, are getting chewed up in the process. Forget recreation and habitat for a minute. Who doesn't find it pleasing to drive from one place to the next while looking out at forest, fields, or even desert, rather than still another subdivision or shopping mall, however attractive the latter might be? We have never regulated land use very much at the federal level in the United States, and that's not all bad—the thought of social planners in Washington telling local communities who can build what and when, not to mention what it ought to look like, is not reassuring. But leaving the protection of a prototypic public good like open space *solely* to locals surely has its own set of problems. We have to do better at preserving some natural beauty and habitat while still accommodating our growing numbers.

That's how I see it, anyway. I think our environmental laws have served us reasonably well over the years, with the one qualification and two conspicuous exceptions mentioned above. Unfortunately, it is more difficult to conclude that those laws are the appropriate ones for the challenges that lie ahead. Nor am I confident that EPA still has the vitality and creativity to be as effective as it was in the early years, though that is for others to decide.

36. WHERE THINGS STAND WITH HAZARDOUS WASTE REGULATION

Sarah Stafford

is the Verkuil Distinguished Associate Professor of Economics and the associate director of the Thomas Jefferson Program in Public Policy at the College of William and Mary. Her research focuses on hazardous waste regulation and corporate environmental behavior, with an emphasis on compliance and enforcement.

One problem in hazardous waste regulation is the difficulty of ensuring regulatory compliance, not least because violations are often inadvertent. Therefore, complementary programs, such as compliance assistance, environmental audits, and voluntary compliance initiatives, can play a valuable role.

The U.S. economy generates a significant amount of waste. According to recent estimates, on average we generate about 250 million tons of trash each year, or 4.5 pounds per person per day. In addition to municipal solid waste, the United States generates 50 million more tons of hazardous waste each year.

Hazardous waste is a relatively new phenomenon and was not generated in significant quantities until we started using fossil fuels and chemicals in earnest at the beginning of the industrial age. Initially it was not considered to be any different from other waste and so was essentially unregulated. Hazardous constituents were routinely released into the environment, where they polluted groundwater, rivers, and lakes and killed people, livestock, and wildlife. As the consequences of uncontrolled management of waste became clear, the public began to call for regulations to protect human health and the environment.

FIRST, SOME HISTORY

The first environmental law that specifically addressed the generation and management of hazardous waste was the Resource Conservation and Recovery Act (RCRA), passed in 1976. RCRA's Subtitle C delineated the basic structure of federal hazardous waste regulation and required EPA to establish criteria for identifying and listing hazardous waste and to develop standards applicable to generators, transporters, and managers of hazardous waste. In 1984, Congress passed the Hazardous and Solid Waste Amendments (HSWA), which expanded the scope of RCRA by requiring EPA to develop treatment standards for hazardous waste, minimum technological requirements for hazardous waste management units, and a corrective action program for contamination at active waste management facilities. Together these two acts provide the mandate for EPA's current hazardous waste program, commonly referred to as the RCRA program, which covers hazardous waste "from the cradle to the grave."

Although hazardous waste is often referred to as toxic waste, a material does not have to be toxic to be considered hazardous. Hazardous waste includes any discarded material that is potentially harmful to human health and the environment because it is ignitable, corrosive, reactive, or toxic, as long as the material has not been specifically excluded from the definition of hazardous waste. Two major categories of waste have the potential to be classified as hazardous but have explicitly been excluded from regulation as such—agricultural and mining wastes.

Even with these exclusions, the RCRA-regulated universe is both large and diverse, including well over 600,000 facilities in the United States, ranging from large chemical manufacturers and petroleum refiners to small dry cleaners and photo finishers. Nonprofit and government entities, such as hospitals, universities, and military bases, generate hazardous waste as well.

Interestingly, perhaps the most well-known toxic waste sites—Superfund sites—are not part of the RCRA universe. The Superfund program was established separately to cover cleanup of hazardous waste at inactive or abandoned sites and hazardous waste

spills that require an emergency response, whereas RCRA covers only active hazardous waste facilities.

MUCH SKEPTICISM

RCRA is a relatively mature program, and over the past decade there have been only minor changes to hazardous waste regulations. With no new regulations to implement, EPA has turned its focus toward waste minimization and improving regulatory compliance.

Waste minimization, which includes both pollution prevention and increased recycling, has been promoted primarily through voluntary initiatives such as WasteWise, the National Environmental Performance Track, and Responsible Care. The majority of these programs are cross-media and, in theory, have the potential to increase environmental performance because they encourage facilities to think holistically about their environmental impacts. Both industry and EPA have been enthusiastic about such programs, but many in the environmental community are more doubtful because of the general lack of public accountability or oversight.

Over the past few years, researchers have conducted a number of studies to analyze the effectiveness of voluntary environmental programs. Only a few have been able to show that voluntary programs can significantly improve performance for more than a limited set of facilities. This lack of evidence may be behind EPA Administrator Lisa Jackson's suspension of the National Environmental Performance Track.

Under previous EPA administrators, voluntary programs were not limited only to waste minimization efforts; during the Bush administration, the agency placed increased emphasis on voluntary compliance initiatives and self-policing. But still, neither voluntary nor command-and-control approaches appear adequate to get the job done. Many are skeptical that voluntary efforts are effective at increasing compliance, while others doubt that traditional enforcement can bring all facilities into compliance because many violations appear to be due to confusion or ignorance, rather than deliberate decisions to violate the rules.

Although a facility may knowingly violate RCRA regulations by sending hazardous waste to a nonhazardous waste landfill for disposal, it may also inadvertently violate regulations if one of its hazardous waste storage tanks leaks. Traditional enforcement measures, such as inspections and fines, can help decrease the level of deliberate violations by making violations more expensive for the facility. When EPA revised its RCRA penalty policy in 1991 by drastically increasing its fines to 10 or 20 times the previous fine levels, hazardous waste compliance increased. Similarly, increasing the probability of a compliance inspection has been shown to increase the likelihood that a facility will comply with RCRA regulations.

For inadvertent violations, however, increasing penalties and inspections may not be very effective at increasing compliance. Facilities may be noncompliant because they do not fully understand the regulatory requirements, do not fully know their facility's operations, have poor internal environmental management systems, or do not have the ability to comply. Alternative policies such as compliance assistance or environmental audits may help to increase compliance.

In my research, I have found some evidence to support the effectiveness of compliance assistance programs. In a study on RCRA compliance behavior to try to determine whether facilities were deliberately or inadvertently violating hazardous waste regulations, facilities in states with compliance assistance programs were found to be less likely to violate than facilities in states without them. Environmental auditing has not been shown to be as effective. While facilities in states with environmental audit privilege and self-policing policies are less likely to violate, a more recent study of Michigan hazardous waste facilities suggests that facilities that implement environmental audit programs are not any more likely to be in compliance than facilities that do not audit.

Although the data on the ability of voluntary compliance programs to improve environmental performance are limited, I nonetheless believe that there is an important role for such programs to play in complementing traditional enforcement and improving compliance in the future. Facilities violate hazardous waste regulations for a variety of reasons, and we must develop an equally wide range of initiatives and programs to increase compliance. Voluntary programs should not supplant traditional enforcement efforts but instead should be used in tandem.

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37. REINSTATING THE SUPERFUND TAXES

Good or Bad Policy?

Kate Probst

is a senior fellow at Resources for the Future. She has conducted numerous analyses of environmental programs, focusing mainly on improving the implementation of Superfund and other hazardous waste management programs.

This discussion of the state of funding for the cleanup of polluted sites under EPA's Superfund Program adds context to the debate about whether to reinstate dedicated taxes for the program to supplement general revenue sources and, potentially, increase program funding.

With Democrats back in power in both Congress and the White House, there is a renewed effort to reinstate the taxes that once stocked the Superfund trust fund. While proponents argue that the taxes are critical to ensuring that the "polluter pays," the reality is a little more complicated. Two questions are always raised in this perennial debate: (1.) Does EPA need more money to pay for Superfund cleanups? The unequivocal answer is "yes." And, (2.) Should the taxes that once stocked the Superfund trust fund be reinstated? Here, the answer is "maybe."

While it has been nearly 30 years since the law was first implemented, there are still sites contaminated with hazardous substances that need to be cleaned up. To date, 1,596 sites have been placed on EPA's National Priorities List (NPL), all highly contaminated sites where trust fund monies can be used to pay for cleanups. While construction of the proposed remedy is completed at the majority of those sites (1,065), more work remains to be done at fully one-third (531).

Just because implementation of the remedy is complete does not mean that cleanup goals at the site have been achieved. At many sites, long-term operation and monitoring activities will continue for years, if not decades, requiring government oversight. And the percentage of sites where remedies are implemented—and paid for—directly by those parties responsible has been decreasing. For much of the 1990s, private parties paid for 70 percent of site remedies. By FY2008, this figure had fallen to 56 percent. While it would be nice to think that we no longer need the Superfund program, this simply is not the case.

But first, a little funding history. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—better known as Superfund—put in place two mechanisms for ensuring the cleanup of sites contaminated with hazardous substances: broad liability provisions to require the "responsible parties" to pay for and implement cleanups themselves and a dedicated trust fund to provide funds for the government to clean up sites where those responsible did not have needed funds, had gone out of business, or were recalcitrant.

For the first five years of the program, total appropriations were $1.6 billion, and the majority of the funds came from excise taxes on petroleum and chemical feedstocks, plus additional funding from general revenues. When Congress reauthorized the program in 1986, annual appropriations were increased to $1.6 billion, thus *quintupling* the size of the program. Congress added a third tax to generate revenues for the Superfund trust fund, the corporate environmental income tax, which was based on every corporation's modified alternative minimum taxable income. Many different kinds of companies paid this tax, not just the chemical and petroleum companies subject to the excise taxes.

When authority for the Superfund taxes expired at the end of 1995, annual appropriations for the program did not decrease immediately, because of a large unobligated balance in the trust fund. Appropriations continued at approximately $1.5 billion through FY1999. Annual appropriations declined to $1.2 billion in FY2003, where they have pretty much stayed ever since.

But by the late 1990s, it was clear that EPA was experiencing a shortfall in funds needed for cleanup. Work by Resources for the Future in 2001 estimated a "best case" funding shortfall of just over $2 billion over the 10 years from FY2000 through FY2009. In the years since then, EPA's Office of the Inspector General and senior EPA officials have documented funding shortfalls that have prevented remediation from moving forward at a host of specific sites. The number of sites each year where cleanup activities are completed—which reached a high of about 80 sites per year in the late 1990s—fell to 47 in FY2001 and to an all-time low (not counting the first few years of the program) of 24 in FY2007.

While fewer sites are being added to the NPL each year—in FY2008, only 18 new sites were added—the funding shortfall is likely to continue for the foreseeable future. Just how big this deficit is, and how long it will continue, is unknown as there have been no comprehensive estimates of funding needs made public since the RFF report that was released nine years ago.

In addition, it has become clear that some of the sites that warrant federal attention—mining sites and contaminated waterways—are among the most complex and expensive types of sites to remediate. No public estimates exist regarding how many of these sites will likely be placed on the NPL in the future.

TO TAX OR NOT TO TAX?

Supporters see reinstating the expired Superfund taxes as a way to increase funding for cleanups. And when the trust fund was flush, appropriations were certainly higher. According to the U.S. Government Accountability Office, from 1981 through 1995, taxes accounted for about 68 percent of trust fund revenues. From FY1996, when the tax expired, through FY2007, however, taxes accounted for just 6 percent of all trust fund revenues.

But in these difficult economic times, it is worth asking whether it makes sense to reinstate one, two, or three distinct taxes—with their attendant transaction costs—to raise what is, in fact, a minuscule amount of funding in the overall federal budget.

What, then, about the argument that reinstating the taxes will ensure that the polluter pays? While this sounds good, it really does not hold water. It is true that the Superfund taxes are paid by private industry, and that a large percentage of the taxes are levied on corporations that produce hazardous chemicals and substances that contaminate the environment. And, in some cases, it is likely that the companies paying the taxes did contaminate sites and groundwater, and may well have sites that have been—or will be—cleaned up either through federal enforcement actions or because they are on the NPL.

But those companies that contaminated sites and are now out of business will not be paying Superfund taxes in the future. And many companies that will pay the taxes include entities already being held liable for cleanup and paying directly for site-specific activities.

Before seeking to reinstate the Superfund taxes, Congress should focus on figuring out the program's real funding needs. Sadly, the questions that need to be asked—and answered—today are much the same as those Congress asked RFF to address a decade ago:

- How much will it cost to clean up those sites already on the NPL?
- How many and what kinds of sites are likely to be added to the NPL in the near future?
- What are the likely costs of postcleanup activities for NPL sites?

With a new administration in the White House and at EPA, it is time to increase the transparency of the Superfund program. EPA should, on its own, commit to again preparing an annual progress report on the Superfund program that clearly lays out past accomplishments, future challenges, and future funding needs. To ensure the integrity of this effort, EPA should create an outside review panel to evaluate the proposed data and methodologies before the analysis is conducted, and also review the interim results and final report.

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38. TRASH TALK

Don Fullerton
is the Gutgsell Professor of Finance at the University of Illinois. He specializes in environmental and energy economics, public economics, and taxation.

Margaret Walls
is the Thomas J. Klutznick Senior Fellow at Resources for the Future. She specializes in environmental and energy policy and urban land use.

What are the merits of charging households by the can or bag for their garbage, and what other policies might help promote conservation of trash without encouraging illegal dumping?

An inevitable by-product of our consumer society is the generation of trash. And continued economic development combined with population growth in communities across the United States and around the world are only making matters worse.

In this country, the problem is a big one. Americans generate about 4.5 pounds of trash per person per day, 95 percent more than our neighbors to the north in Canada, 64 percent more than Australians, and 37 percent more than the French. This high per capita rate, combined with our large population, means that the United States generates far more trash each year than other developed countries. The amount is also much greater than it used to be: in 1970, the average American generated only 3.25 pounds per day.

Recycling and composting do make a dent: in 1970, composting was virtually nonexistent and only 7 percent of solid waste generated was recycled. But by 2005, the numbers had risen to 24 percent for recycling and 8.4 percent for composting. These figures have remained relatively unchanged for the past several years, however And while some materials have relatively high recycling rates—half of all paper and paperboard is recycled—others pose perennial problems. Less than 6 percent of plastics are recycled because the process is difficult and costly. Furthermore, products like cell phones and computers are creating new headaches.

What are the key problems that government officials and policymakers need to address with respect to solid waste? And what policy instruments do the best job of tackling those problems?

For local communities, three goals seem paramount: trash needs to be managed properly without the high social costs of litter and other forms of illegal disposal; the amount of legally disposed waste should be reduced to a level that accounts for its own social costs; and particularly hazardous or toxic wastes need to be disposed separately, not thrown in the landfill with other trash.

Policymaking inevitably involves trade-offs, so furthering one goal may reduce progress toward another. For the most part, developed countries have figured out how to manage solid waste to avoid extensive dumping. Local communities provide trash collection and disposal services—usually through government provision, franchises, or contracts with private companies. Although the number of landfills has fallen in the past 15 years or so, landfill capacity has remained steady. Moreover, landfills are safer than they used to be because of requirements for liners, methane control, and monitoring. What is less clear is how best to reduce the volume of solid waste in the first place. Based on economic analysis, empirical research, and years of real-world experience, our view is that no "one size fits all" solution exists. An array of policies can best make the trade-offs for different locations and different waste materials.

The economist's typical solution to an externality problem is a Pigouvian tax: charge a tax or fee per pound of trash exactly equal to the social damages imposed by that trash. That would reduce waste in landfills, but it raises two questions. The first is whether the social damages can actually be estimated. Even if policymakers know what to charge, however, the second question is whether any such fee can feasibly be administered and enforced.

Some communities charge for each can or bag of trash, under a system commonly called "pay as you throw" (PAYT). Households might be charged one monthly amount for one can a week, or a higher monthly amount for a larger can or two cans a week. But not every can gets filled every week, leaving households with no incentive at the margin to reduce waste. A better system, closer to true marginal cost pricing, requires households to buy a special bag at the grocery store, or a special tag to use on a bag of garbage of a particular size.

EPA estimates that approximately 7,100 communities in the United States use some kind of PAYT, making it available to approximately 25 percent of the country's population. The number of communities has risen over time and, in some areas of the country, is quite high. Some states (Wisconsin, Oregon, and Minnesota) even have a law requiring that communities use PAYT.

Does it work? Results from the economics literature suggest that demand for garbage collection is relatively unresponsive to prices, but PAYT towns have experienced some reductions. And it is important to keep in mind that even if reductions are small, charging the right price may result in the *right* amount of garbage disposal. Fixed monthly charges—the norm in many places—set a zero price for an additional bag or can and thus provide no incentive for households to conserve.

The big question for PAYT communities, though, is what households are doing with the garbage they no longer place at the curb. To avoid paying the fee, households can reduce their waste by recycling, composting, consuming less in the first place, or disposing illegally—burning, finding a commercial dumpster, or throwing it by the side of the road. Recycling does increase with PAYT but not enough to account for all of the reduction in trash. Clearly, municipalities can help themselves by providing free curbside collection of a wide variety of materials for recycling and yard waste collection for central composting. Towns also must choose how much to spend on enforcement and how to set penalties.

PAYT is most effective in small cities and suburban areas but has not worked so well in densely populated urban areas where apartment dwellers use chutes and dumpsters for their normal disposal (and might easily use vacant lots for everything else). PAYT is also not as well suited to very rural areas where illicit dump sites are similarly easy to find. In general, it is most feasible where we can measure and monitor individual households' weekly trash and recycling.

Even in towns where a PAYT fee works well to reduce waste amounts without increased dumping, it does nothing special for separate handling of hazardous and other troublesome items like batteries, tires, or used electronic equipment. These products, especially, are candidates for some kind of deposit refund system (DRS). Experience has shown great success with a DRS applied to certain products: beverage containers in "bottle bill" states have recycling rates that range from 60 to 95 percent, significantly higher than in states without such a program; 96 percent of lead-acid batteries are recycled; and tires in states with a DRS are recycled at a 72 percent rate. But the idea can be generalized, in a "two-part instrument," a general sales tax on everything at the store (all of which eventually becomes waste) along with a subsidy per ton of waste handled at the recycling center. Products like computer monitors could still be specifically targeted with a special fee, but most items could be treated in bulk, without time-consuming transactions to count or weigh individual items.

Thus the "best" policy is not any single policy. PAYT can successfully be employed in at least some communities, and probably in more than are currently doing so. Other towns, however, need a two-part instrument—a general sales tax on new items at the store, plus a subsidy for recycling. And products that pose special problems may need targeted deposits or refunds. Different circumstances therefore call for different policies—PAYTs, DRSs, or two-part instruments. All of these options have a key feature in common, and one that economists invariably seek in all of their policy prescriptions: they provide the proper incentives to consumers and others to generate a socially desirable outcome.

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39. THE NEW ECONOMICS OF MANAGING THE NATION'S WASTE

Molly K. Macauley

is a senior fellow and a director of research at Resources for the Future. She specializes in space economics, the economics of new technologies, recycling and solid waste management, climate policy, and incentive-based environmental regulation.

Stephen W. Salant

is a professor of economics at the University of Michigan, specializing in industrial organization and natural resource economics, and a nonresident fellow at Resources for the Future. He previously worked at the Federal Reserve Board and at the RAND Corporation, where he served as the first editor of the *RAND Journal of Economics*.

While the development of large, state-of-the-art landfills encouraged greater interstate shipments of solid waste, regulations and taxes affecting these shipments have also proliferated. How have such policies raised the overall costs of managing waste disposal in the United States?

It's an industry worth over $40 billion dollars a year and the bane of every city mayor—managing the nation's solid waste stream.

Some 20 years ago, we disposed of most of our waste at the local dump. New environmental regulations that took effect in the 1990s as a result of the Resource Conservation and Recovery Act (RCRA) led to the closure of most local dumps and, in their place, the opening of a smaller number of large, state-of-the-art landfills. These new facilities required that waste be hauled long distances, often across state boundaries.

A funny thing happened on the way to the landfill, however. Local governments began to get involved in the waste market. Intervention took many forms, but because it affected interstate transport of waste, each gave rise to legal challenges on the basis of the U.S. constitutional provision (the "commerce clause," Article 1, Section 8) for unimpeded transport of goods and services across state lines.

For example, states that hosted large landfills began to require that their state's waste go to that landfill, even if the waste was generated in a jurisdiction for which the nearest fill was just over the border in a neighboring state. This practice arose in states for which the scale of operation of the landfill required large amounts of waste.

Other states jealously guarded their landfills and prohibited imports of waste from other states, deeming the state landfill a precious resource with limited capacity reserved for in-state waste only.

In some cases, jurisdictions levied fees on out-of-state waste. Sometimes jurisdictions justified these on the basis of needing to finance bonds issued to build the landfill. Jurisdictions also intervened to manage waste flows to achieve scale economies at recycling and incineration facilities.

In West Virginia, which, along with the state of Washington, regulates waste through state public service commissions, the commission put in place a set of licensing and other requirements for out-of-state waste haulers.

These interventions all have had the effect of restricting waste flows and impeding their least-cost management. A more cost-effective approach would take into account the distance between where the waste is generated and the nearest disposal facility, plus the cost of transportation, the remaining capacity in the disposal facility (a measure of opportunity cost), and other factors. Distorting the interplay of these factors can reduce benefits of cost-effective waste management for households. Although it can transfer benefits to owners of waste disposal facilities, the net effect on society is likely to be cost, not benefit.

Disentangling these effects on households and waste facility owners has been the subject of research we have conducted. We estimated the total loss and, given the new pattern of landfill location, the regional distribution of losses and gains across the nation under different kinds of interventions, including state and local requirements stipulating where waste must be landfilled, prohibitions on the import and export of waste across state boundaries, quantitative limits on these flows, and extra fees levied on imported waste.

In all cases, overall social welfare declines, but some geographic regions, consumers, and landfill owners bear relatively higher costs than others. For example, the discounted present value of the reduction in overall social welfare over a 20-year period if trade is prohibited is about $3.8 billion, or twice as much as volume-based restrictions capping the size of the waste flows or imposing $1 per ton surcharges. The losses are largest for consumers and producers in the Northeast, where waste exports are large, and smallest for those in the Midwest. Short of prohibiting trade entirely, the largest loss in discounted social surplus occurs under a policy that restricts the maximum volume between states and does not allow states to trade at all unless they had been "grandfathered in" because they had been trading before announcement of the policy.

In addition, and perhaps most important, some policies to restrict exports may substantially *increase* the number of interstate waste shipments as some states export smaller volumes to more destinations in order to meet limits on the size of shipments to any one state.

The courts have been extremely busy hearing the legal arguments for and against interstate restrictions. High-level courts have heard nearly 20 cases, and the U.S. Supreme Court has heard 2. By and large, most decisions, including the first of the Supreme Court findings, struck down restrictions. But the most recent decision, in 2007, found the opposite: the court held that because the waste disposal facility was owned by the local government, the commerce clause would "allow for a distinction between laws that benefit public, as opposed to private, facilities." But in the dissenting opinion, three judges held that the "public-private distinction drawn by the Court is both illusory and without precedent."

Our story is thus one of technological change (from the town dump to state-of-the-art regional landfills) in response to regulation (as set forth in RCRA) and the transformation of a local market into a national one. The recent Supreme Court decision notwithstanding, the new economics of our waste market emphasize the advantages of unimpeded trade among states.

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40. ENHANCING PRODUCTIVITY WHILE SAFEGUARDING ENVIRONMENTAL QUALITY

David Zilberman

is a professor and holds the Robinson Chair in the Department of Agricultural and Resource Economics at the University of California, Berkeley. His research interests include agricultural and environmental policy, economics of technological change, economics of natural resources, and microeconomic theory.

Steven Sexton

is a Ph.D. candidate in the Department of Agricultural and Resource Economics at the University of California, Berkeley.

Regulating agricultural use of pesticides involves complex trade-offs. For example, regulators must take into account health risks to consumers and farm workers, broader environmental damages from farm runoff, and the risk that extensive pesticide use will speed up the evolution of pest resistance. How might current policies be improved?

Calculating the benefits and costs of pesticides is highly controversial. On the one hand, they are responsible for considerable improvement in the human condition. They have increased food supply and enabled agricultural production in regions where it would otherwise be impossible. By reducing the damage pests inflict on crops, pesticides improve farm yield as much as 100 percent in some cases. They reduce the costs of agricultural inputs like labor and energy. Also, they confer environmental benefits by reducing pressure for agricultural expansion and by enabling environmentally beneficial farming practices, like low tillage, which reduces soil erosion and permits carbon sequestration in the ground.

On the other hand, chemical pesticides can be harmful to humans and the environment, potentially causing health problems in farm workers exposed to toxic materials and to consumers exposed to residues on food. They can pollute the environment by runoff and drift, contaminating ground and surface water and affecting nontarget species. In addition, excessive pesticide use can also reduce pest susceptibility, making it a resource that may suffer the tragedy of the commons. These negative side effects of pesticide use make a strong case for regulation.

The current pesticide regulatory structure in the United States does not take sufficient account of the public health benefits of pesticides (in terms of diseases prevented or reduced cost of food). And regulators are too quick to react to public opinion and do not fully acknowledge the results of the risk–benefit balancing they are required to do under law. As a result, no one is well served—not consumers, who face higher prices; nor farmers, who contend with higher costs and lower productivity; nor pesticide manufacturers, who have weaker incentives to innovate. And it is not clear whether there is an improvement in public health or environmental quality, given the problem of regulating pesticides sequentially.

First off, the process of testing potential chemicals and the criteria and standards imposed on final products should be consistent and integrated across the three government agencies that have a role in pesticide regulation: the U.S. Department of Agriculture, the Food and Drug Administration, and the Environmental Protection Agency. An essential step will be to eliminate the inevitable redundancies that exist among the agencies.

While the current system of testing and screening chemicals before they are approved for market is necessary, it is not without very real costs. It takes roughly $15 million to bring a pesticide to market in this country, certainly enough to act as a barrier to entry and lead to market concentration in the agrochemical industry. As per capita income rises, consumers are demanding ever-lower levels of human and environmental risk.

But the pursuit of safety must have its limits. Risk is inherent in all new technologies. While laboratory testing should ensure a basic level of safety, chemicals that fare well in the lab should be brought to market where monitoring in the field can provide additional validation. Should pesticides approved for market prove unsafe in some re-

spect, domestic and international regulations permit their use to be restricted or banned altogether.

Regulators all too often respond to revelations of adverse effects by banning implicated pesticides altogether, ignoring the benefits they provide as well as the potential for narrower responses. Some pesticides may be beneficial from a social perspective despite some risks. The much-maligned DDT, for example, was banned after it was known to cause significant environmental damage and substitutes were available. However, it enabled eradication of malaria in parts of the United States and Europe, and selective use could have saved tens of thousands of lives in Africa.

The use of chemicals that have negative impacts under certain circumstances, such as in specific areas or weather conditions, should be restricted accordingly. As much as 80 percent of the benefit of some chemicals is derived from as little as 20 percent of their applications, suggesting that use restrictions dominate pesticide bans from a social welfare perspective. Bans not only eliminate the benefits of pesticide use, but also increase the likelihood of resistance by restricting the damage control portfolio of farmers and making them dependent on a small set of pesticides.

Regulatory compliance poses additional challenges. Pesticide application guidelines are far from binding and leave users with considerable latitude. Enforcement is difficult because pesticide contamination is a nonpoint-source pollutant; for example, many farmers may contribute to contamination of a watershed. However, new technologies make monitoring and enforcement more feasible. California has developed a strong regime of pesticide-use reporting that capitalizes on wireless technologies.

The value and effectiveness of pesticides can vary by chemical, crop, location, application technology, weather, and other factors. Policy must recognize this heterogeneity and aim to permit pesticide applications where the total social benefits exceed the total social costs. A pesticide fee, for example, would discourage chemical use in instances when the benefits are small. Another policy option to achieve more efficient pesticide use would be a regional cap-and-trade program (similar to the sulfur dioxide trading program under the Clean Air Act) that limits the use of pesticides in a region and permits farmers to trade allowances.

Regulators can go one step further and develop incentives that vary by location, recognizing that contamination of a certain area poses greater risk to environmental services, biodiversity, and human health than in others. In the same vein, policies should provide disincentives for application technologies that result in drift and runoff, such as aerial spraying. Incentives that account for all forms of heterogeneity may be too costly and information intensive from a regulatory standpoint, but to the extent policy can rely on new information and communication technologies and employ economic instruments, it should.

The introduction of better monitoring and traceability requirements can lead to reliance on financial incentives that penalize misuse and reward decisions that lead to environmental benefit, such as carbon sequestration. Pesticides have been essential in enhancing agricultural productivity and improving human welfare, but they have substantial negative side effects. It is crucial to develop systems that result in better products and improve pesticide use. Pesticide regulation should be an ongoing activity that takes advantage of new scientific and technical capacities, utilizes better information, and incorporates more intensively refined and enforceable incentives that result in better outcomes.

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41. WHY WE NEED TO TREAT NITROGEN AS A SYSTEMS PROBLEM

Andrew Manale,
with the U.S. EPA's Office of Policy, Economics, and Innovation, has analyzed a wide range of environmental policy issues, generally from a systems perspective, for various levels of federal and state governments, nonprofit organizations, and the private sector.

A discussion of the sources and environmental impacts of reactive nitrogen is followed by an examination of why a comprehensive portfolio of policy approaches is needed to contain nitrogen pollution.

Too much of a good thing leads to a decline in our well-being.

Nitrogen is an essential element in the building blocks of life, constituting 80 percent of Earth's atmosphere. Though surrounding us in vast quantities, nitrogen exists in a biologically inaccessible (inert) form, with only about a thousandth of 1 percent biologically available. Nature—through the electrical process of lightning, biological fixation, and combustion—makes it available in a reactive form (rN), literally out of thin air. With it, life blooms because it is generally the limiting factor for growth. With too much in its reactive form, though, fragile systems within which flourish higher life forms, such as mammals and reptiles, fail.

Before the German chemist Fritz Haber in 1909 discovered a ready means for creating large quantities of rN, societies recycled it. Human "night soil" and animal manure were collected and applied to the land as fertilizer. It was scarce, hence it was valuable. Where there were virgin lands, such as in the New World, early settlers mined soils for their nitrogen, moving on when soils failed. Haber's technological breakthrough made rN abundant. Forty percent of all humans now alive owe their existence to anthropogenically created rN because of the additional food production it has facilitated. But with abundance comes waste and ever more rN lost to the environment, harming ecological systems more than it benefits them.

Excess rN causes myriad environmental problems. Atmospheric emissions that have increased fivefold since preindustrial times contribute to the formation of ozone, a major air pollutant. Atmospheric deposition rates now exceeding natural rates by more than tenfold and too much nitrogen-containing runoff from the land reduce the biodiversity of ecosystems and degrade the quality of rivers, lakes, streams, and estuaries for all uses. Severe eutrophication of 44 estuaries along the nation's coasts can be attributed to rN. The excess rN that causes hypoxia (low oxygen levels) in marine environments now accounts for over 200—and growing—dead zones around the world, doubling in just 10 years.

When overapplied as chemical fertilizer or deposited as acid rain, rN can acidify waters and soils, damaging crops and forests and lowering economic output. In drinking water, it can cause health problems in infants, such as blue-baby syndrome. And under oxidative conditions, agricultural soils, nitrate-saturated rivers and streams, and episodic dead zones become sources of nitrous oxide (N_2O), a greenhouse gas with over 300 times the warming potential of carbon dioxide, the primary greenhouse gas.

Humans have more than doubled the total annual global production of rN over natural levels, a rate that is accelerating. Fertilizer rN accounts for some 38 percent that is anthropogenically introduced. Other sources include burning of biomass, land clearing, and the draining of wetlands, all of which release stored (sequestered) nitrogen into the environment (33 percent); legumes, such as soybeans (19 percent); and combustion of fossil fuels (10 percent and growing). With economic growth in the developing world, its imbalance in ecosystems will correspondingly increase, as wealth drives meat and dairy consumption and the crops that feed livestock. Wealthier societies also consume more electrical power, generated largely through the combustion of fossil fuels. Fertilizer demand grows at over 3 percent and electricity generation at 2.9

percent a year.

The problem of the introduction of ever greater amounts of rN would not be so severe were the rate of the reverse process—the rate at which reactive nitrogen is converted back to inert nitrogen (denitrification) or the rate at which reactive nitrogen is biologically sequestered in soils and plants—growing as well. No longer can we count on natural denitrification and sequestration processes, such as those that occur in wetlands, seasonally wet agricultural soils, and marine environments, nor grasslands and forests to serve as "sinks," for tilling soil and land conversion release rN from its organic complex. There are plenty of economic incentives to increase the amount of rN introduced into the environment; few or no private incentives exist for denitrification, except where clean water is scarce.

Despite successful national regulatory programs for nitrogen, there are gaps in controls. Clean Air and Water Acts regulations cover air emissions of nitrogen oxides and water emissions of rN from large point sources, such as sewage treatment plants. However, continued economic growth—and hence industrial and commercial activity—only heightens the need to do ever better just to maintain current levels. Moreover, not all sources of rN are regulated. Agriculture, which is largely outside EPA's regulatory authority, is the primary user of fertilizer. Voluntary interventions for managing the loss of rN have had mixed success.

More importantly, interventions to date have treated rN as a conventional pollutant for which a control technology is identified and imposed. Many of these interventions simply shift reactive nitrogen from one medium to another rather than destroy or capture it in long-term storage, such as in sustainably managed soils. Nitrogen contained in municipal sewage sludge applied to the land and not managed sustainably can be released to water bodies in rainwater runoff. Thus excess rN in the environment is a systems issue where sources, sinks, and control options vary across the landscape. Economic interests, left unchanged, favor increased generation and environmental emission of reactive nitrogen.

Imbalance of rN in the air, water, and soil is perhaps the best single indicator that the environment is not being managed sustainably. Nitrogen is tied to other chemical cycles, such as carbon and water. Mismanagement of one leads to imbalances of the others.

The following example illustrates the magnitude of the problem. The great majority of nitrogen other than in its inert form is locked up in soil organic matter—1.5 million times a million metric tons (1,500 petagrams, or Pg). All plants and animals, in contrast, only contain 1 percent as much (15.2 Pg). Most of this organic nitrogen is contained in arctic and boreal soils that have, for thousands of years under permafrost conditions, accumulated both carbon and nitrogen. If ecosystems are managed unsustainably, especially given the increasing threat of global warming, that stored nitrogen could be released, overwhelming any current regulatory effort.

Just reducing fertilizer use, as economic theory has dictated in the past, will not suffice if major emissions come from broadscale land modifications and land-use changes. As developed and developing nations demand more agricultural production of food, feed, fiber, and now fuel, the problem escalates. The seemingly small changes to our ecosystems over many generations—such as the draining of wetlands, the straightening of rivers, agricultural monoculture, and confined animal feeding operations—aggregate to the very large impact experienced today.

Without a new focus on reducing excess rN in the environment, a decline in well-being, evidenced by degradation of habitat and our soils and water, will ultimately affect human health, whether through degraded water quality or increasing global temperatures or loss of biological species. A systems problem, such as rN, requires a systems solution that addresses the multiple objectives inherent in managing ecosystems and the linkages between levels of rN in soil, water, and air, and management of the carbon cycle and water resources.

How does one deal with a systems reactive nitrogen problem? Store it, through land-use and management practices that put carbon back into the soil and protect and restore wetlands, which sequester rN. Destroy it by protecting denitrifying aquatic and terrestrial systems. And, of course, what civilizations that preceded us learned through wisdom accumulated through the ages—we can recycle it, making commercial use of waste products containing rN and transforming waste into a valued commodity.

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The views expressed here do not necessarily represent those of the U.S. Environmental Protection Agency or other federal entities. No EPA endorsement should be inferred.

42. THE EFFECTIVENESS OF VOLUNTARY ENVIRONMENTAL PROGRAMS

Richard D. Morgenstern
is a senior fellow at Resources for the Future. His research focuses on the costs, benefits, evaluation, and design of environmental policies, especially economic incentive measures.

William A. Pizer
specializes in environmental policy evaluation, with a particular focus on climate policy. This commentary was completed while he was a full-time senior fellow at Resources for the Future.

Drawing on case studies of seven voluntary environmental programs across the United States, Europe, and Japan, this commentary discusses the effectiveness of such programs, their pros and cons, and their possible role as a complement to mandatory emissions control policies.

Voluntary environmental programs have been multiplying at an explosive rate since the early 1990s in the United States and many countries abroad. The trend reflects growing optimism about the possibilities of cooperation between government and business. It also is fed by frustration with the long and expensive battles that often arise from regulatory controls. But how much actual impact are the voluntary programs having?

Our own findings, drawn from research on a number of programs, are that they are having a real but limited effect. Compared with a credible baseline, they reduce releases of pollutants by probably not more than 5 percent.

Now a 5 percent reduction is not trivial: many nations have commitments under the Kyoto Protocol that are roughly of that order of magnitude (although the United States and Canada would impose much larger requirements). In addition to near-term reductions, voluntary programs may influence corporate attitudes and management practices, leading in time to broader-scale improvements in performance.

But it is hard to argue for voluntary programs where there is a clear desire for dramatic changes in behavior, as would be required to achieve virtually any of the goals now being discussed in Congress.

Out of the thousands of these programs now in operation, which cover a wide range of environmental issues, we chose seven prominent examples (Morgenstern and Pizer 2007) for a close look, including EPA's 33/50 program aimed at toxic releases, along with energy or carbon dioxide reduction programs in the United States, Europe, and Japan. While the U.S. programs all involve participation criteria established by government, the UK, Danish, and Japanese programs we studied rely on explicit negotiations between industry and government to set emissions reduction goals and other parameters of agreement. In contrast, all the key programmatic decisions in the single German program examined were made by industry.

Even though most of the programs had extensive operating experience, our evaluation was hampered by concerns about the self-selection of participants—those firms that participated may be planning to do the relevant activities anyway, which would generate coincidental reductions—and by the absence of good emissions or energy-use data derived from a well-defined baseline.

Voluntary programs offer valuable opportunities for firms to get practical experience with new types of environmental problems without the straitjacket of mandatory regulation. In the process, firms are able to enhance their reputations with a broad range of constituents. These programs also give government agencies a similar chance to deal with new challenges and new industries, sometimes with more holistic approaches than the media-specific, end-of-pipe focus of most existing legislation.

On the other side of the ledger, voluntary programs are limited by the absence of clear price or regulatory signals to push changes in corporate or consumer action, or to stimulate demand for cleaner technologies. "Free riding," where some firms avoid making any effort while others voluntarily address a problem and keep further regulation at bay, may be an issue in some cases. Arguably, a voluntary approach may

shift attention from the biggest polluters—which may be the source of both more emissions and more low-cost emissions reductions—to cleaner firms that emit less and have already taken significant action. Some in the environmental community see voluntary programs as a distraction from the real work of taking mandatory action.

Extensive work has been done on the motivation for firms to participate: doing so may help preempt the threat of regulation, influence future regulation, improve stakeholder relations, or gain competitive advantage. Several studies have shown the importance of public recognition to be a key inducement. The nature of the firm's market may also be important as well as the willingness of its customers to pay for green products.

Incentives offered by some voluntary programs to firms that join and take stipulated actions can affect the magnitude of the efforts they make. Among the voluntary programs that we studied closely, those that provide greater financial incentives or relief from other requirements seem to facilitate larger results than those without incentives, although the difference is not significant. However, incentives may draw more firms into the program and thereby increase its impact by multiplying the number of contributors. Consequently, environmental results may be enhanced by expanding participation rather than seeking deeper cuts from a limited number of firms.

Another question is whether, under voluntary cooperation, the initial gains will persist over time, both as the program is broadened and more participants come in, and as the original participants mature. Among the cases that we studied, the evidence showed that some initial gains may not persist. Typically, the most profitable gains are taken early and the most cooperative firms join first, with the result that the program may lose momentum over time. Or it may be that program participants are simply taking actions earlier than other firms would within a few years.

In designing a voluntary program, significant initial considerations must be the targeted environmental mediums and the activities being addressed. If it is a novel and unstudied area, or one that involves clear impacts on local communities—as was the case with toxic pollutants 20 years ago—there may be opportunities for more significant improvements at low cost. At the same time, if it is an area that has already been carefully scrutinized with fewer local consequences, as we believe the case to be for energy efficiency, effective opportunities are less likely.

At the end of the day, voluntary programs can indeed affect behavior and produce environmental benefits—but the limitations are clear. These programs make sense when mandatory action seems premature or lacks legal or political support. They are a useful step when mandatory programs will take a long time to implement. But we have seen no solid evidence that voluntary action can produce sharp and truly fundamental improvements in environmental protection.

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43. DOES GREEN CORPORATE SOCIAL RESPONSIBILITY BENEFIT SOCIETY?

Thomas P. Lyon
is the Dow Professor of Sustainable Science, Technology and Commerce at the University of Michigan's Ross School of Business. His research interests include environmental information disclosure, corporate greenwash, voluntary environmental programs, nongovernmental organizations, and renewable energy.

John W. Maxwell
is a professor of business economics and public policy at Indiana University's Kelley School of Business. He specializes in business strategy in the nonmarket environment, with a focus on interactions among firms, government, and special interest groups.

What does corporate social responsibility (CSR) actually mean in an environmental context? The case for or against CSR from a broader social perspective is rather nuanced and calls for examining instances of CSR on a case-by-case basis to judge whether it provides overall net benefits, or net costs, for society.

Corporate social responsibility (CSR) is not a new concept, but over the past decade its focus has shifted from labor issues and local philanthropy toward environmental actions. More and more companies desire to go green and are building to Leadership in Energy and Environmental Design (LEED) certification standards, joining the Chicago Climate Exchange, and producing corporate social reports to make public their environmental performance in accordance with the Global Reporting Initiative. Numerous factors are driving this trend, including managerial altruism, cost-cutting efficiency improvements, the emergence of a new generation of green consumers, and savvier business leaders who take proactive steps to avert political conflict rather than reacting to public pressure after the fact. Despite creeping concerns that some of the resulting corporate actions may be mere "greenwash," for the most part they are welcomed by employees, consumers, investors, regulators, and the public. But is it really socially desirable for managers to take on costly environmental initiatives that are not required by law?

WHAT DO WE MEAN BY CSR?

One of the perplexing things about CSR is that it has long meant different things to different people. To some, an action only counts as true CSR if it is unprofitable and hence motivated by altruism. This was the position taken by Milton Friedman in his highly influential 1970 *New York Times Magazine* article on the social responsibility of business. In this view, socially beneficial actions that increase profits are merely strategic CSR, or in Friedman's words, "hypocritical windowdressing." However, even advocates of altruistic CSR admit that most CSR actions can be viewed through a strategic lens. Thus we take a pragmatic perspective and define environmental CSR simply as environmentally friendly actions not required by law, encompassing both possible motives.

IS CSR GOOD FOR SOCIETY?

One familiar argument against CSR is that it imposes a manager's preferences on a whole group of shareholders, who might prefer to allocate their charitable contributions in different ways. This is a powerful argument in a world where shareholders are motivated solely by maximizing the monetary earnings from their investments, the market for charitable donations is perfectly competitive, and the political marketplace efficiently internalizes all environmental externalities. If these assumptions do not hold in practice, however, the distinction between "altruistic" and "strategic" CSR blurs, and the argument against CSR weakens.

Socially responsible firms can be viewed as a vehicle for combining an investment with a charitable contribution, which can be attractive to investors since it avoids both taxation of corporate profits and the transaction costs of personal giving.

Even if investors prefer to make direct charitable donations, socially responsible firms can still survive in the marketplace, although they will trade at a discount to

other firms. If investors are informed about the firm's CSR activities at the time they invest, then it is the entrepreneurs who have created the firms that bear the cost of the CSR activities, not ordinary shareholders. The entrepreneur's creation of a CSR firm is a gift to society—he or she benefits from starting the firm, investors benefit from the expanded range of investment opportunities, and the recipients of CSR benefit directly.

Even if CSR offers some benefits to investors, the question remains: is it more appropriate for altruistic managers and shareholders to work through the political system rather than through corporate voluntarism? If legislators and regulators actually pursue the public interest, there is little scope for CSR to improve on enlightened government regulation. However, many would argue that regulatory agencies are often captured by the companies they regulate, implying that the political marketplace is far from efficient. If so, then the welfare effects (or net benefits) of strategic CSR depend on the political context in which it occurs.

Even when politicians are well intentioned, government regulation can be a cumbersome and costly enterprise. As a result, CSR can be a less costly substitute for government mandates, and hence increase welfare. Industry self-regulation that preempts legislation is typically welfare-enhancing because consumer groups can intervene in the political process if they find the firm's CSR efforts unsatisfactory. Similarly, if CSR is executed through voluntary agreements with regulators, this improves welfare as long as the regulator has society's best interests at heart. However, there is no guarantee that society gains if regulators are influenced by particular interest groups with narrow agendas.

CSR activities may influence regulatory decisions in several ways. CSR can benefit society by signaling to regulators that pollution abatement is not prohibitively costly, encouraging new regulations that may produce a competitive advantage for the signaler. However, if leading firms make modest environmental commitments, this may induce regulators to eschew tough environmental standards, potentially making society worse off. A company's CSR investments may also induce regulators to shift enforcement resources toward other firms that are more likely to be out of compliance with regulations. This can be beneficial for society, but there is also a risk that firms will become overzealous in their CSR efforts as they attempt to deflect regulatory attention toward other firms.

Over the past decade, there has been a rise in direct engagement between firms and environmental nongovernmental organizations (NGOs). While sometimes hostile, this engagement can also take the form of a partnership where an NGO advises a firm and then endorses its green products and services, often through a formal certification program such as the Forest Stewardship Council for forest products or the green-E scheme for renewable energy and carbon offsets. In an unregulated market, NGO approval can increase sales of environmentally friendly products and therefore enhance social welfare when consumers switch from "brown" to green products. When there is a possibility of government regulation, however, NGO involvement does not necessarily enhance social welfare. The existence of an NGO certification scheme can induce firms to lobby against government standards that might be of even greater value to society.

Firms have multiple motives for undertaking CSR, and its welfare effects are highly contingent on the institutional context in which it is undertaken. This makes it a fascinating field for researchers but a potentially tricky one for citizens and policymakers.

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44. THE EVOLVING SO_2 ALLOWANCE MARKET

Title IV, CAIR, and Beyond

Karen Palmer
is the Darius Gaskins Senior Fellow at Resources for the Future and the director of the Electricity and Environment Program. She specializes in environmental and public utility regulation.

David A. Evans
is an economist at the U.S. EPA's National Center for Environmental Economics, specializing in regulatory design, stated preference methods, and evaluation of federal air quality regulations.

While the sulfur dioxide cap-and-trade program has been highly successful in generating substantial pollution-related health benefits at relatively low cost, this commentary suggests ways to make the program still more efficient. Recent regulatory initiatives are also considered, as well as how they may have contributed to recent volatility in SO_2 allowance prices.

Recent congressional debates over a potential cap-and-trade program to combat global warming have brought renewed attention to the sulfur dioxide (SO_2) cap-and-trade program established in 1990 under Title IV of the Clean Air Act. This program has brought about large reductions in SO_2 emissions from the electricity sector and at a dramatically lower cost than originally anticipated, demonstrating that cap-and-trade programs can work in practice as well as in theory. However, researchers have identified potential improvements to the program, and regulatory initiatives are motivating further SO_2 reductions. These initiatives, in turn, have been subject to legal uncertainty that has influenced the market for SO_2 allowances.

TITLE IV

The primary motivation for the SO_2 program was to reduce ecological damages from acid rain—the deposition of sulfuric compounds into soils and waterways—in regions distant from emitting power plants. Under the program, firms are required to surrender one allowance for each ton of SO_2 emitted. Firms may transfer allowances to other firms and bank them for future use. While there are few restrictions on allowance transactions, there are strict emissions monitoring requirements, which provide regulators confidence in the environmental performance of the program and affected firms confidence in the market.

The goal of the program is ultimately to cap annual emissions from electricity generators to 8.95 million tons, a 10 million ton drop from the 1980 level. Reductions to achieve this goal have taken place in two phases. Phase I began in 1995 and affected the 110 dirtiest coal-fired generating facilities. In Phase II, which started in 2000, most other coal-fired facilities came under the program, and the allocation of allowances to Phase I sources was reduced by slightly over half. Emissions reductions have resulted largely from installation of postcombustion scrubbers and a shift from high-sulfur coal from the East to western low-sulfur coal, which was facilitated by lower freight prices following railroad deregulation.

While the program was motivated by concerns over acid rain, it has also reduced fine particulate matter concentrations, creating health benefits that are an order of magnitude greater than the costs of the program. Reductions in acid deposition have produced ecological benefits as well, but those estimated benefits are small relative to the human health benefits.

IMPROVING UPON THE TITLE IV PROGRAM

Despite the success of the Title IV program to date, significant improvements in SO_2 control can be made along two dimensions: the level of the cap and the location of emissions.

For the current cap, the marginal cost of reducing emissions is around $150 to $300 per ton, which is well below the $1,800 to $4,700 per ton estimates of the marginal

benefit of further reductions. An annual cap that maximizes the net economic benefits of the program would be between 1 million and 3 million tons and yield a $3.6 billion to $23.5 billion increase in annual net benefits.

Requiring plants that cause more damages due to their location to surrender more allowances per ton emitted than those that cause less damage would also increase the benefits of the program. The estimated annual gains from such spatial refinement are around $310 million to $940 million.

Another potential improvement to the regulation of SO_2 would be to use an emissions tax approach. Given that the damage from an additional ton of emissions is roughly constant with respect to SO_2 emissions levels, a tax per ton equal to the additional damage is a preferable method for controlling SO_2 as the tax will always yield an emissions level that maximizes net benefits regardless of the level of control costs. This is true even if SO_2 control costs change because of the regulation of other pollutants, such as carbon dioxide.

RECENT POLICY DEVELOPMENTS AND ALLOWANCE PRICE FLUCTUATIONS

In May 2005, EPA adopted the Clean Air Interstate Rule (CAIR), which both effectively reduces the Title IV cap and treats facilities differently based on their location. In part, the purpose of CAIR is to reduce SO_2 emissions in upwind states that contribute to violations of EPA's primary ambient air quality standards for fine particulates in the eastern United States. The primary ambient standards are intended to be protective of human health. The CAIR SO_2 program applies only to facilities in 25 eastern states and the District of Columbia. Sources subject to CAIR must surrender 2 Title IV allowances for every ton of emissions from 2010 to 2014, and 2.86 allowances for every ton thereafter.

In July 2008, the DC Circuit Court of Appeals vacated CAIR in part because the trading program could not assure protection of downwind ambient air quality; however, in December 2008, the court allowed EPA to administer CAIR while it develops a replacement program. The form of the replacement EPA will adopt is unknown, but modifying a cap-and-trade approach to meet these concerns may be both more effective and less costly than a conventional approach, such as imposing emissions rate standards. Furthermore, while it is possible for the allowance market to move emissions across space, it is also possible for the electricity market to do the same with an emissions rate program.

The allowance price provides information regarding market conditions and expectations, and we see this in the market response to the CAIR rulings. For example, when CAIR was vacated, the price of an allowance that can be used this year (that is, the spot price) fell from $300 to $80, and on news of the decision to temporarily reinstate CAIR, the price rose from $140 to $210. Currently, 2010 allowances are trading at about half the $70 spot price, reflecting expectations that the CAIR 2-to-1 2010 compliance rate will hold in the near term. The long term suggests a different story. In March 2009, EPA auctioned Title IV allowances that can be used beginning in 2016. The clearing price for these allowances was $6.65, about two-thirds lower than the price suggested by a combination of the 2016 2.86-to-1 compliance rate and recent prices of allowances that can be used after 2010.

The CAIR rulings, current financial conditions, and depressed electricity demand help explain recent declines in the spot price. However, it is not clear why the recent auction price for 2016 allowances is low relative to the current spot price, although there are a few possible explanations. Notably, EPA has suggested that it will take about two years to develop a replacement for CAIR. If the replacement does not implicitly adjust the Title IV cap through compliance rates, as the court's ruling seems to prohibit, then the Title IV cap would become slack. Expectations of future carbon dioxide regulation may also be influencing the allowance price. For example, EPA climate bill analyses, which include CAIR in the baseline, forecast about a 60 percent reduction in the Title IV allowance price from capping carbon dioxide, but they also predict a decline in the spot price.

CONCLUDING THOUGHTS

The SO_2 trading program has been a success, but there is still room for improvement. The regulation of SO_2 will continue to develop over time, which is a lesson for the design of new cap-and-trade programs. An advantage of a cap-and-trade program is that the allowance price provides information about how the market views changing market conditions and the likelihood of future regulatory developments.

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The views expressed here do not necessarily represent those of the U.S. Environmental Protection Agency or other federal entities. No EPA endorsement should be inferred.

45. THE COOLING WATER INTAKE STRUCTURES RULE

Winston Harrington
is a senior fellow and an associate director of research at Resources for the Future, specializing in urban transportation, motor vehicles and air quality, and environmental policy cost assessment.

Why was EPA unsuccessful in its attempt to introduce more flexibility and cost–benefit considerations into traditional technology-based regulations governing the use of water for cooling systems?

Typically, technology-based (TB) regulation involves the Environmental Protection Agency (EPA) identifying a technology that meets some conception of "best" performance (as defined in legislation) and then establishing a standard that achieves this level of performance. The costs, expected environmental improvements, or the value of those improvements are not taken into account in setting the standard. In one recent case, however, EPA took an alternative approach, calling instead for minimization of adverse environmental impacts, which gives regulated plants more flexibility than usually permitted.

The case involved Section 316(b) of the Clean Water Act, which regulates water withdrawals for cooling purposes and the accompanying return flows. A steam-electric plant, for example, may draw millions of gallons per day and the intake flows may cause mortality among crustaceans, fish, and even diving birds, by pinning them against screens (impingement) or sweeping them into the cooling system (entrainment). In fact, these processes can affect entire aquatic ecosystems by killing eggs, juveniles, and small organisms at the bottom of the food chain. Moreover, the water itself discharged from cooling systems can further affect aquatic ecology, by eliminating species sensitive to heat and favoring more heat-tolerant species that may not be natural to the local area.

As required under the statute, EPA identified the "best technology available," closed-cycle cooling, which minimizes thermal releases, impingement, and entrainment through the use of cooling towers that draw much less water. Following executive orders mandating regulatory impact analyses (RIAs) on major rulemaking processes, however, the Office of Management and Budget recommended removing this technology requirement and suggested a compliance option based on a plant-specific comparison of benefits and costs. The final rule, issued in 2004, was a complicated but flexible approach to TB regulation, involving several components.

Among the most important of those were a baseline against which performance was to be measured, namely the estimated mortality of marine organisms at a facility with "once-through" cooling and no controls on impingement or entrainment; a performance standard requiring both an 80 to 95 percent reduction in impingement mortality (compared with the baseline) and a 60 to 90 percent reduction in mortality from entrainment; and the identification of two designated technologies that EPA felt would meet the performance standards: a closed-cycle cooling system and a special screen designed to minimize mortality from withdrawals. Unlike most TB performance standards, these standards were based not on the capabilities of the technology but directly on the estimated effect of the technologies on the natural environment. EPA's rule would allow a steam plant even further departures from the usual practice in TB regulation, including investment in ecological restoration measures that would, on net, reduce the mortality involved in water withdrawals and return flows, or a demonstration that it was entitled to a site-specific determination of compliance technology because the cost of adopting the designated technology would be significantly greater than the costs estimated in the rule or the expected benefits at the site.

INNOVATIONS

These measures were both innovative and controversial. EPA recognized that the costs and biological effectiveness of abatement technologies for cooling water intake systems depended on local configurations and conditions, and on the local aquatic environment and its species. The desire to bring environmental effects into the rulemaking led the agency to an unusual definition of performance standards. Customarily, EPA defines the performance standard in terms of the performance of the technology itself, such as percentage reduction in emissions compared with no treatment. For this rule, the standard was written in terms of the effects on natural organisms—percentage reduction in mortality from impingement and percentage reduction in entrainment.

Other features were equally novel. While the use of compensatory restoration had for years been an option for developers seeking permits from the Corps of Engineers to alter wetland environments, this was among the first attempts to use it in more traditional regulation. And the site-specific cost–benefit analyses had a rough parallel in the "footprint" approach to the CAFE regulations for light trucks promulgated in 2005. Those regulations set manufacturer-specific standards based on the expected cost to manufacturers of modifying each model in their truck fleet. This feature exceeds even the requirement for regulatory impact analyses—that the total benefits of a rule justify the total costs. Indeed, the cooling water intake structures (CWIS) rule considered the potential of not just total but marginal cost–benefit comparisons. This is much closer to economists' conception of how benefit and cost information should be used.

For EPA, estimating expected costs and benefits was complicated by the site specificity of cooling water intake systems. On the cost side, EPA was uncertain whether the lowest-cost compliance alternative would actually meet the performance standards at particular plants, so a more costly technology had to be assumed.

On the benefits side, EPA had to determine the physical and biological effects of the regulation, quantify those changes, and then estimate (in dollars) the value of those changes. Some categories of benefits resisted the final valuation step, and some could not even be quantified.

Ultimately, the only benefits valued were the benefits to commercial and recreational fishing. Costs of the rule exceeded benefits by a factor of about five. As this ratio makes clear, the nonmonetized benefits did receive consideration in the analysis, but necessarily were left out of the cost–benefit comparison.

THE LEGAL CHALLENGE

The cooling water intake structure rule was challenged by states, environmental groups, and the utility industry. The individual appeals were merged into a single case (*Riverkeeper, et al. v. U.S. EPA*), which was decided in January 2007.

The U.S. Court of Appeals for the Second Circuit ruled that EPA's use of cost–benefit analysis was an incorrect reading of the statute. The "best technology available" performance standard precluded the balancing of benefits and costs, it said; the only legitimate question here was whether the cost of meeting the performance standard was something that industry could reasonably bear (and the court observed that several plants had already installed the designated technology).

The court then called on EPA to tighten up the ranges in the performance standards so that a plant could not get away with minimum performance: the plant should do its best, not the minimum. The court also rejected the use of restoration as a compliance alternative, ruling that restoration was not "minimization" but impermissible "compensation" for environmental impacts, and in any event, restoration was not "technology." Finally, the court remanded the site-specific compliance alternatives—the cost–cost test and the benefit–cost test. Thus, most of the rulemaking innovations were either rejected outright or remanded to EPA for clarification.

EPA subsequently suspended its cooling water intake rule and has not yet issued revisions. Meanwhile, industry petitioners appealed the decision to the Supreme Court. In its decision, rendered on April 1, 2009, the court reversed the appeals court and ruled that EPA may, at its discretion, use cost–benefit analysis in the CWIS rule. The rule was remanded to EPA, which, of course, is not the same EPA that promulgated the original rule. At this writing, the agency has not indicated whether the rule will be revised.

The story of this regulation illustrates not only the legal difficulty of building flexibility and cost–benefit consideration into technology-based rules, but also the conceptual difficulty of basing regulatory decisions on the likely consequences if the knowledge base for determining those consequences is deficient. This is not to say that a conventional technology-based standard would perform any better. It is difficult to determine whether, by limiting the flexibility of plants in meeting environmental standards, the court improved matters or made them worse.

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46. THE FUTURE OF REGULATORY OVERSIGHT AND ANALYSIS

Susan E. Dudley
served as the administrator of the Office of Information and Regulatory Affairs (OIRA) at OMB from April 2007 through January 2009.

Art Fraas
is a visiting fellow at Resources for the Future and the former chief of the Natural Resources, Energy, and Agriculture Branch of OIRA at OMB. Much of his work has examined the federal regulatory process, with a particular focus on the impact of environmental regulations.

What is the role of the Office of Information and Regulatory Affairs (OIRA) in providing independent assessments of the benefits and costs of agency rulemakings? How might regulatory oversight and analysis be improved by creating an earlier review process for important regulations and expanding the scope of OIRA's coverage to the so-called independent regulatory agencies?

As the Obama administration advances its agenda for change, many of its most important actions will be implemented through regulations. Compared to programs financed directly through taxes, the effects of regulations—their benefits and costs—are less visible and less well understood. Particularly in today's economic climate, a careful and deliberate consideration of the effects of regulatory actions, facilitated by effective, centralized review, is important to ensure regulations are accountable to the American people.

Like presidents before him, President Obama recognizes the importance of the "dispassionate and analytical 'second opinion' on agency actions," that the Office of Information and Regulatory Affairs (OIRA) within the Office of Management and Budget (OMB) provides, and is seeking ways to improve this regulatory oversight function. Here we provide recommendations on what has worked and what could be improved.

WHAT WORKS

Centralized regulatory review has withstood the test of time. While regulatory agencies tend to shape their decisions to accommodate the interest groups most directly affected, OIRA's mandate is to advance the general public interest. OIRA currently operates under President Clinton's 1993 Executive Order (EO) 12866, which requires centralized, coordinated review of regulations and states that agencies should "adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs."

Cost–benefit analysis: not perfect, but the best we've got. Presidents over the last three decades have recognized that while cost–benefit analysis (CBA) is not perfect, it is the best tool available for understanding the effects of potential regulations and determining whether regulatory alternatives will do more good than harm. CBA provides an extremely useful framework for decisionmaking by identifying the underlying problem to be solved, identifying and evaluating alternative regulatory (and nonregulatory) approaches, and organizing this information in a consistent, coherent, and comprehensive way. Though it does not serve as the sole basis for crafting regulations, it does help decisionmakers consider a wide range of possible effects. EO 12866 directs agencies to "select those approaches that maximize net benefits (*including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity*), unless a statute requires another regulatory approach" (emphasis added).

Analyzing and understanding distributive effects is a particularly important aspect of CBA because regulatory actions are sometimes regressive, imposing net costs on lower income groups or on other specific subgroups of concern. Even in cases where it is not regressive, regulatory action generally represents a relatively ineffective way of addressing concerns about income distribution.

Critics of CBA rightly point out that it will never be capable of quantifying all the

different effects of regulation, nor will any level of analysis allow government decisions to improve upon those that are best left to individuals acting on their own behalf. CBA is, however, still the best tool available for ensuring that when government action is appropriate, it is designed to make the public better off. Alternatives are bound to be less robust, less transparent, and result in decisions that are less well informed.

WHAT COULD BE IMPROVED

While the analytical framework established in EO 12866 remains generally sound, two changes to the executive order could make the review process more effective: (1) creating an explicit "early review" mechanism for major regulatory actions, and (2) subjecting independent agencies to executive oversight.

Early review. OIRA's review occurs after an agency has developed a proposed or final rule. Agencies often complete the regulatory analyses required by EO 12866 just in time for OIRA review—well after the agency has made key decisions on the draft rule. Regulatory analysis prepared after policy decisions are made often becomes an exercise in supporting the rulemaking. At this point, regardless of the merits of arguments raised during interagency review, regulatory agencies are understandably dug in and reluctant to deviate from a specific approach.

Furthermore, this end-stage review process has been susceptible to gamesmanship that undermines the purposes of the EO. Though the EO envisions up to 90 days for interagency review, reviews are often severely curtailed—sometimes lasting only a few days—because of internal agency delays combined with either an internal administration deadline or a statutory or court-related deadline. In March 2009, for example, after only one day of OIRA review, EPA published a proposed rule with estimated costs of $350 million per year and benefits of roughly $1 billion or more. The hasty review was necessitated by the obligation to meet a deadline arising from a settlement agreement.

This is not a new problem. Previous administrations have addressed it informally at the staff level, through briefings and discussions of early drafts of regulations subject to tight time frames. These informal reviews have raised questions, however, so in keeping with this administration's focus on transparency and its interest in increasing the integrity of the regulatory review process and the quality of analysis underlying its major regulatory initiatives, it should adopt a formal early review process for key regulatory issues. It would cover the administration's most significant rulemakings, including all major rules expected to have annual benefits or costs in excess of $1 billion.

Under this early review process, OIRA would formally designate key rulemakings, probably about 20 per year, after consultation with the affected agencies and other offices within the Executive Office of the President. After designating a rulemaking for early review, OIRA and the agency would form an interagency group to play an active role in both identifying issues and options and developing the associated regulatory analysis. This process would encourage broader discussion of options and issues at an early stage in the development of these rulemakings and provide greater policy consensus within the administration on regulatory decisions. In doing so, it would help to address the "endgame" confrontations between OIRA and the agencies and the resulting delays that arise under the current EO process.

Independent agencies. Some of the most highly publicized regulatory problems today stem from so-called independent regulatory agencies, such as the Securities and Exchange Commission, the Commodity Futures Trading Commission, the Federal Communications Commission, and the Consumer Product Safety Commission. These agencies have never been subject to the analytical or procedural requirements of executive oversight. Because they adopt regulations of enormous consequence to the nation, President Obama should subject their regulatory decisions to executive order review to ensure they provide net benefits to the public and do not duplicate or conflict with other government actions.

LOOKING FORWARD

As President Obama considers improvements to the regulatory analysis and oversight process, he should recognize that centralized oversight of regulatory development is essential for an accountable government, and, though not perfect, a goal of maximizing net benefits using a CBA framework provides the most transparent and robust approach to ensuring regulatory proposals make Americans better off.

While executive oversight has served presidents and the American people well for almost three decades, President Obama could improve the process by adopting a formal early review process for the most significant regulatory actions and holding independent agencies to the same analytical and oversight standards as other agencies.

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47. A PLEA FOR ENVIRONMENTAL ACCOUNTS

James Boyd

is a senior fellow at Resources for the Future and has carried out his research there since 1992. He studies the fields of environmental regulation and law and economics, focusing on the analysis of environmental institutions and policy.

This commentary discusses the case for creating a system of national environmental indices, analogous to the national income accounts. Unfortunately, however, there is much to be done in terms of both developing capacity to monitor environmental trends and developing widely accepted methods to weight or value different classes of environmental goods.

Over the last 80 years, our nation has moved from crude, limited measures of economic activity to an incredibly sophisticated system of national accounts. In the 1930s, if you wanted to know the state of the U.S. economy, you would have had to count boxcars traveling between New York and Chicago or the number of unemployed you could see in the streets. All we had was impressions of the economy, not measures that allowed for diagnosis, prediction, and cure.

We are at a similar moment today with respect to our natural economy—the environmental goods and services we don't pay for but that make all other economic activity possible. We know the natural economy is under stress and clearly in decline in some areas.

Unfortunately, we are at the "counting boxcars and breadlines" stage of seeing these changes. Our knowledge of natural systems is impressionistic, not systematic. The lack of well-documented, comparable, time-series data on environmental conditions hinders strategic efforts to address our fundamental environmental problems.

GDP allows us to see the market economy it measures. Green accounts will do the same thing. Without it, we are doomed to surprises, an inability to experiment and learn, and poor public accountability. Accounting systems exist because of a simple human truth: complexity is overwhelming, whether you're a household, business, or nation. Accounting embraces that complexity but ultimately simplifies it into a clear message.

It is upsetting to note that, by cutting off funds, Congress has for 15 years actively obstructed the development of environmental accounts akin to GDP. Madness? No, just politics. One can imagine certain industries or companies, for example, whose net contribution to society is negative once environmental losses are taken into account. For some, killing the messenger makes good political sense.

GDP: THE PROBLEM OR THE SOLUTION?

Some view our economic accounts, like GDP, as part of the problem. Even to its practitioners, GDP is unsatisfying because of what it leaves out—namely, goods and services that aren't bought and sold in markets. Household labor isn't there. Open source software isn't there. Random acts of kindness aren't there. And most of nature's goods and services aren't there.

At root, all GDP does is track the amount of things we consume, weight those things by the prices we pay for them, and add the result up. When GDP goes up, it means we are producing and consuming more things and more things of higher value. That is a reasonable way to measure things, as long as you're measuring everything.

But because of what is left out, GDP can easily deceive. GDP always goes up when we use more energy, develop more shopping centers, build more dams, and take more fish out of the sea. We know that can't be right. Read naively, GDP arguably lulls us into a false, excessively material view of our welfare.

But for all its problems, the *idea* of GDP is sound. GDP is a triumph of our political and economic system. It is systematic, objective, and politically insulated. There is nothing else like it. And the evidence that GDP matters is all around us. As it rises and falls, so do political fortunes. Capital markets move on its growth or decline. The press even pays attention.

What we need is an environmental analogue to GDP—a scientific, consistent, apolitical way to measure the health of our natural economy. Integrated accounts will allow us to pinpoint the most important adverse environmental trends and intervene accordingly.

Without objective accounts built on solid data, we will be doomed to squabbling, confusion, and manipulation by the cleverest purveyors of anecdotes and counterclaims. Imagine the quality of our economic policy debates if we first had to argue over the facts of GDP, consumer prices, and the labor market.

HOW TO DO IT?

It will be a challenge to create a set of national environmental accounts. It will require coordination among our federal and state agencies and confrontation with those whose interests are not served by a clearer view of the natural economy. Will it take a lot of money? That depends on your perspective. The 2010 census—another large data collection effort—is budgeted at $11 billion. If we spent just one-tenth of 1 percent of that sum on environmental accounts, it would be $11 million more than we currently spend (zero).

Once we find the political will to experiment with environmental accounts, the next step is practical measurement of natural goods and services. Resources for the Future (RFF) has an ongoing history of working on this exact measurement problem. If we are to create a green GDP, what should we count and how should we count it?

An economic account requires two things. First, clear definitions are needed of the goods and services to be counted. In order to avoid double-counting, GDP counts only final goods and services, not all the other inputs used to create them (though indices for inputs are also a part of our national accounts). An environmental index should have the same property: namely, we should count only *final* environmental goods and services.

What are final, public environmental goods and services? The issue is complex and one that RFF's research addresses directly. In the simplest terms, final goods are those things and qualities that individuals, households, and businesses directly make choices about. Many environmental goods and services are not final goods, but that does not mean they are not valuable. Rather, it means that their value is embodied in the value of the final goods. Consider a salmon population that is commercially or recreationally harvested. The salmon population is a final good, but the food chain on which the salmon depends is not.

Other final environmental goods and services include commodities like water supplies, timber, and open space. These commodities should be measured as place- and time-specific amounts, because their value depends on where and when they are available. Air, water, and soil quality are final environmental goods as well. We should also measure environmental services like reduced flood, fire, and disease risks because these too are valuable.

In almost all of these cases, goods and services should be measured as place- and time-specific commodities. Satellite monitoring and the growing availability of geospatial measurement will be very important to the measurement of goods and services.

Second, we need weights to attach to those final goods and services so that differences in the value of goods and services are reflected in the index. GDP uses market prices as weights. These are not ideal because market prices do not reflect the consumer surplus associated with consumption. But prices are the best practical measure because they are easily observable. Since the goal of an environmental index is to evaluate the contributions of public goods, we must find a substitute for market prices. This challenge should not be underestimated. Without the market's invisible hand to tell us the appropriate weights, the weights must be derived some other way. Economists have ways around this—that is, formal statistical derivations of willingness to pay for public goods—but the methods are more technically demanding, time-consuming, and controversial than the use of market prices that are observable to all. Moreover, once we have a goods and services "quantity index," we can use it to explore the effect different weights have on the overall index. In other words, we can show what *kinds of* weights lead to a declining versus increasing environmental index.

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48. THE POLITICAL ECONOMY OF ENVIRONMENTAL JUSTICE

Spencer Banzhaf

is an associate professor of economics at Georgia State University and a faculty research fellow at the National Bureau of Economic Research. His research focuses on the interactions among local environmental quality, real estate markets, and demographics.

Poor people and minorities are more likely to live in neighborhoods at greater risk of environmental hazards. To what extent, if any, might public policy intervention be warranted on the grounds of environmental justice, and what form should any such intervention take?

Over the years, the hard evidence, both documentary and academic, has shown convincingly that poor people and minorities are more likely than other groups to live in polluted neighborhoods. This pattern has been found again and again, in numerous places and with all sorts of pollutants. For example, disadvantaged groups live closer to hazardous waste facilities and landfills, live closer to large air polluters, and live in communities with higher measures of air pollution.

These findings have sparked the "environmental justice" movement, which has had mixed success in pushing its agenda. At the federal level, it won an important victory when President Clinton issued Executive Order 12898. Still in force, the order requires nondiscrimination in federal environmental programs and focuses federal resources on low-income and minority communities. However, the movement has failed to see an environmental justice act passed in Congress, though several have been introduced. It has also been rebuffed in its pursuit of legal action in federal courts under the Civil Rights Act. But other victories have come at the local level. Stakeholders have won a bigger voice in the approval process for new polluting facilities. And in one prominent case, local activists forced California's Southeast Air Quality Management District to settle a suit over the geographic distribution of pollution under its pollution trading program.

SOURCES OF ENVIRONMENTAL INEQUITY

But before prescribing any remedies for environmental inequity, it is essential that we understand the social mechanisms underlying it. Such mechanisms determine the nature and locus of any injustice, how a policy affects the distribution of pollution across places and population groups, and who bears the costs and who reaps the benefits of cleanups.

Consider just three of the most likely sources of the disproportionate pollution burden borne by disadvantaged groups. First, disadvantaged groups have less political power. Consequently, they may be less successful at lobbying government agencies to block polluting facilities in their neighborhoods. Likewise, they may be less successful at pressuring such agencies to monitor existing facilities for compliance with environmental regulations. Closing the circle, polluting firms therefore may seek out such communities for the very reason that they know they will not be scrutinized so closely. There is some evidence for this mechanism, with pollution increasing in areas with lower voter turnout. If the correlation between pollution and demographics lies in these mechanisms, then it arises from government failures. In this case, either governmental reforms are required or, alternatively, nongovernmental mechanisms for determining pollution patterns should be considered.

Second, disadvantaged groups may live in more polluted areas for the simple reason that to be poor means not having the resources to "purchase" the good things in life—including a clean environment. That is, the poor may not be able to afford to buy or rent a house or apartment in a clean neighborhood, which will be more expensive than one in a polluted neighborhood. The rich, on the other hand, can afford to pay

this premium. In other words, firms may make their polluting decisions based on factors that have nothing whatsoever to do with local demographics, yet households will move in such a way that the poor end up living nearer pollution. In this case, the source of environmental inequity is the more fundamental inequity in the distribution of income.

But this mechanism has an important implication: the observed demographic patterns arise from decisions that individuals have made to make the best use of their limited resources. Saving money for food and clothing through inexpensive housing may be a higher priority for the poor than a clean environment. A cleanup may cause a neighborhood to gentrify, increasing housing prices. While this represents a capital gain to owners, 83 percent of people poor enough to qualify for welfare are renters. For them, these costs are out of their pockets and can make the poor worse off in the end. In effect, the cleanup often forces the poor to pay a price they cannot afford.

A third and final mechanism may be that some communities have features that are attractive to both disadvantaged households and polluting firms. For example, both may be attracted to lower real estate prices. Moreover, real estate prices may be lower near transportation corridors like highways or railroads. The poor live near them because of these lower costs; polluting facilities may locate near them because the transportation route reduces the cost of moving manufactured goods or wastes. And finally, both poorer households and polluting facilities may be mutually attracted by low-skilled labor markets. In this case, the correlation between pollution and disadvantaged groups again arises from the simple fact that these groups have lower incomes. The effect is reinforced by the unhappy coincidence that some features of the inexpensive communities affordable for the poor are actually attractive to polluters.

AVOIDING UNINTENDED CONSEQUENCES

For existing cleanup efforts such as the Superfund and brownfields programs, these mechanisms suggest guidelines that can help minimize unintended consequences like gentrification. Two recommendations stand out. First, as emphasized by the National Environmental Justice Advisory Council, projects should involve local participation. This will increase the likelihood that new amenities fit the preferences of incumbent residents rather than those of prospective gentrifiers. Second, projects might prioritize areas with high rates of home ownership, where local residents will capture the full value of the cleanup.

But there is a larger point at stake. When experiencing poor environmental quality is a consequence, rather than a cause, of poverty, then cleaning up the environment to help the poor is like treating the symptom rather than the disease. Some symptoms, like a moderate fever, represent the body's best efforts to heal itself. In such cases, treating the symptom may actually be counterproductive. This does not mean there is no role for a physician. But the best physician facilitates the body's natural healing processes. Like the body, the market is a remarkably efficient machine.

Accordingly, the best way to help disadvantaged groups may be to empower them, strengthening their position within the market system. Redistributing income to the poor, for example, would provide them with more resources to pay for those things they most want, including a cleaner environment. Encouraging home ownership would put more people in a position to truly benefit from neighborhood improvements such as environmental cleanups. Providing legal aid, facilitating conflict resolution, and otherwise helping poor residents in environmental disputes can help the legal bargaining process to function better and enable the poor to participate in it fully. These may be the more effective routes for helping the poor—and may prove to have "win–win" outcomes for society.

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49. OVERCOMING DISTRIBUTIONAL OBSTACLES TO MARKET-BASED ENVIRONMENTAL POLICIES

Roberton C. Williams III

is a senior fellow at Resources for the Future. He is on leave from the University of Texas at Austin, and is a visiting associate professor at the University of Maryland. He has served as a coeditor of the *Journal of Environmental Economics and Management,* and is currently a coeditor of the *Journal of Public Economics.*

Economists have long advocated putting a price on greenhouse gas emissions and substantially raising the federal gasoline tax. One of the key obstacles to these policies has been that they would impose a larger burden on low-income groups. How can market-based environmental policies be designed to overcome their adverse distributional consequences?

The cost advantage of market-based approaches to environmental policies over traditional command-and-control regulation is widely accepted. By placing a price on emissions, environmental taxes and cap-and-trade systems provide incentives for emissions reductions in many different channels throughout the economy. For example, tightening fuel economy standards would lead to more fuel-efficient cars, whereas raising gasoline taxes would provide a similar improvement in fuel efficiency but would also provide an incentive to drive less. Consequently, a gas tax can achieve a substantially larger reduction in gasoline consumption at the same cost to the economy.

However, policymakers have shied away from market-based approaches in cases where they would have significant impacts on the prices consumers face. U.S. fuel taxes are very low by international standards; indeed, federal fuel tax rates have been constant since 1993 and have fallen since then when adjusted for inflation. Similarly, there has been strong opposition to putting a price on emissions of carbon dioxide and other greenhouse gases.

One key obstacle to more widespread use of market-based approaches is that they are often regressive: for many polluting goods, low-income consumers spend a bigger portion of their budgets on the polluting goods than do high-income consumers. Thus, the burden of a tax that raises the price of one of these goods will be borne disproportionately by lower-income households. In such cases, it may not be enough simply to show that a policy is justified on cost–benefit grounds alone; addressing distributional objections is also important.

FACTORING EQUITY INTO POLICY ANALYSIS

One possible response might be to follow a cost–benefit approach, but to count costs for different income groups differently (for example, counting $1 of costs for a low-income person the same as $10 for a high-income person). For a regressive policy, this procedure will raise the assessed costs and imply that the optimal policy will be less stringent. But this approach is unsatisfactory, because it makes the choice of how much to count the costs of any particular income group very arbitrary.

Another approach, included in the climate change proposals currently under consideration in the Senate, is to provide rebates that directly reduce consumers' electricity bills, offsetting the higher cost of energy. However, such rebates may substantially reduce incentives for energy conservation, depending on how they are structured and on how consumers interpret them. This raises the overall costs of the policy as greater emissions reductions must be found elsewhere (through fuel switching in the power sector, for example) to meet a given emissions cap.

A more promising approach would be to combine a change in an environmental tax, together with a change in the broader income tax and transfer system that would approximately offset any distributional effects of the environmental policy. For example, the average share of the household budget spent on gasoline is roughly twice

as high among households earning $25,000 per year as it is among households earning $100,000 per year. But that cost could be offset by cutting income tax rates (and/or increasing government transfers), using some of the revenue raised by the increased gas tax in a way that would particularly benefit lower-income households. The resulting combined policy would then affect households of all income levels equally.

This approach recognizes that using the tax and transfer system to compensate for the burden of an environmental tax is a much more efficient way to address distributional concerns than is altering the regulation itself in a way that makes it less efficient. Devoting a portion of the revenues from an environmental tax to provide such compensation ensures that no income group would bear a disproportionate burden, and does so in a way that still preserves consumers' incentives to reduce consumption of polluting goods.

Moreover, even if a particular proposal does not include this type of compensation, analyzing how much compensation would be needed (and what the effect of such compensation would be) is still a valuable analytical tool, because it provides an objective way of gauging the importance of distributional objections to a given policy.

LIMITATIONS

Transfers like this might well increase the costs of environmental regulation, relative to what those costs would be if the same amount of revenue were used to cut taxes equally for all income groups. Economists typically find that the economic efficiency gains from increased work effort and savings tend to be larger for an across-the-board tax cut than for a cut specifically targeted at lower-income households.

Consequently, the estimated optimal gas tax will be lower than it would be if the tax were simply set to maximize economic efficiency without regard for distributional effects. And the same would be true for other policies that would have a similarly regressive distribution of costs and benefits.

However, there is still a strong case for higher environmental taxes. For example, in a 2007 paper, Sarah West and I estimated that the efficiency-maximizing gasoline tax rate for the United States is approximately $1.38 per gallon (in 2009 dollars). Modifying that analysis to take distributional effects into account, by analyzing a gas tax increase together with a compensating income tax change, leads to a significantly lower estimate of the optimal tax: approximately $1.22 per gallon. But even that lower estimate is still far above current U. S. gas tax rates, which average roughly 38 cents per gallon.

Similar results are likely to apply for other pollution taxes and environmental regulations, such as a tradable permit system for carbon dioxide or for local air pollutants. In many cases, the distribution of the costs of regulation is regressive, which means that regulation should be somewhat less strict than what a simple cost–benefit analysis might indicate. But this effect is modest; such regressive effects can be offset through the tax and transfer system at relatively low cost. In short, distributional effects need not pose a serious problem for environmental policy, if the political process allows adjustments of the broader tax and benefit system to compensate for higher energy prices.

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50. WHAT DO THE DAMAGES CAUSED BY U.S. AIR POLLUTION COST?

Robert Mendelsohn

is the Edwin Weyerhaeuser Davis Professor at the Yale School of Forestry and Environmental Studies. He specializes in valuing environmental damages including global warming impacts.

Nicholas Z. Muller

is an assistant professor of economics at Middlebury College. His research focuses on modeling the damages from local air pollutants, environmental accounting, and the design of efficient market-based pollution regulation.

How do economists measure the human health and environmental effects of local air pollution in the United States, the sources of pollution emissions, and how large environmental damages are relative to the overall economy?

The major pollutants first regulated by the Clean Air Act are still causing substantial damages in the United States, particularly to human health. Specifically, ammonia and the five criteria pollutants—fine and coarse particulates, sulfur dioxide, nitrogen dioxide, and volatile organic compounds—currently cause damages that range from $75 billion to $280 billion annually. Here we will explain how these damages are estimated, what sources are responsible for the damages, and compare them with estimates of the damages from greenhouse gases (GHGs).

Economists measure the impacts of air pollution using integrated assessment models that logically connect emissions to their final effects on society. Of primary concern are the human health effects associated with air pollution, including premature mortality, chronic illness (such as bronchitis and asthma), and several acute illnesses. However, the models also measure the damages from reduced crop and timber yields, impaired visibility, deterioration of man-made materials, and diminished recreation services.

Integrated assessment models applied to the United States begin with available emissions data and then calculate pollution concentrations across the Lower 48 states. These concentrations are then converted to "exposures," using county-level population information. Exposures, in turn, are converted into physical effects using concentration-response functions that capture the number of physical effects a certain exposure is likely to cause. Finally, physical effects are converted to dollar damages through valuation techniques.

We rely on an integrated assessment model that we developed, called air pollution emission experiments and policy (APEEP), to capture each of the steps above. APEEP resembles other integrated assessment models in the literature. However, the way we are using APEEP is innovative. First, APEEP calculates the damages due to current emissions from all existing sources. One ton of emissions is then added at a single source, and APEEP recalculates the aggregate damage. The change in the aggregate damage is the marginal damage of the additional ton of emissions. By repeating this experiment for the six pollutants and 10,000 source locations, APEEP estimates the marginal damage of all emissions of these pollutants in the United States. Multiplying the tons of emissions from each source location by the source-specific marginal damage and summing across all sources yields the gross annual damage (GAD). This is a measure of the value of air pollution damages just as GDP is a measure of the value of economic production.

We find that GAD in 2002 is between $75 billion and $280 billion (0.7 to 2.8 percent of GDP). The estimates vary so widely because of three controversial issues: the value of mortality risks, the age dependency of this value, and the relationship between exposure to air pollutants and mortality rates.

First, although the values of many damages from air pollution are known—reduced crop yields, for instance—the value of human health and longevity (and their inverse, illness and death) is contentious. One approach is to use the extra wages paid to workers in risky jobs. This is problematic, however, because mortality risk in the workplace is often associated with sudden death, whereas mortality from air pollution is usually

due to long-term exposure. It is also true that people do not agree on what value to place on a small risk of death, and so any single estimate will be contentious no matter how it was estimated.

The second controversy is whether the value attributed to mortality risks should be the same for all age groups or decline with expected years of remaining life. That is, should a smaller value be assigned to older age groups? Age-specific values are rational because remaining consumption declines with age. However, American principles of equality as guaranteed by the Constitution may dictate that every person be valued the same, regardless of age. Finally, the magnitude of the physical impact of exposure to pollutants is also uncertain. Because controlled experimentation (intentionally exposing humans) is unethical, epidemiologists must rely on natural experiments and toxicologists must rely on animal experiments to learn about human sensitivity to pollution. Unfortunately, these methods are less precise, and so the estimates are "noisy." For all these reasons, the range of GAD values is wide.

Turning from aggregate damage to individual pollutants, we find that not all pollutants are equally harmful. Although emissions of fine particulate matter ($PM_{2.5}$), ammonia, sulfur dioxide, and volatile organic compounds make up only half of all emissions by weight, these pollutants cause almost 80 percent of total damages. $PM_{2.5}$, very tiny particles that can lodge in the lungs, accounts for only 6 percent of total emissions by weight, but causes 23 percent of total damages. In contrast, nitrogen oxides and coarse particulates are responsible for almost half of the total tonnage but only 20 percent of damages.

What fraction of GAD is due to different effects? We find that human health damages account for more than 95 percent of GAD. Loss of visibility is clearly one of the most palpable costs of air pollution, but its contribution to GAD is small. The same can be said for crop damage, forest damage, and material damages.

The largest source is still industrial production, which causes 50 percent of air pollution damages. The largest single industrial source of emissions is coal-fired power plants, which cause 20 percent of GAD. Mobile sources are responsible for the next largest share, 35 percent. Light-duty gasoline-powered cars and motorcycles contribute 9 percent, SUVs and light-duty gasoline trucks contribute 7 percent, diesel trucks and heavy-duty gasoline vehicles contribute 15 percent, and rail vehicles, aircraft, and marine vessels generate the remaining 4 percent of mobile source damages. Residential combustion of fossil fuels and wood, primarily for heating, produces perhaps more damage than people think—5 percent. Finally, agricultural sources also cause a surprisingly large share of damages (10 percent), from ammonia from livestock production and fertilizers, and dust from tilling cropland.

The above GAD estimates do not include GHGs. How does their impact compare to GAD? Although they have high current visibility on policymakers' agendas, we believe that current GHG emissions, at least, are not nearly as harmful as criteria pollutants. The empirical impact literature estimates that current emissions will cause future global damages of between $0.50 and $10 per ton of carbon dioxide (when future damages are discounted at market rates). So the current six billion tons of carbon dioxide emitted annually in the United States will likely cause future global damages of between $3 billion and $60 billion. Greenhouse gas emissions consequently cause from 4 to 18 percent of the total damages from air pollution. GHGs do need to be addressed, but the damages that current emissions will cause are relatively small compared to the damages from criteria pollutants. Of course, GHGs are accumulating and future emissions will cause higher damages, so they will become relatively more important to control in the future.

Tighter regulations on emissions of ammonia, fine particulates, and sulfur dioxide are needed. Important sources of these emissions include coal-fired power plants, diesel vehicles (especially marine vessels and heavy-duty trucks), and some industrial sources. Two other sources that have generally escaped attention must also be examined: residential homes and farms. Although each farm and each house contributes only a little to GAD, the net effect of all homes and all farms is substantial. Finally, pollution control efforts aimed at reducing solid waste (incineration) and water pollution (waste treatment plants) generate an inordinate amount of air pollution damage. Regulators need to think more carefully about integrated pollution management so that in the effort to reduce one pollution problem, they do not create a larger one.

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51. WHAT CAN POLICYMAKERS LEARN FROM EXPERIMENTAL ECONOMICS?

John List

is a professor in the University of Chicago Economics Department, a research associate at the National Bureau of Economic Research, and a nonresident fellow at Resources for the Future. Much of his work has focused on the use of field experiments in economics.

How does research on field experiments bear on the issue of how we might quantify the benefits of environmental policies? Such valuations are a critical ingredient for judging whether or not individual policies make sense on cost–benefit grounds.

How can we value the benefits of preserving wilderness areas and wetlands, providing the recreational benefits of cleaner lakes and rivers, and reducing the pollution in the air? Good policy requires good data on economic values, and generally economists rely on markets to provide them. But in some areas, notably environmental protection, we often need to know the worth that society assigns to incremental benefits for which there are no markets.

This need is frequently a legal requirement. Ever since President Reagan's 1981 executive order, federal agencies, including EPA, have been required to consider both the benefits and costs of regulations for economically significant rulemakings before implementation.

Economists rely on several different methods to estimate environmental benefits or damages. For example, one approach to valuing the benefits of cleaner air is to looke at compared how much extra people are willing to pay for houses in regions with good air quality, such as in Laramie, Wyoming, with houses in regions with relatively dirty air, like Los Angeles. The main challenge here is trying to separate out, statistically, the price premium for clean air from all the other factors that may cause property prices to differ across regions—including local factors such as climate, job opportunities, crime levels, school quality, and so on. Moreover, this approach is limited in that it cannot be used, for example, to value how much people would be willing to pay to know that Alaska's Arctic National Wildlife Refuge will be passed on to future generations in pristine condition, even though they may never visit the refuge themselves. As opposed to the value of clean air, which people inhale and thus "use," these other kinds of values are considered "nonuse values." They pose problems in that they generally lack markets—and therefore prices—that economists could use for analysis.

The most widely used approach to estimating the total value of nonmarket goods and services is known as contingent valuation (CV). Under this approach, the researcher uses a questionnaire to ask respondents contingent questions concerning how much they would be willing to pay in donations, taxes, or price increases to achieve a certain goal—preservation of an endangered species, perhaps, or the cleanup of a contaminated area.

Possibly the most celebrated example of CV in an environmental case arose from the 1989 Exxon *Valdez* oil spill. On behalf of the state of Alaska, a group of economists conducted a large-scale CV study of Americans' willingness to pay for the avoidance of another oil spill in Prince William Sound, and the state used the resulting figure, $2.8 billion, in court. The final settlement was $1 billion on top of the $2 billion that Exxon itself spent on restoration.

In California, in another notable case, a fight over water rights raised the question of whether it was worth diverting water into Mono Lake to ensure the survival of the lake's flora and fauna. Certain downstream parties derided it as a choice between the interests of "300 fish versus 28,000 people." But the state's Water Resources Control Board was persuaded otherwise and ordered an increase in the flows into the lake that significantly decreased the city's water rights.

Even though the CV approach has clearly influenced the policy process, it has remained highly contentious, for it is difficult to know whether people's answers to hypothetical questions provide a reliable guide to the amounts that they would actually be willing to pay in practice. Here, the techniques of experimental economics are making a significant contribution. Experimental economics sets up choices that people actually make, whether in the laboratory, under carefully controlled conditions, or in the field, where their decisions can sometimes be compared with results in real markets.

In one of the early uses of the technique, the researcher Peter Bohm, a generation ago in Sweden, compared respondents' answers to hypothetical questions about the value of admission to a sneak preview of a television show with the prices in an actual market for admission. He found that the hypothetical values were higher, but only moderately so. In a recent analysis of these kinds of studies, Craig Gallet and I found that, on average, hypothetical values are three times larger than what people are actually willing to pay in a market setting, implying that we need to be cautious in interpreting the results from CV studies. Further laboratory and field experiments should make plain the situations wherein CV might be viable.

Another complication associated with nonmarket valuation is that differences in values arise, depending on the way in which a question is posed. Sometimes people are asked what they would pay to prevent the loss of a certain environmental benefit, such as a wetland. Sometimes researchers reverse the question, and ask what their respondents would consider fair compensation for the loss of that benefit—suffering the loss of that wetland. Typically, people set a much higher figure for compensation than they are willing to pay to avoid the loss.

At first, many economists argued that the answers on compensation were unreliable and should not be taken seriously. But lab experimentation reinforced the survey evidence, confirming that the difference between willingness to pay and fair compensation is robust across a wide variety of goods. Field experiments have complemented the extant lab and survey evidence by showing the limitations of such results. For example, my own work shows that people experienced with trading ordinary private goods, like mugs and candy bars, are not subject to this value disparity. Other field evidence using public goods, such as increased environmental quality, has reinforced these results and shown that the value disparity lessens because people with experience state much lower fair compensation values. One implication is that we should look at whether CV studies carefully control for (lack of) experience when estimating fair compensation. And when inexperienced agents are important in the valuation process, willingness-to-pay statements of value should be used rather than willingness to accept, since the latter tends to converge to the former with market experience.

Experimental research now under way in the field demonstrates that there is much to be gained from designing economic experiments that span the gap between the laboratory and the world outside, with important implications for economics. Examples include developing new auction formats to distribute pollution permits, exploring compensation mechanisms in social dilemmas (such as what is necessary for many endangered species cases), and examining efficient means to provide public goods. For instance, the optimal approach to engage providers of public goods to actually give resources and what factors keeps people engaged are beginning to be better understood because of field experiments.

What has become clear in this process is that field experiments can play an important role in the discovery process by allowing us to make stronger inference than we could make from lab or uncontrolled data alone. Similar to the spirit in which astronomy draws on the insights from particle physics and classical mechanics to make sharper insights, field experiments can help to provide the necessary behavioral principles to permit sharper policy advice.

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52. ENVIRONMENTAL FEDERALISM

Wallace E. Oates

is a professor of economics at the University of Maryland and a university fellow at Resources for the Future. He specializes in public finance (with a focus on fiscal federalism and state-local finance) and environmental economics (with a focus on economic incentives for environmental management).

What are the pros and cons of setting environmental policies at the state and local levels, as opposed to the federal level? Several examples are given to help answer this question, and evidence is presented on the claim that competition among state governments will result in insufficient environmental protection.

The basic principles of economics make a compelling case for environmental regulation because of the excessive use of our freely available, but scarce, environmental resources under a system of free markets—or, in the jargon of economics, as a result of "externalities." But in a federal system, with several levels of government, the next question involves the locus of regulatory authority: which *level* of government should undertake a specific regulatory responsibility?

A cursory look at U.S. policy on this issue reveals some puzzling anomalies. Under the Clean Air Act in 1970, the U.S. Congress instructed the newly formed EPA to set standards for ambient air quality in the form of maximum permissible concentrations of pollutants applicable to *every* jurisdiction in the country. Only two years later, under the Clean Water Act (1972), the states were assigned the responsibility for setting standards for water quality within their own boundaries. It is not at all clear why standards for air quality should be centrally set and uniform across the nation, while determining standards for water quality is left to the states.

Economics, as it turns out, can provide some guidance on this issue. From an economic perspective, standards for environmental quality should be tightened so long as the benefits from incremental cleanup exceed the additional costs. However, the geographic setting for applying this principle varies among different forms of pollution. In some instances, such as carbon dioxide emissions, which contribute to global climate change, all that matters is the aggregate level of emissions—the precise location of their emission into the atmosphere doesn't matter (at least for purposes of global climate change). For pollutants of this kind, what we need is a national (or, really, a global) program to restrict emissions.

In contrast, both the benefits of cleanup activities and costs of certain other forms of pollution can vary dramatically across different jurisdictions. This, for example, can be the case for various forms of air and water pollution, where one size doesn't fit all. An efficient outcome in such a setting requires different standards for environmental quality depending on how damaging the effects are and how costly it is to control the polluting activity.

A particularly interesting and provocative case in point arose in the waning days of the Clinton administration in 2000, when EPA introduced a new measure to reduce the permissible level of arsenic in U.S. drinking water by 80 percent. The "arsenic rule" applied to all jurisdictions in the nation. Careful analysis of the new provision revealed that it promised only a minuscule reduction in health risk on a national scale. EPA estimated that the tough new standard could save approximately 20 to 30 statistical lives per year (the value of a "statistical" life is typically understood by economists to be the cost of reducing the average number of deaths by one). But this estimate was subject to sufficient uncertainty that it is not unreasonable to believe that no lives would be saved under the standard.

Of special interest in this case was the enormous variation across the country in the cost per household of meeting the arsenic standard. Huge economies of scale exist in the treatment of drinking water such that the new measure could be met in a large

water district like New York City for under $1 per year per household. In fact, many large districts were already in compliance with the new standard. But in very small water districts, largely in rural areas, the cost of meeting the new standard was in excess of $300 per household per annum, dwarfing any prospective gains. Indeed, far greater health benefits could be achieved if such sums were used for other public (or private) health measures, such as increasing the frequency of mammograms, colon screenings, or a host of other procedures. One size certainly didn't fit all in this case: the arsenic rule *may* have made sense for large water districts, but it was economically wasteful for smaller districts.

Critics of this approach to environmental federalism contend that it overlooks the fact that municipalities compete for new business investment and jobs. If we leave important matters of environmental regulation to state or local governments, we can set in motion a competitive "race to the bottom," with officials setting lax environmental standards as a means of reducing the cost to new (and existing) businesses. Consequently, the critics argue, it is necessary to centralize standards setting to avoid a competitive depreciation of environmental quality.

However, a closer look suggests that both in theory and in practice, the case for a race to the bottom is not very compelling. A standard theoretical model in which government seeks to maximize the well-being of its citizenry reveals no such race. People care about the quality of the environment—and a government that fails to respond to these concerns is unlikely to stay in office. Moreover, the existing evidence provides little support for this view. Under the Reagan administration in the 1980s, several measures were introduced that effectively moved the responsibility for environmental management on a number of fronts back to the states, creating a favorable setting for a race to the bottom. Three empirical studies have carefully examined this episode, however, and none found any evidence of a competitive reduction in environmental standards. On the contrary, increased state spending on environmental programs and improvements in environmental quality continued unabated through this period.

Basic economics thus suggests an important principle for the structure of environmental regulation: polluting activities that degrade environmental quality in a local jurisdiction should therefore be a local responsibility (including the setting of standards). This way, regulatory measures can be tailored to the specific circumstances of each jurisdiction. In contrast, those forms of pollution that reach beyond state or local borders require a national approach to the setting of standards. This does not, incidentally, imply that there is no role for a centralized agency with regard to local environmental issues. An agency like EPA can provide critical information and guidance on the potential damages from various forms of pollution and on the costs of pollution control. State or local jurisdictions would then be in a position, either through their own officials or, perhaps, through some kind of referendum, to establish standards and a regulatory framework that address the particular circumstances of local environmental issues.

The appropriate use of decentralized environmental decisionmaking can have further benefits. In a federal system, state and local governments have the opportunity to introduce new and innovative regulatory measures. They can serve as laboratories in which to conduct experiments that can provide valuable lessons on the potential of new approaches to public policy. Under the Clean Air Act, for example, many state and local governments introduced a variety of emissions-trading systems that both demonstrated their effectiveness and exposed certain problems in their design. I doubt that the United States would have introduced the very successful national cap-and-trade program in the 1990 Clean Air Act Amendments to control sulfur emissions to reduce acid rain without the invaluable earlier experience with this policy approach at state and local levels.

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