The SO_2 Allowance Trading System and the Clean Air Act Amendments of 1990: Reflections on Twenty Years of Policy Innovation

Faculty Research Working Paper Series

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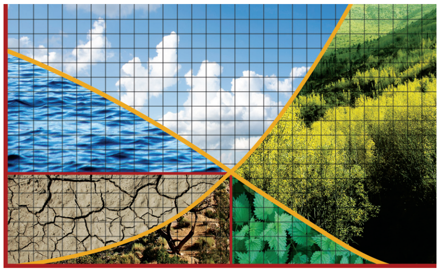

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Supported by the Alfred P. Sloan Foundation

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JOHN F. KENNEDY SCHOOL OF GOVERNMENT

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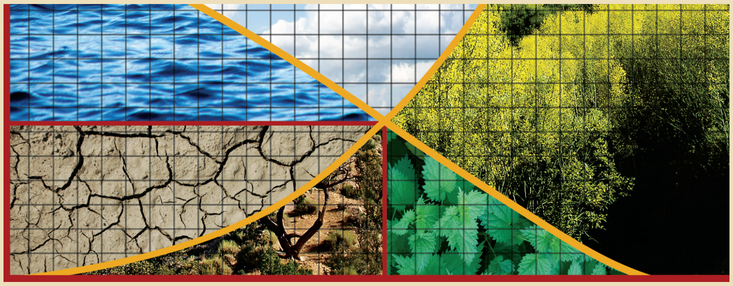

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ABSTRACT

The introduction of the U.S. SO_2 allowance-trading program to address the threat of acid rain as part of the Clean Air Act Amendments of 1990 is a landmark event in the history of environmental regulation. The program was a great success by almost all measures. This paper, which draws upon a research workshop and a policy roundtable held at Harvard in May 2011, investigates critically the design, enactment, implementation, performance, and implications of this path-breaking application of economic thinking to environmental regulation. Ironically, cap and trade seems especially well suited to addressing the problem of climate change, in that emitted greenhouse gases are evenly distributed throughout the world's atmosphere. Recent hostility toward cap and trade in debates about U.S. climate legislation may reflect the broader political environment of the climate debate more than the substantive merits of market-based regulation.

Key Words: cap-and-trade, market-based environmental policy, acid rain, sulfur dioxide, Clean Air Act Amendments

JEL Classification: Q520, Q550, Q580

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Preface

In 2009, the U.S. Congress considered but ultimately failed to enact legislation aimed at limiting U.S. greenhouse-gas (GHG) emissions.[1] Over several months of often contentious debate, millions of Americans were introduced to the phrase "cap and trade," a regulatory approach that first came to prominence in the 1990s as the centerpiece of a national program to address the threat of acid rain by limiting emissions of sulfur dioxide (SO_2), primarily from electric power plants.

The 1990 SO_2 cap-and-trade program was conceived by the administration of President George H. W. Bush and was widely viewed as a success. Yet cap and trade became a lightning rod for congressional opposition to climate legislation from 2009 through 2010. Some of that hostility reflected skepticism about whether climate change was real and, if it was, whether humans played a key role in causing it. A larger group of opponents in Congress worried about the proper role of government and the costs of combating climate change, particularly given the lack of commitments for action by the large emerging economies of China, India, Brazil, Korea, South Africa, and Mexico. The congressional debate touched only lightly on the relative merits of various policy options to reduce greenhouse-gas emissions. Thus, cap and trade may not have been defeated on its merits (or demerits), but rather as collateral damage in the larger climate policy wars.

Congress (to the extent it did assess policy alternatives to cap and trade), as well as the broader community of analysts and observers in the late 2000s, raised a number of substantive questions about the merits of this policy instrument as a means for responding to a major environmental policy challenge of the sort posed by climate change (Peace and Stavins 2010):

- Cap and trade is part of a larger class of policy approaches to alleviating pollution and managing natural resources that rely on market mechanisms.[2] How do the costs of such a market-based approach compare with traditional regulatory policies to reduce pollution?
- Can market-based policies—and the markets they create—be trusted to reduce emissions? That is, are they environmentally effective?

1 The bill under consideration at that time, the American Clean Energy and Security Act of 2009, was the last in a series considered over several years. Sponsored by Representatives Henry Waxman (D-California) and Edward Markey (D-Massachusetts), the bill passed the U.S. House of Representatives but failed to win sufficient support in the Senate. No legislation was enacted, and by 2010, both Congress and the White House had abandoned efforts to pass federal climate legislation. For text of and information on the bill and its legislative context, see: www.govtrack.us/congress/bill.xpd?bill=h111-2454.

2 The principal market-based alternative to cap and trade is a tax on emissions (see text box). For a comprehensive discussion of market-based environmental policy, see Stavins (2003).

- What are the distributional impacts of market-based environmental policies; who are the winners and losers?
- How well does a cap-and-trade system stimulate technological innovation, as compared with an environmental policy that sets performance standards, specifies technologies for reducing pollution, or both?

In May 2011, the Harvard Environmental Economics Program hosted a two-day research workshop and policy roundtable in Cambridge, Massachusetts, to reflect on these and other questions in light of twenty years of experience implementing the SO_2 cap-and-trade program, established under Title IV of the Clean Air Act Amendments (CAAA) of 1990.[3] Also known as the Acid Rain Program and the SO_2 allowance-trading system, Title IV represented the first large-scale application of cap and trade to control pollution—in the United States or any other country.[4]

This policy brief synthesizes the main conclusions and insights that emerged from the May 2011 workshop and roundtable, which included economists and legal experts who had conducted extensive research on the SO_2 allowance-trading system, as well as leaders of non-governmental organizations and former government officials who had guided the formulation and passage of the CAAA.[5] Participants discussed the SO_2 cap-and-trade program's design, implementation, performance, and legacy—and its implications for the issues that emerged in recent congressional debates about U.S. climate policy. This policy brief draws on their analysis and on supplementary evidence.[6]

We gratefully acknowledge the contributions of participants in the research workshop and policy roundtable, as well as the comments and edits some provided on an earlier draft of this brief. Their expertise and experience made the project possible. (Comments made by participants in the workshop were not intended for attribution, and specific insights are not referenced in the brief. For a list of participants, see inside the back cover.) We also thank Marika Tatsutani, who edited the brief and provided valuable substantive insights, and Bryan Galcik, who designed and produced the document. Finally, we are grateful to the Alfred P. Sloan Foundation, which provided generous support for the workshop and for the preparation of this study.

3 For the text of the amendments and other information see www.epa.gov/airmarkets/progsregs/arp.

4 The largest emissions trading program in the world is now the European Union Emissions Trading System (EU ETS), a greenhouse-gas, cap-and-trade system that was implemented in 2005 and whose design was influenced by the U.S. SO_2 program.

5 See the list of participants inside the back cover.

6 For background on and analysis of the SO_2 allowance-trading program, see generally Ellerman, et al. (2000) and Stavins (1998).

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1. Introduction

In 1990, the U.S. Congress passed and President George H.W. Bush signed into law amendments to the Clean Air Act, which included a path-breaking, market-based approach to addressing the threat of acid rain. The SO_2 allowance-trading program established under the 1990 Amendments was the world's first large-scale pollutant cap-and-trade system. This policy brief examines the design, enactment, implementation, and performance of that system, with an eye toward identifying lessons learned for future efforts to apply cap and trade to other environmental challenges, including global climate change. The first section provides background on the Acid Rain Program and summarizes data and analysis on its benefits. Subsequent sections examine key questions regarding cost, environmental effectiveness, market performance, distributional implications, and effects on technology innovation. We then examine the political context of the formulation, enactment, and implementation of the SO_2 allowance-trading system. Finally, in the conclusion, we briefly reflect on implications for climate change policy.

2. The Acid Rain Program: Background and Benefits

By the late 1980s, there was growing concern that acid rain was damaging aquatic ecosystems, forests, and buildings in the northeastern United States and southeastern Canada. Acid rain is the result of SO_2 and, to a lesser extent, nitrogen oxides (NO_x) reacting in the atmosphere to form sulfuric and nitric acids, which are deposited on the Earth's surface through either precipitation or dry processes. Flue gas emissions from coal-fired, electric-power plants were (and remain) the primary source of SO_2 emissions and a major source of NO_x emissions in the United States.

The stated purpose of Title IV of the Clean Air Act Amendments (CAAA) of 1990 was to reduce total annual SO_2 emissions in the United States by ten million tons relative to 1980, when total U.S. emis-

7 Chan and Sweeney are Ph.D. students in Public Policy; Stavins is the Albert Pratt Professor of Business and Government; and Stowe is the Executive Director of the Harvard Environmental Economics Program.

sions were about 25.9 million tons.[8] The program mandated an allowance-trading system[9] and specified that this goal would be accomplished in two phases. Phase I (1995–1999) required significant emissions reductions from the 263 most polluting coal-fired electric generating units, almost all located east of the Mississippi River.[10] Phase II, which began in 2000, placed an aggregate national emissions cap of 8.95 million tons per year on approximately 3,200 electric generating units—nearly the entire fleet of coal-fired plants in the continental United States (Ellerman et al. 2000, 6–7; NAPAP 2005, 6–7). This cap—affecting almost exclusively the power sector—represented an approximately 50 percent reduction from 1980 levels, when power-sector emissions were about 17.5 million tons.

The SO_2 allowance-trading program had a number of features that would subsequently become common to virtually all cap-and-trade systems. (See box on cap and trade.) At the beginning of the program, the government (freely) allocated allowances, denominated in tons of SO_2 emissions, to power plants covered by the law, according to formulas contained in the legislation and elaborated upon by regulation. If annual emissions at a regulated facility exceeded the allowances allocated to that facility, the facility owner could either buy allowances or reduce emissions, whether by installing pollution controls, changing the mix of fuels used to operate the facility, or by scaling back operations. If emissions at a regulated facility were reduced below its allowance allocation, the facility owner could sell the extra allowances or bank them for future use; these opportunities created incentives to find ways to reduce emissions at the lowest cost.

By contrast, most air pollution regulations prior to the 1990 CAAA took a much more prescriptive approach, either by setting uniform emission limits on classes of emitters or by specifying the type of pollution-control equipment to be installed. Such requirements are relatively inflexible, imposing the same abatement path upon a range of heterogeneous facilities and ignoring the fact that the costs of compliance might vary widely across individual facilities depending on the age, technology characteristics, operating conditions, and quality of fuel used. This type of inflexible environmental regulation came to be known by the somewhat pejorative term "command-and-control," invoking visions of Soviet-style planning.

The environmental objective of the Acid Rain Program was to reduce emissions of SO_2 and NO_x, but its effectiveness in achieving these objectives should be distinguished from the benefits of the program

8 The legislation itself did not specify a target year. For SO_2 emissions data, see U.S. Environmental Protection Agency, National Emissions Inventory Air Pollutant Emissions Trends Data; "1970–2011 Average annual emissions, all criteria pollutants in MS Excel – October 2011," tab "SO_2." For power-plant emissions, see line "FUEL COMB. ELEC. UTIL." www.epa.gov/ttn/chief/trends/index.html.

9 We use the phrases "allowance trading" and "cap and trade" interchangeably. The CAAA also mandated a smaller quantity of power-sector NO_x reductions, but the NO_x program did not allow for allowance trading and is not addressed in this brief.

10 A number of additional units that were to be regulated only in Phase II opted-in early for Phase I.

(intended or not). The intended benefits of the program were associated with reduced acidification of aquatic ecosystems, primarily in the Northeast. However, subsequent assessments of the program found that by far the greatest benefits were in the form of avoided health damages from reduced levels of airborne fine particles derived from SO_2 emissions.[11] Estimates of these health benefits vary widely, but they appear to be on the order of $50 billion per year by 2010. This compares with estimated program costs (see below) on the order of $0.5 billion (Burtraw 1998; NAPAP 2005, 64; Shadbegian, Gray, and Morgan 2005; U.S. EPA, Office of Air and Radiation 2011).[12]

3. Cost

A key question concerns cost—specifically, how the costs of achieving environmental objectives through cap and trade compare with those of a "counterfactual" (hypothetical alternative) command-and-control regulatory approach. Indeed, policy makers asked this question during discussions in the late 1980s about a new program for SO_2 emissions reduction. They proceeded on the basis of projections[13] and economic theory suggesting that cap and trade would be much less costly, relative to traditional, prescriptive regulatory approaches.[14]

Extensive analysis has demonstrated over the subsequent twenty years that these projections were largely correct. A summary of economic research addressing this question and presented in the workshop identified a range of 15–90 percent savings, compared to counterfactual policies that specified the means of regulation in various ways and for various portions of the program's regulatory period.[15]

In addition to being less costly than traditional command-and-control policies would have been, the program's costs were significantly below estimates generated by government and industry analysts in the debate leading up to the passage of the CAAA. In 1990, the U.S. Environmental Protection Agency

11 Though the program's SO_2-emissions-reductions targets were achieved, and there has been an observed, significant reduction in acid precipitation in the Northeast, it takes much longer to reverse the acidification of ecosystems, which is the environmental harm that inspired the legislation in the first place (NAPAP 2005, 58–64). However, health benefits will dominate ecological benefits regardless of the time required for ecosystem recovery.

12 Attempts to quantify the benefits of the Acid Rain Program have generally not included all improvements to ecosystems, both because these are much more difficult to estimate and because they are much smaller than human health benefits—by at least an order of magnitude. See especially Burtraw (1998). More than a decade after passage of the CAAA, Banzhaf, et al. (2006) found that the benefits of ecosystem recovery in the Adirondacks justified the costs of the acid rain program, notwithstanding the substantially greater public health benefits. For a detailed analysis of costs and health benefits associated with recent policies intended to replace the SO_2 allowance-trading system, see Schmalensee and Stavins (2011).

13 These projections were largely the result of modeling conducted by ICF, a consulting firm retained by the U.S. Environmental Protection Agency. See, e.g., references in Burtraw and Palmer (2003).

14 Costs referenced in this section include those to industry for complying with the program and to government for administering the program.

15 See, among others, Carlson, et al. (2000); Ellerman, et al. (2000, 253–295); Keohane (2003).

What is cap and trade?

The fundamental motivation for any government policy to reduce emissions is that pollution imposes costs on *society* (related to health and environmental quality) that are not borne by polluters—"external costs." These costs to society must be "internalized" or made the responsibility of the polluter, if the polluter is to have an incentive to abate. A *cost-effective* system of regulation would be one in which the costs incurred are minimized, relative to other systems of regulation with commensurate environmental results.

Several basic features are common to all cap-and-trade programs. First, government decides on the total (aggregate) quantity of emissions to be allowed under the program for a stated time period (usually per year)—that is, the "cap." Next, government creates allowances (or "permits"), denominated in quantities of the pollutant in question. The total number of allowances issued is equal to the cap.

At the start of the program, allowances may be given to the entities subject to the program (firms, facilities) for free or sold for a price (usually through an auction)—or some combination. A regulated entity must hold and surrender to the government at the end of each compliance period allowances equivalent to that entity's actual emissions during the period. If a firm does not hold sufficient allowances, it is subject to penalties or other enforcement actions. In the case of the SO_2 program, these penalties were, for the first time, specified in the statute, set at levels significantly higher than the anticipated compliance costs, and imposed automatically, thus providing certainty with regard to consequences for noncompliance.

Firms may buy allowances on the market to meet their compliance obligations, or they may choose to reduce their emissions. For companies holding too few allowances, the choice to abate or buy allowances would depend on the cost of compliance versus the price (or anticipated price) of purchasing allowances.* Because each individual company (or facility) has the flexibility to choose the course of action that costs it the least to achieve compliance, investment in abatement technology or procedures would flow to where it was least costly to reduce emissions. (The marginal cost of abatement becomes equalized across all entities.) In aggregate, the mandated environmental target is achieved at lowest cost; this is why cap and trade is generally considered a cost-effective form of regulation.

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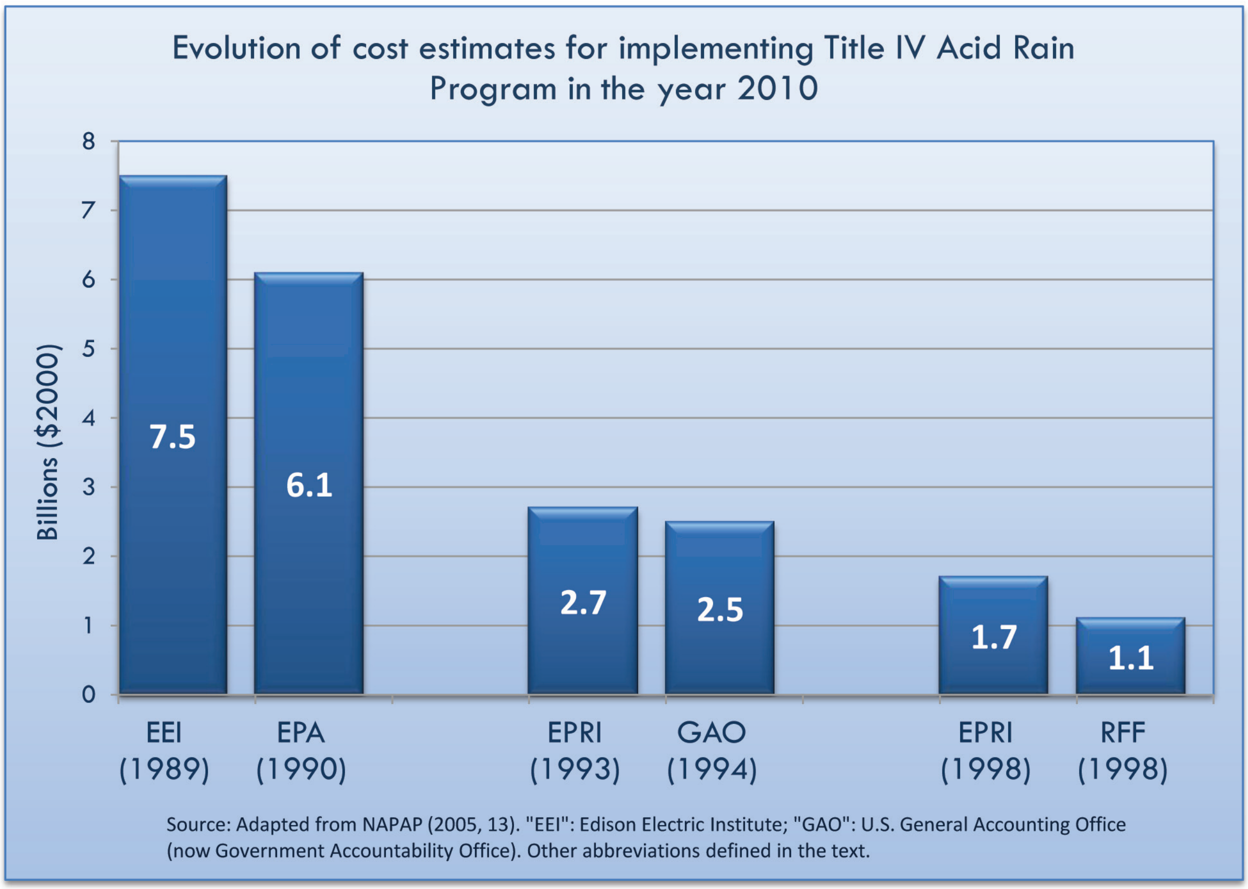
* Covered entities that hold too *many* allowances would make precisely the same calculation about whether to abate; if the cost of abatement (per ton) is lower than the price of allowances, the firm with a surplus will abate and have more allowances to sell on the market (for a higher price than it costs to abate).

(EPA) estimated the cost of implementing the Acid Rain Program (with allowance trading) at $6.1 billion. In 1998, the Electric Power Research Institute (EPRI), an industry organization, and Resources for the Future (RFF), an independent think tank, estimated that total implementation costs would be $1.7 and $1.1 billion respectively (based in part on actual figures for the first few years of the program; NAPAP [2005, 13]). (See Figure 1.)

Figure 1



Several factors explain the large decline in the cost estimates. Power-plant operators in the eastern states benefited from increased access to—and falling prices of—low-sulfur coal from the Powder River Basin (PRB) in Wyoming and Montana, due to the deregulation of the railroads in the 1980s, which reduced transportation costs (Ellerman et al. 2000, 82–89). For many facilities this made fuel switching less expensive than installing scrubbers.[16] (The primary technology for reducing SO_2 emissions is flue-gas desulfurization, and equipment employing this technology is commonly known as a "scrubber." Scrubbers

16 Of the 263 Phase I units, 136 (52 percent) pursued fuel switching or blending. These units accounted for 59 percent of Phase I emissions reductions; scrubbers were installed at 27 (10 percent) of the units, accounting for 28 percent of the emissions reduction (Lange and Bellas 2005, 547).

remove SO_2 from a boiler's flue gas stream before the gas enters the atmosphere.) At the same time, coal-mine operators elsewhere in the country responded to PRB competition and changing fuel demands by exploiting medium-sulfur coal seams. Coal from these seams would produce emissions just above the limit of 1.2 pounds of SO_2 per millon BTUs[17] set by the Clean Air Act of 1970 for new plants, but not enough in excess of that limit to be worth scrubbing. Finally, technological innovation in both scrubbers and power plants (some of it prompted by the trading program itself, as discussed below) reduced costs over this time period, primarily through better management of the fuel mix. Taken together, these developments made it possible for electric utilities to achieve greater SO_2 reductions through fuel switching, relative to more expensive investments in new equipment.[18]

While the costs of the SO_2 allowance-trading system were low, other evidence suggests that they were not as low as they could have been, in the sense that they did not achieve the theoretical least-cost abatement solution for a cap-and-trade system. One study suggests that costs remained $280 million (51 percent) and $339 million (59 percent) higher than the least-cost solution in 1995 and 1996, respectively (Carlson et al. 2000, 1295–1296, 1318). Factors that kept costs above the theoretical minimum[19] were, first, provisions in the CAAA that encouraged early scrubbing to limit impacts on high-sulfur coal producers, and second, lack of information about marginal abatement costs and other crucial factors on the part of market participants. In the early years, power-plant operators may have lacked the information (and associated experience and confidence) to take full advantage of the flexibility that the SO_2 allowance-trading system offered. Third, in the early years of the program, utilities were subject to economic regulation at the state level that had the effect of distorting or constraining their responses to market-based federal environmental regulation (Arimura 2002; Bohi and Burtraw 1992). Some faced uncertainty over whether state regulators would approve the inclusion of costs incurred to purchase emissions allowances, in those states that allowed costs to be recovered from electric ratepayers. Similarly, there were interactions between the SO_2 system and other federal regulations, such as New Source Review and New Source Performance Standards, which may have created inefficiencies in how the program operated. Finally, there was considerable policy uncertainty, particularly in Phase II, when regulators and policy makers were considering further reductions in the national SO_2 cap, as is discussed below.

17 British Thermal Units—a measure of the quantity of heat.

18 Some analysts have suggested that because the reduction in fuel costs would have occurred anyway—and would have reduced the costs of a command-and-control SO_2 program as well—then the cost savings attributed to the SO_2 allowance-trading program (relative to a command-and-control system) should be adjusted downward (Carlson et al. 2000, 1314). However, a prescriptive regulatory approach (such as a policy that required the installation of scrubbers at all power plants) might have prevented utilities from taking advantage of these alternative compliance options.

19 That marginal abatement costs still varied across facilities, even after the SO_2 cap-and-trade system was implemented, is evidence that the cap-and-trade system did not always yield cost-effective mitigation outcomes; some utilities ended up paying more on a dollar-per-ton basis to comply with the program than others. Analysts disagree, though, on the significance of these variations, largely depending on whether they are compared with much larger heterogeneity in abatement costs prior to the SO_2 allowance trading system or with the ideal convergence of marginal costs in a cost-minimizing outcome.

In sum, the SO_2 allowance-trading system's actual costs, even if they exceeded the cost-effective ideal for a cap-and-trade system, were much lower than would have been incurred with a comparable traditional regulatory approach, and were much lower than the trading system's predicted costs. There is broad agreement that the SO_2 allowance-trading system provided a compelling demonstration of the cost advantages of a market-based approach. It is important to elaborate on this conclusion, however, by examining two ancillary issues that have significant cost implications: uncertainty and the problems of combining policy approaches.

Cost-Uncertainty and Cap and Trade

Firms desire certainty (low variance) in regulatory requirements and compliance costs, the latter being facilitated by flexibility in the means to comply. A regulatory instrument that offers a predictable compliance regime and greater cost certainty[20] will usually enable companies to take advantage of longer-term investments that may reduce costs over time. Cost certainty is especially important for the electric power industry, whose capital assets (physical facilities) are long-lived.

Compared with an emissions tax (see box) or technology-standards-based, command-and-control-style regulations, a cap-and-trade system offers individual firms less certainty about abatement costs, because the price of allowances fluctuates with market conditions. Firms that make incorrect predictions about allowance prices (or, alternatively, marginal abatement costs) are less likely than competitors with better foresight to select an optimal compliance strategy. However, ancillary policy-design elements of the SO_2 allowance-trading system mitigated this uncertainty. Banking provisions gave firms the flexibility to save ("bank") allowances from one compliance period for use in a future compliance period, thus effectively smoothing price fluctuations (Burtraw and Mansur 1999). Another program feature that required EPA to auction small percentages of the total allowance pool "facilitated both the price discovery process and the development of the allowance market" (Schmalensee et al. 1998, 66). This allowed firms to forecast allowance prices more accurately.

The difficulty of predicting program costs and benefits suggests that it may have been desirable to build more capacity for adaptation into the SO_2 system—including with regard to the cap. Instead of legislating a fixed cap on emissions in years well beyond the planning horizon of decision makers at the beginning of the program, the 1990 Amendments could have given EPA authority to adjust the SO_2 cap in future years as the science evolved and as better information on real-world control costs became available. Alternatively, the 1990 Amendments could have implemented a rule-based adjustment process that might

20 Or at least, in the case of regulated electric utilities, greater ability to *recover* costs through rate increases.

have been easier for firms to anticipate. For example, Burtraw, Palmer, and Kahn (2010) discuss the role of a reserve price in the revenue-neutral auction that, if triggered, could have tightened the cap automatically when abatement costs turned out to be lower than expected.

Tension exists between providing regulatory certainty over long periods of time (which is desirable from the standpoint of reducing costs) and allowing for flexibility to adjust program goals (which may be desirable from the standpoint of maximizing net program benefits over time).[21] In striking that balance, the 1990 Amendments may have leaned too heavily towards providing certainty at the cost of allowing for flexibility to adjust the policy as understanding of both science and markets improved. This preference undoubtedly also reflected a certain amount of distrust of the EPA on the part of Congress, with a corresponding unwillingness to cede to EPA the right to set program requirements in the future without congressional input and approval. The inability of the Acid Rain Program to adjust ultimately led to its demise, as is discussed below.

Exclusion of Command-and-Control Add-Ons

An important feature of the SO_2 allowance-trading program was what was *not* included in the program. Despite widespread skepticism about the cost and environmental effectiveness of a cap-and-trade system, the 1990 CAAA largely avoided imposing supplementary mandates for SO_2 abatement, whether through specific pollution control technology requirements or performance standards for individual plants.[22] This enabled the system to capture the efficiency gains of allowing flexibility in the *methods* of abatement used by different firms and making it possible for firms with high abatement costs to trade with firms that faced low abatement costs.

When the SO_2 allowance-trading program was introduced, power plants around the country had widely different emissions profiles. Older coal-fired plants in the East tended to have high SO_2 emissions, while the relatively newer power plants in the West and Southwest generally had much lower emissions—

21 As one workshop participant noted, resetting the SO_2 cap would have also required future adjustments to the allocation of free allowances under the cap. This would have been politically contentious and could have created an additional source of uncertainty for affected firms. This problem could be alleviated in the future by defining free allocations as a percentage of the cap rather than as a specific number of tons. This practice is routine in fisheries management, which utilizes similar mechanisms known as Individual Transferable Quotas (ITQs). Over the past fifteen years, proportional adjustments to the 1990 allocations have been proposed in unpassed legislation (Acid Deposition Control Act, 1997 [U.S. EPA, Office of Air and Radiation 2000], and Clear Skies Act, 2002 [www.epa.gov/clearskies]) and in finalized regulations (Clean Air Interstate Rule [2005; www.epa.gov/cair] and Cross-State Air Pollution Rule [CSAPR, 2011; www.epa.gov/airtransport]). The latter rules resulted in a significant reduction in SO_2 emissions (beyond Title IV); their impact on allowance prices was complex and is discussed below.

22 More recently, however, new regulations, especially CAIR and CSAPR (see note above), have contained plant-level requirements that have sharply curbed, to the point of virtually eliminating, emissions trading in SO_2.

in part because they were built after the introduction of stringent EPA standards regulating newly-constructed facilities (New Source Performance Standards), and because they burned primarily lower sulfur coal from mines in the West.

Largely because of this heterogeneity, had the 1990 CAAA included a technology (most likely scrubber) mandate, aggregate compliance costs would have been much greater. Technology mandates would also have constituted an obstacle to firms reducing emissions further than was either required by regulation or was otherwise financially reasonable.[23] Absent a requirement to invest in a specific manner to comply with a technology mandate, plant operators who discovered new, cost-effective abatement opportunities had an incentive to implement them so that they could bank or sell the excess allowances (which were then worth more than the avoided emissions as a result of taking advantage of these new opportunities). There is significant evidence of such "over-compliance" under the SO_2 allowance-trading program (as discussed in a later section on the effectiveness of the program's banking provisions).

4. Environmental Effectiveness

Environmental effectiveness refers to the degree to which a policy achieves its objective. In the case of a cap-and-trade program, the question is whether emissions are kept at (or below) the cap. Can cap-and-trade systems (compared with command-and-control regulation) be relied on to produce desired levels of emissions reductions? If the answer were no, cap and trade would probably be a poor policy choice regardless of its cost advantages.

In exploring this question, it is important to make a distinction, relevant to all environmental policy, between the stringency or ambition of the program—that is, whether the goal set for emission reductions is adequate to address the public health or environmental damages that have been identified—and the effectiveness of the policy in achieving whatever goal is set (that is, whether targeted reductions are, in fact, realized). Deciding the stringency of the program—that is, setting the level of the cap—is the first critical step in designing a cap-and-trade system.

Setting the Level of the Cap

The efficient level of pollution abatement occurs when the cost of reducing emissions by one additional unit equals the benefit to society of an additional unit of pollution reduction. In practice, it is

23 A number of Senators from eastern states that produced high-sulfur coal did insert a provision into the CAAA to award bonus allowances to plant operators who installed scrubbers. These states had an interest in promoting greater reliance on scrubbers, since this abatement option—in contrast to fuel-switching options—allowed for the continued use of the high-sulfur coal that was mined in their states (Ellerman et al. 2000, 59, 69–70). The provision was of sufficiently small scope that it did not significantly affect the cost effectiveness of the system.

Taxes vs. Cap and Trade

Emission taxes are a market-based alternative to cap and trade (Metcalf, 2007): Like cap and trade, they create a price signal that provides incentives for emissions reductions while leaving individual firms the flexibility to pursue whatever abatement strategy is least costly for them. Emission taxes have some potentially important advantages over cap and trade: First, they do not require the government to track or allocate allowances and thereby avoid questions about how to allocate allowances in the first place. (Calculating tax charges does require monitoring of actual emissions, just as determining compliance with an allowance-trading system would.) Second, taxes provide price certainty—once government sets the tax rate, everyone knows exactly what the cost per ton will be for as long as the tax is in place (Weitzman 1974). Third, taxes avoid concerns about distortion, manipulation, or excessive price volatility in allowance markets. Finally, in countries that may not have a well-developed institutional infrastructure to support commodity markets, taxes may be a more feasible option, administratively.

Taxes also have disadvantages. Of particular concern to environmental advocates is that a tax does not guarantee specific quantities of emissions reduction. Annual emissions-reductions will fluctuate, depending on the cost and availability of abatement options (which cannot be precisely known in advance) relative to the level of the tax. Second, taxes often raise distributional concerns (e.g., the concern that emission taxes are regressive or might fall more heavily on some groups than others), although it is the case that any regulatory policy creates winners and losers. (See below for more on distributional issues.)

Third, while concerns about market complexities and failures arise with cap and trade, a tax is subject to becoming increasingly complex, to being changed in the future, and to having revenues redirected to other purposes as exemptions, deductions, loopholes, and subsidies are introduced through the interplay of interest-based politics and the legislative process. The most complex aspects of a cap-and-trade system usually involve the distribution of free allowances, but these allocation decisions have no effect on the cost-effectiveness of the system (to a close approximation, but see Stavins [1995]). In tax legislation, by contrast, complexity arises when tax preferences of various sorts are granted to favored interests. Such preferences *do* adversely affect the cost-effectiveness of the system. In particular, when lower tax rates or exemptions are granted to some parties or interests, the same quantity of emissions will have multiple prices. This detracts from the cost effectiveness of the policy. A cap-and-trade system, on the other hand, preserves a single price per unit of emissions, even when relief is granted to favored interests through free allocation.

Finally, and perhaps decisively, taxes are extremely unpopular. Taxes make the costs of abating emissions highly visible, whereas in an allowance-trading system, these costs are less obvious. Having said this, given the extreme fiscal pressures sure to be faced by the U.S. government over coming years and the unpopularity of cap and trade in recent climate debates, it is possible that a carbon tax, in some form, will be among the options considered as lawmakers look for ways to raise needed revenue.

usually difficult to determine the efficient level of abatement, both because it is difficult to assess the marginal cost of abatement in advance and because it is difficult to quantify, in monetary terms, the environmental or public health benefit that would result from an additional ton of emissions reduction. Partly because of this uncertainty, political negotiations over program stringency tend to focus on identifying a level of perceived benefits for which costs are acceptable, rather than employing formal benefit-cost analysis to find the level of action at which the difference between benefits and costs is greatest (Arrow et al. 1996). This was the case both for the Title IV program and in more recent climate proposals.

The explicit and implicit analysis carried out by the George H.W. Bush Administration in the context of the 1990 CAAA focused almost exclusively on the cost side. The benefits considered were those associated with reducing the ecological impacts of acid rain. Not surprisingly, analysts failed to foresee either lower-than-expected abatement costs or the substantial human health benefits of reducing fine particulate pollution, which also originates from SO_2 emissions. Had those lower costs and added benefits been fully appreciated, policy makers might have pursued an even lower SO_2 cap. According to workshop participants, formal analysis was neither fully ignored by nor fully incorporated into the decision-making process; rather it was overwhelmed by heuristic ("back of the envelope") sketches of real and perceived costs—to industry, electricity ratepayers, and the economy as a whole—and of potential environmental effectiveness.[24]

That the SO_2 emissions cap was not determined by formal benefit-cost analysis, but instead reflected a qualitative collective judgment about what constitutes an acceptable balance of cost and environmental protection, does not make the decision about the cap any less important to the design or effectiveness of the cap-and-trade program. On the contrary, the level of the cap in the SO_2 allowance-trading system was very important for political and economic reasons and of great concern to electric utilities. As one workshop participant put it: "Above all, what stands out for me in the policy lessons about acid rain is that the cap is the essential driver. And the best role of government is to have government deciding how much environmental protection it's going to afford and…give the market the flexibility and entrepreneurs the flexibility to figure out how to deliver that in the least expensive way." This view of the central rationale for a cap-and-trade system can be traced to an idea articulated by Baumol and Oates (1971): If it is too difficult to determine what level of pollution control is perfectly efficient in every instance (in the sense that the marginal costs incurred to provide that level of control are exactly offset by the marginal benefits), then government can simply set an acceptable standard and focus on minimizing the costs of achieving it (and perhaps iterating through subsequent adjustments).

24 Benefit-cost analysis has developed very considerably since 1990 and is now more regularly and systematically deployed in meaningful ways to inform policy decisions.

Given that decisions about major new environmental policies are—to some degree—determined by political leaders' evaluations of how both costs and environmental effectiveness will be perceived by stakeholders, a cap-and-trade system offered promise on both fronts. Cap and trade can reduce costs, and it offers a clear and stable environmental target—the emissions cap. The challenge remained, in the case of acid rain, to convince stakeholders that the cap was low enough.[25] By reducing the costs of regulation relative to conventional prescriptive approaches, cap and trade made it politically feasible to reduce emissions more than might otherwise have been the case. Without the cap-and-trade architecture, it is unlikely that a ten million ton reduction would have been endorsed by the Bush Administration or would have had the votes to pass the Congress.

Apparently, the one type of formal economic analysis that White House policy makers *did* consider was the so-called "knee" or "elbow" of the cost curve analysis—that is, identifying the level of pollution control at which the marginal cost of abatement began to increase sharply. Again, there was considerable uncertainty, but it appeared that the knee was in the range of a seven to eight million ton reduction over the approximate time period envisioned for the program. Adopting cap and trade would move the knee up (enabling larger emissions reductions before marginal costs rose sharply), but workshop participants agreed that no one knew by how much. The Bush team eventually chose a ten million ton reduction policy, which was the most ambitious of the three options presented to the President by the Domestic Policy Council at the time, according to workshop participants. (The other options proposed targeted reductions of six and eight million tons.)[26] This ten-million-ton option presented marketing opportunities: It was a double-digit number, and it represented a 50 percent reduction in emissions, both of which signified that Bush was serious about pollution reductions.

Effectiveness in Achieving the Cap

The SO_2 allowance-trading program was highly effective. SO_2 emissions from electric power plants decreased 36 percent (from 15.9 million to 10.2 million tons) between 1990 and 2004,[27] despite the fact that electricity generation from coal-fired power plants *increased* 25 percent over the same period (growing

25 And that the market for allowances would work, but for that see below.

26 It also represented the greatest reduction of the more than 70 legislative proposals offered in the preceding ten years and was consistent with reductions advocated by Canada and the environmental community. For example, a bill sponsored by Senator George Mitchell (D-Maine) called for a twelve million ton reduction from projected 2000 emissions, which was consistent with a ten million ton reduction off actual 1980 levels as contained in President Bush's proposal and the enacted legislation (Jackson 1987; Joskow and Schmalensee 1998, 48).

27 U.S. Environmental Protection Agency, National Emissions Inventory Air Pollutant Emissions Trends Data; "1970–2011 Average annual emissions, all criteria pollutants in MS Excel—October 2011," tab "SO_2," line "FUEL COMB. ELEC. UTIL.". www.epa.gov/ttn/chief/trends/index.html.

from 1.59 to 1.98 billion megawatt hours).[28] The program's long-term goal of reducing annual nationwide utility emissions to 8.95 million tons was achieved in 2007; by 2010 emissions had declined further, to 5.1 million tons, in response to the related Clean Air Interstate Rule (CAIR), which was promulgated in 2005 under the George W. Bush Administration. (CAIR is discussed further in a later section.)[29]

The SO_2 allowance-trading program delivered emissions reductions more quickly than expected. Because of its banking provisions, many utility companies—some of which owned plants that were very dirty and had large and relatively inexpensive abatement opportunities—over-complied in the first phase of the program. As a result, actual emissions during Phase I of the program (1995–1999) fell well below the Phase I target. One workshop participant remarked that the Phase I reduction in emissions was "the most striking feature of [the acid rain] program … There has never, in the history of 40 years of clean air regulation, been a comparable, quick, and significant reduction of emissions at one time." Again, utilities were not compelled to over-comply in the early years of the program; rather, incentives internal to the program led to the decisions that produced these large, early reductions. On the other hand, in the early years of Phase II (2000–2010), national emissions exceeded the national cap as firms applied excess allowances banked during Phase I.

Effective monitoring and compliance mechanisms played a major role in the SO_2 allowance-trading system's environmental effectiveness, in the view of both environmental advocates and industry stakeholders. One participant noted that while he initially opposed the requirement that regulated units install costly, real-time, continuous emissions monitors, he later came to view this requirement as central to the legitimacy of the program.

Although the specific cap was identified and set in a somewhat *ad hoc* manner, the SO_2 allowance-trading system is widely viewed as having been highly effective. The program achieved its emission-reduction goals with relatively little government intervention (of the traditional type) and with very high levels of compliance among regulated entities (compared with significantly lower levels of compliance for most previous traditional regulatory policies). These results were achieved despite considerable concern that the SO_2 allowance market would fail to function properly—a topic to which we now turn.

28 U.S. Energy Information Administration, "Electricity Net Generation: Total (All Sectors), 1949–2010," http://205.254.135.24/totalenergy/data/annual/txt/ptb0802a.html.

29 U.S. EPA, National Emissions Inventory, as above; and U.S. EPA (2011). On CAIR, see notes above and www.epa.gov/cair.

5. Market Performance and Regulatory Complexity

Because a cap-and-trade system for emissions had never been implemented on a large scale prior to 1990, considerable concern arose during the CAAA debate about how well the SO_2 allowance market would work in practice. One potential problem was that the market would have too few buyers and sellers of allowances—insufficient liquidity—to function well. In that case, utilities needing allowances to comply might not be able to obtain them. A related concern was that incumbent firms might use the allowance market to construct barriers to entry against new entrants. To address these issues, approximately three percent of the allowances allocated to installations were retained by EPA and auctioned annually, with the proceeds (less expenses) returned *pro rata* to those same installations. But these concerns did not materialize, and the allowance auction proved to be largely unnecessary for liquidity purposes.[30]

Other potential problems with the SO_2 market centered on access to information and on transaction costs: Specifically, that information about buyer and seller positions might be difficult to access and that transaction costs in the allowance market would be high. Again, these problems did not materialize in practice, and the SO_2 market supported a robust level of trading activity almost from the outset. By March 1998, 20.3 million allowances had been traded between unrelated entities and another 1.3 million allowances had been purchased through EPA auctions (Ellerman et al. 2000, 178). The banking provisions included in the program helped the market adjust to fluctuations in allowance supply and demand over time.

There is broad consensus that the SO_2 allowance market operated transparently and fairly. According to Burtraw and Szambelan (2009, 2), "Transparent data systems, public access to information, and strict and certain penalties for noncompliance have led to a virtually perfect compliance record." And evidence suggests that both traders and EPA auctions played valuable roles in the price discovery process during the early years of the SO_2 allowance-trading system (Joskow, Schmalensee, and Bailey 1998, 676–678).

Excessive price volatility would be an indicator of potential problems in the allowance market, particularly if volatility were driven by trading behavior rather than by changes in market fundamentals. In general, participants at the workshop agreed that SO_2 allowance prices had tracked the fundamentals in the market, but there was some discussion about what can be considered a "fundamental" in a market that is created by regulation. For example, it is unclear if expectations of a future policy change should be considered a "fundamental" in the SO_2 emissions-trading market.

30 The CAAA also included a provision that allowed firms to purchase SO_2 allowances directly from the government at a fixed price of $1,500 per ton. However, SO_2 allowance markets functioned well and allowance prices remained at or below $200 per ton through 2003—well below prices anticipated prior to implementation of the program. The direct sale provision was nullified in 1997 because it was deemed unnecessary. On this, see: www.epa.gov/airmarkets/progsregs/arp/basic.html#auctions.

A major source of uncertainty with any government-created market is that the government can undo what it created—possibly unintentionally. In essence, this is what has transpired in the SO_2 allowance market. It was recognized by the late 1990s that SO_2 reductions in excess of those resulting from Title IV would be required by other provisions in the Clean Air Act and would otherwise be warranted in any case, given the significant adverse health effects of fine particulates associated with SO_2 emissions. Questions remained about how to accomplish these additional reductions. In 2005, after Congress failed to pass President George W. Bush's Clear Skies Act of 2002,[31] which would have tightened the SO_2 cap, the Administration promulgated CAIR with the same intentions. CAIR lowered the cap on SO_2 emissions—in part by applying more stringent emission requirements on certain "upwind [primarily midwestern] states that were contributing to violations of EPA's primary ambient air quality standards for fine particulates in the eastern United States." (Palmer and Evans 2009) CAIR attempted to do so while maintaining the nation-wide, cap-and-trade system (and the allowances) established under Title IV.

SO_2 (Title IV) allowance prices rose in anticipation of CAIR (which one would expect if the cap were to be lowered). Thereafter, an array of factors led to much greater volatility—and reduced liquidity—in the SO_2 allowance market. Among these factors were natural disasters (including Hurricanes Katrina and Rita, which impaired petroleum refining capacity) and developments in broader energy markets. Importantly, in 2008, the D.C. Circuit Court of Appeals ruled that CAAA Title IV SO_2 allowances could not be limited on the basis of facility location to address the other Clean-Air-Act requirements (ambient air standards) in question (U.S. EPA 2011). Neither the Bush nor the Barack Obama Administrations appealed that decision, and congressional attempts to affirm the reduction in the cap (which industry had already begun implementing) were unsuccessful. In response to the court's 2008 decision on CAIR, the Bush and Obama Administrations developed new rules to replace CAIR that employ trading only *within* states and do not employ Title IV allowances; the Cross-State Air Pollution Rule (CSAPR) was finalized in July 2011.[32] Subsequently, SO_2 (Title IV) allowance prices fell to near zero (Burtraw and Szambelan 2009).[33]

In sum, the recent history of SO_2 regulation is complex—and that is the point. The allowance-trading system was highly successful in its first decade of operation, in terms of both aggregate cost and environmental effectiveness—and showed every sign of continuing to be so. However, conflicts arose between market-based and traditional regulatory methods, as well as between objectives specified in law and regulation. While the Title IV allowance market itself functioned transparently, effectively, and with great

31 www.epa.gov/clearskies

32 www.epa.gov/airtransport

33 See also Belden (2005); Bravender (2009); Palmer and Evans (2009); Schmalensee and Stavins (2011, 4–5); Spinney (2011); U.S. EPA (2011). For recent allowance prices, see: www.ferc.gov/market-oversight/othr-mkts/emiss-allow/othr-emns-no-so-pr.pdf.

integrity, the broader regulatory environment for this market—to the chagrin of almost all stakeholders—served to end its life prematurely.

6. Distribution of Allowances and Fairness of Impact

A program that is seen as unfair or inequitable in its distribution of benefits and costs can have difficulty winning political support. Three distributional issues are particularly relevant to the SO_2 allowance-trading system: (1) the method by which emissions allowances were allocated; (2) the geographic distribution of program benefits and costs; and (3) the distribution of benefits and costs across socio-economic groups.

Allowance Allocation

To a close approximation, regulated entities in a cap-and-trade system will face the same incentives to reduce emissions, regardless of how allowances are initially allocated, including, specifically, how many allowances a given firm holds at the outset (Montgomery 1972). What matters with regard to firms' decisions to trade or abate are marginal abatement costs, and these costs are generally unaffected by the initial allocation of allowances.[34]

Emissions allowances have monetary value as a result of the aggregate cap placed on emissions, combined with the system's enforcement mechanisms. Government, in effect, is creating a new commodity (that is, a new property right in limited supply, in place of a previously unlimited open-access resource) and must decide at the outset how to transfer that commodity to the private entities that will need it to demonstrate compliance. As discussed above, the government has two basic options: Allowances can be given away or sold (preferably through an auction, which will facilitate smooth functioning of the market).

The intent of the Acid Rain Program was to cut permitted emissions in half. To achieve this goal, emitters were expected to incur billions of dollars per year in new compliance costs. Congress and the George H.W. Bush Administration judged that it was politically untenable to double the cost of the legislation by requiring SO_2 emitters to pay the government for the emissions they were still allowed under the new policy. In particular, the free allocation of allowances was critical for gaining the support, or at least the acquiescence, of the expected "losers" in the SO_2 allowance-trading program—that is, high-sulfur-coal-intensive power companies in the Midwest and their congressional representatives.

34 For an examination of the conditions under which this theorem of the independence of the initial allocation from the equilibrium allocation after trading is violated, see Hahn and Stavins (2010). See also Stavins (1995).

Free allowances represent a cash transfer to firms and so can be used to compensate firms that face particularly high costs, without changing the cap or distorting the market incentives of the program that lead to a cost-effective solution. Although free allowances can, under some circumstances, constitute a significant windfall, the option to freely allocate some or all allowances nonetheless provides an opportunity to build political support for a nascent cap-and-trade program. Conversely, an auction forces emitters to pay for permitted emissions for which they have previously not had to pay.[35]

Indeed, members of Congress fought intensely to increase the share of freely allocated allowances that would go to utilities in their home districts, as a means to sell the SO_2 allowance-trading program to constituents.[36] In the end, the distribution of free allowances to individual firms was largely based on prior regulatory benchmarks associated with emissions per unit of heat. This general principle allowed for considerable political horse-trading at the margin, however—that is, awarding a few more allowances to a particular plant in a particular district while maintaining the total cap—to win support for the overall policy.[37]

At the time the CAAA were being debated, consumer advocates, economists, and environmental organizations exerted little pressure to consider alternatives to free allocation, the most significant of which is an auction that would raise public revenues. Economic analyses conducted since that time have elucidated the relative merits of free allocation and auctions, with regard to distributional issues and cost-effectiveness. Three conclusions are relevant to the SO_2 allowance-trading program:

1. Unless the overall emissions cap is very stringent, the sum of the market value of allowances is likely to substantially exceed the total abatement costs incurred to meet the cap. Thus, recipients of free allowances are likely to be overcompensated for their actual compliance costs, resulting in a windfall.[38]

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35 As noted above, EPA each year withheld a small number of allowances (2.8 percent of the total) to sell through a spot auction. This provision was originally introduced to ensure that new entrants could obtain the allowances they needed to operate, and in the early years it may have provided valuable information on future allowance prices. The first spot auction was held in 1993, two years before Phase I went into effect. This auction indicated that allowance prices were likely to be lower than the industry had predicted. This information led several companies to cancel orders for expensive scrubber systems. See also Ellerman, et al. (2000, 175).

36 For detailed quantitative analyses of the political economy of the congressional process that determined allocation methods, see Joskow and Schmalensee (1998) and Ellerman et al. (2000, 31–76).

37 An important adjustment that was made for political purposes was to allow utilities to select the average annual fuel consumption of a plant in the years 1985-1987, to account for those power plants that were operating at less than capacity or were inoperative for maintenance for all or a portion of the year 1985.

38 The magnitude of the windfall to emitters could be even more significant in the context of a much larger market for greenhouse-gas allowances. The experience of the European Union Emissions Trading System provides some evidence for this windfall effect. An approach that would fully compensate emitters (on average, across all sectors) in a U.S. economy-wide CO_2 cap-and-trade system would initially auction 50 perecent of the allowances and move gradually to a 100 percent auction over 25 years. This would be roughly equivalent to a 15 percent free allocation in perpetuity (Stavins 2008).

2. In competitive markets, free allocation does not reduce firms' incentives to pass the marginal cost of emissions control (as reflected in the market price of allowances) through to customers. Again, this is because the cost to a firm of using an allowance is the same whether the firm already holds the allowance (in which case it is foregoing the opportunity to sell that allowance at the market price) or has to purchase the allowance. This means that a large share of the costs of a cap-and-trade program can be expected to ultimately be borne by consumers. In effect, free allowances amount to a transfer of wealth from consumers to the shareholders of the firms holding the free allowances. However, under cost-of-service regulation of electric-utility companies, which is still in place in many states, regulators are unlikely to allow firms to pass through the market price of allowances if those allowances have been received for free. In these cases, free allocation will lead to lower electricity prices. This will create significant differences in effects in different regions of the country, based on whether markets are competitive or regulated.

3. An allowance auction generates public revenues that can be used to reduce distortionary taxes in the economy (especially taxes on income or investment).[39] In this way, an auction can improve overall economic efficiency and reduce costs to society, even though the private costs incurred for pollution abatement under the policy remain unchanged.

Regional Distribution of SO_2 Program Costs and Benefits

Most of the nation's coal-fired, electric-generating capacity is concentrated east of the Mississippi River, and much of that capacity was built more than a generation ago.[40] Plants in the West tend to be newer. Air pollutants emitted from the tall smokestacks of older plants are transported long distances in the lower atmosphere, causing environmental harm hundreds and even thousands of miles from their sources.[41] Because of prevailing west to east wind patterns, much of the pollution emitted by large coal plants in the upper Midwest and Ohio River Valley is carried to the northeastern and mid-Atlantic states (as well as eastern Canada). Thus, it was reasonable to expect that most of the cost of SO_2 controls would be concentrated in the midwestern states, while most of the benefits would accrue to northeastern states.

However, from the beginning, there were concerns that a cap-and-trade system could not guarantee that emissions reductions would occur in the quantities and *at the locations* needed to protect all areas from environmental harm. Indeed, the advantage of cap and trade is that it directs abatement to where it

39 This is an application of a more general principle that society would often benefit from shifting the burden of taxation from social "goods" (primarily investment or income) to social "bads" (such as pollution).

40 In aggregate, coal-fired capacity in the United States (approximately 330 gigawatts in 2000) had an average age of 35 years in 2002 (Deutch, Moniz, et al. 2007, 17–18).

41 The tall stacks employed by coal-fired power plants were themselves a response to earlier Clean Air Act regulations that governed ambient concentrations of SO_2 and other so-called criteria air pollutants.

is least costly, not necessarily to facilities causing the most geographic-specific damage. Northeastern states worried that the ability to buy allowances in lieu of installing SO_2 controls might leave upwind sources too much latitude to avoid making the actual emissions reductions needed to address downwind impacts.

New York and North Carolina, among other eastern states, implemented their own regulations to direct abatement to where it would produce the most benefits for their residents. New York, in particular, conducted a lengthy legal campaign to maintain its more stringent standards (Palmer, Burtraw, and Shih 2005; Stavins 2003, 28–29; Winebrake, Farrell, and Bernstein 1995, 244–246). These actions highlight something of a tension between geographically broad-based, cap-and-trade approaches and state and local authorities' desires to limit emissions within a particular area or from a particular set of sources. As suggested in the discussion of regulatory complexity above, extending the allowance-trading program over the largest geographically-relevant area and minimizing (or eliminating) overlapping regulatory requirements was key to realizing its potential to be cost-effective. On the other hand, any source that might be compelled by state or local regulations to implement extra pollution controls would end up with extra allowances under the federal program that could then be sold to other sources in a different jurisdiction.[42] The end result would be no net change in total emissions over the larger region covered by the cap.

Distributional concerns also arose with respect to impacts on electricity rates. To the extent that midwestern utilities implemented the largest share of SO_2 reductions, they (and their ratepayers) also incurred the largest share of SO_2 control costs. Nevertheless, the SO_2 allowance-trading system on the whole did not produce substantial rate differentials across regions, in part because overall compliance costs ended up being quite low, but also because coal hardly ever sets the electricity price in competitive markets. As a result, the effect of the program on marginal electricity prices was small. This was true despite it being common in regulated electricity markets for state regulators, legislators, or both to adopt policies that discouraged the pursuit of least-cost compliance options.

For example, a number of states tried to direct in-state utilities toward using in-state coal or installing scrubbers so they could continue using in-state, high-sulfur coal rather than taking advantage of lower cost fuel-switching options from out-of-state sources. Such state policies were struck down by the courts as interference with interstate commerce. These types of policies would have made the national SO_2 trading program more costly. Nonetheless, the rate impacts were still small, particularly since electricity rates in the regulated, coal-intensive areas of the Midwest were generally quite low to begin with (and considerably lower than rates in the downwind northeastern states).

42 For a discussion of parallel concerns about the interaction of federal and state regulations, pertaining to greenhouse gases, see Goulder and Stavins (2010).

The acid rain experience and subsequent debates about the use of cap and trade in other contexts suggest that issues of geographically-specific impacts and state and local control should be considered in light of the type of pollutant being regulated, its behavior in the environment, and the specific harm being addressed. For some pollution problems, particularly those characterized by well-defined relationships between sources and points of damage (receptors) combined with increasing marginal receptor damages, cap and trade (or other flexible, market-based mechanisms) can lead to problematic "hot-spots"—or geographically-concentrated damage—which increase total damages and hence may not be appropriate. By contrast, in the case of climate change, the location of the emissions source has no bearing whatsoever on its environmental impact: GHGs are evenly distributed throughout the global atmosphere, thus emissions from any given source have the same warming effect on the atmosphere as GHGs emitted anywhere else. From this perspective, cap and trade and other market-based approaches are especially well suited to limiting GHG emissions.

On the spectrum from pollutants with primarily local impacts to pollutants with entirely global impacts, SO_2 falls in the middle: Because of its transport and deposition properties, emissions impacts may be dispersed over a very broad region; at the same time there was some heterogeneity in the distribution of benefits across the nation. Concerns about local impacts or potential hot-spots were to some extent alleviated by the existence of separate regulatory protections in the form of federally-mandated ambient air quality standards for SO_2.[43] In addition, modeling analyses undertaken prior to passage of the 1990 CAAA pointed to the likelihood that the distribution of actual emission cuts would be highly correlated geographically with the distribution of the largest and most damaging emissions sources. Thus, policy makers could be reasonably confident that a single national SO_2 market would drive substantial emissions reductions in the Midwest, where the largest coal plants were concentrated. This confidence was largely borne out as the program was implemented (Ellerman et al. 2000, 77–80; Swift 2004, 7–8).[44]

As discussed above, provisions in the Clean Air Act concerning ambient air standards led the EPA under the George W. Bush Administration to develop CAIR, which attempted to reconcile geography-specific remedies with national allowance trading. The courts determined that this attempt was inconsistent with the Clean Air Act and vacated CAIR. The replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR, initially known as the Clean Air Transport Rule), addresses the concerns of the courts, but

43 Near the opposite end of the spectrum from GHGs, the EPA under the George W. Bush Administration attempted to implement a trading system related to its Clean Air Mercury Rule (CAMR), which was intended to reduce mercury emissions from coal-fired power plants. Mercury is not transported far from its source, and concern about hot-spots was one factor (among several) in CAMR not being implemented.

44 Perhaps further vindicating this approach, later efforts to address acid rain in Europe through smaller, regional cap-and-trade programs illustrated the problems that can arise with thin, regionally differentiated markets.

in so doing, effectively eliminated national (interstate) allowance trading[45] in favor of more geographically-restricted trading intended to focus the health benefits of emissions reductions on specific downwind states. This will reduce cost-effectiveness in favor of what is intended to be a more equitable distribution of benefits across geographical regions (Belden 2005; Nelson 2011; Schmalensee and Stavins 2011; U.S. EPA 2011).

Distribution Across Socio-Economic Groups

Any public policy raises concerns about how the benefits and costs of that policy are distributed across socio-economic groups. As suggested in the foregoing section, the possibility that a facility chooses to purchase allowances rather than reduce emissions could result, under certain conditions, in decreased local air quality. In their study of the SO_2 allowance-trading system, Shadbegian, Gray, and Morgan (2005) found that low-income groups received slightly lower benefits than people of higher income, but that minority groups received significantly greater benefits, relative to cost, than the average population. It is likely that this was because minorities are concentrated in cities, where the local health benefits of reduced SO_2 concentrations dominate the benefit-cost analysis.

Evidence indicates that the SO_2 allowance-trading system did not lead to significant hot-spots. A number of explanations for this result were offered at the workshop. One explanation is that local and state regulations—including those intended to achieve compliance with National Ambient Air Quality Standards—tended to preclude hot-spots; another is that trading in conjunction with a significant overall reduction in emissions (via the cap) tended to lead to reductions at the largest-emitting facilities and to smoothing out emissions over space, rather than concentrating them (Swift 2004).

7. Technological Innovation

Advances in technology can expand the menu of abatement options available and substantially reduce the cost of achieving emissions reductions. In choosing among different policy instruments, it is important to consider whether some options are more effective at inducing technology innovation than others (or at least pose fewer impediments to innovation).

On its face, a market-based approach would seem to have advantages over a command-and-control-based approach for at least two reasons: First, the greater flexibility of a market-based approach provides greater latitude for regulated entities to pursue compliance strategies that might not have been an-

45 Previously allowed by the same Court in 2000 when ruling on the NO_x Budget Trading Program (U.S. EPA, National Center for Environmental Economics 2001, 84).

ticipated by policy makers at the outset of the program. Second, while a command-and-control system can create incentives for reducing the costs associated with achieving a given environmental standard, it does not provide incentives for out-performing the standard (or "over-complying," as discussed above).[46] A market-based program, by contrast, creates continuous incentives for innovation, since each additional ton of reduction that can be achieved for less than the market price of an allowance creates value for the entity that produces those reductions. In looking at these issues from the standpoint of real-world experience with the SO_2 allowance-trading system, workshop participants considered the record of innovation in two areas: with respect to improvements in scrubber technologies and with respect to the diffusion of a broader set of emissions-reducing practices unrelated to the use of any particular technology.

Scrubbers—as noted, by far the prevalent technology for removing SO_2 from power-plant emissions—were an established technology in 1990. Environmental regulation under the 1970 Clean Air Act had made the use of scrubbers an important compliance option in newly-built coal-fired power plants (Lange and Bellas 2005). The 1970 legislation had specified an emissions rate that could be met through use of low-sulfur coals found in the East and West, but in response to the 1977 Clean Air Act Amendments, regulations were tightened to require a 70–90 percent removal of SO_2 from the emissions of uncontrolled coal. This could only be accomplished through the use of scrubbers. The 1977 bill also required a 90 percent reduction of emissions from new sources relative to the emissions levels that would prevail without mandated control. This further encouraged the use of scrubbers.

More than half of currently installed SO_2 scrubber systems were installed after the 1990 CAAA, but the timing of more recent installations has come in bursts. From 1990 through 2000, scrubbers were installed at a nearly constant rate; installations slowed early in Phase II of the Acid Rain Program (after 2000), however, as growth in electric-sector demand slowed and as utilities used banked allowances from Phase I to meet their compliance obligations. For utilities subject to Title IV requirements after the passage of the CAAA in 1990, the decision to install scrubber systems involved multiple considerations: the strength of the price signal for SO_2 reductions (as reflected in the market price of SO_2 allowances); the cost and feasibility of other abatement options (such as fuel switching); investment risk (including uncertainty about future allowance prices and about the susceptibility of SO_2 markets to price volatility); cost recovery rules (in the case of regulated utilities); and the effects of state-level (Frey 2008) or other federal regulatory and financial incentives.[47]

46 Under certain conditions, a command-and-control system might even create *disincentives* to further improving on available control technologies—particularly if regulated entities view these improvements as opening the door to ever more stringent pollution control requirements.

47 One workshop participant pointed out that utilities likely considered another advantage of scrubbers: These systems generally can be shut down or bypassed to increase output during periods of high electricity prices and demand. To compensate for excess emissions released during these periods, utilities can purchase allowances or operate at a more stringent level of emissions control during periods of lower demand.

The wave of scrubber installations (technology diffusion) that occurred in the 1990s was attributable in large part to the incentives created by the SO_2 cap-and-trade program, since the high cost of these systems could only be justified in expectation of non-trivial SO_2 allowance prices. Some evidence also suggests that the program succeeded at inducing innovation in scrubber technology. Scrubber performance has improved over the last two decades, and the costs of achieving a fixed level of scrubber performance have declined (Bellas and Lange 2011; Popp 2003; Lange and Bellas 2005; Burtraw 2000; Burtraw and Palmer 2003, 22–24).[48]

The SO_2 allowance-trading program also appears to have sparked innovation in a range of compliance alternatives that could reduce SO_2 emissions without necessitating the use of add-on pollution controls. One example was the diffusion of mining techniques for extracting lower-sulfur coal seams, a practice that was known before the 1990 CAAA but not in wide use. A related strategy deployed in the 1990s involved blending low-sulfur coal with high-sulfur coal to reduce the aggregate sulfur-intensity of boiler fuel. Prior to 1990, many in the industry believed that existing boilers could accommodate only modest levels of fuel blending unless modifications were made that required large capital investments. After the cap-and-trade program went into effect, this view was disproved, with some plants achieving blend levels of as much as 40 percent without significant modifications. Clearly, fuel switching would not have evolved to become a significant compliance option had the government pursued a more prescriptive regulatory policy that required all emissions sources to install add-on controls.

The SO_2 allowance-trading program also stimulated non-technological innovations in the electric utility industry. These included strategies for managing allowance trading within a firm and creating the appropriate financial management and brokerage capacities needed to exploit new market opportunities. More generally, the cap-and-trade system, by its nature, granted the flexibility of a performance (as opposed to a technology) standard on individual sources, and then allowed trading. In other words, even without trading, the cap-and-trade system was less costly than an inflexible technology standard would have been. Workshop participants characterized this as facilitating "cost savings without trading" (Burtraw 1996). Along with improvements in SO_2 control technologies, these examples of innovation and knowledge diffusion played some role in reducing overall Acid-Rain-Program costs and were seen by workshop participants as strengthening the innovation case for favoring market-based environmental regulation.

48 Some cost reduction was probably the result of learning through using, as the number of installed scrubbers increased. Also, a market emerged for much cheaper scrubbers that were somewhat less reliable than New Source Performance Standards allowed, which lowered average cost.

8. Political Context of the Acid Rain Program

In July 1989, President George H.W. Bush proposed substantial revisions to the Clean Air Act, based in part on earlier congressional proposals and in part on new ideas developed by his Administration. The final bill containing the CAAA of 1990 passed the House of Representatives by nearly a 20 to 1 margin (401-21) and the Senate by a large majority (89-11). A joint conference committee met from July to October of 1990 to resolve differences in the House and Senate bills, and both houses approved the package recommended by the conferees with almost identical majorities.[49] The President signed the resulting bill into law on November 15, 1990. The Amendments contained seven titles, each of which substantially updated an existing portion of the Clean Air Act. In addition to the acid rain title (IV), these included programs related to urban smog, industrial emissions of certain toxic chemicals, automobile emissions, and releases of chemicals that deplete ozone in the upper atmosphere.[50]

Unlike most earlier pieces of landmark environmental legislation, the CAAA of 1990 was not precipitated by a "crisis moment," which may have given policy makers greater latitude to implement a flexible and entrepreneurial policy, rather than resorting to a more rigid traditional approach (Wiener and Richman 2010). On the other hand, some workshop participants did point out that concern about the environment was rising generally in the summer of 1988, with unusually hot weather contributing to poor air quality (as evidenced by a high level of ambient ozone—smog—that summer), and with many reports of ocean pollution in New York and New Jersey.

Some workshop participants asserted that the Acid Rain Program flew "under the radar," in terms of the attention it received both from the public and environmental advocacy groups—perhaps because they were more concerned about changes to other portions of the Act or perhaps because the issue had been debated for more than ten years, and the levels of control were consistent with what environmental groups had advocated. These factors allowed for a more calm and deliberative debate about the choice of policy instruments than might have been possible under other circumstances. The Bush Administration, the Congress, and policy entrepreneurs were important in these developments and helped facilitate the adoption of the national SO_2 trading program as part of the Clean Air Act Amendments of 1990.[51]

49 See legislative chronology at www.epa.gov/ttn/caaa/gen/chron.txt.

50 For a summary of the amendments, see: http://epa.gov/oar/caa/caaa_overview.html; For the text of Title IV, see: http://epa.gov/oar/caa/title4.html.

51 For an account of the political and policy process, see Conniff (2009), and for a concise account of the individuals who contributed to the development of the SO_2 allowance-trading program, see Yergin (2011, 471–479).

The Bush Administration

The administration of President Ronald Reagan had been unfavorably inclined to address public-policy problems—including environmental challenges—through regulation. This approach had served Reagan well, on balance, with regard to public opinion about his stewardship of the economy. But it began to present potential political costs for the subsequent Republican presidential candidate, as environmental issues became increasingly important for key demographic groups in swing states with large suburban populations leading up to the 1988 election.

In 1988, Vice President George H.W. Bush made the environment a key theme of his presidential campaign, explicitly promising to update the Clean Air Act and to cut acid rain by half. On February 9, 1989, three weeks after taking office, President Bush addressed a joint session of Congress and said of acid rain that "the time for study alone has passed, and the time for action is now."[52] Five months later, his administration submitted to Congress a single, comprehensive clean air bill, which included the basic structure of the SO_2 allowance-trading program.

Given the confluence of President Bush's ideological preferences and his campaign commitment to reducing SO_2 emissions, it was perhaps not surprising that his administration put forward a market-based approach to SO_2 regulation. The Reagan Administration had deregulated many key sectors of the U.S. economy, including airlines, oil and refined oil products, and trucking.[53] The limits of a command-and-control-style approach to governing had become readily apparent with the collapse of the Soviet Union. With the economic growth of the 1980s beginning to slow, President Bush was concerned about the economic impact of the bill. He wanted to improve air quality at the minimum possible cost to industry and the economy as a whole and believed that a market-based approach could accomplish this.[54]

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52 http://millercenter.org/scripps/archive/speeches/detail/3420

53 However, the Staggers Rail Act, which deregulated railroads and made low-sulfur, Powder River Basin coal more competitive (see above), was passed under President Jimmy Carter in 1980.

54 While workshop participants acknowledged the Bush Administration for its leadership in the legislative process, participants also noted that Bush never received sufficient credit for the CAAA from the environmental community or the press. They were struck by President Bush, despite having launched a number of exceptionally important environmental initiatives, failing to win a single endorsement from an environmental advocacy group in his 1992 reelection bid, opposing Bill Clinton, the Governor of Arkansas, a state then ranked 50th in terms of environmental protection. (Besides the 1990 CAAA, the Bush Administration also funded sewage treatment plants around the country, created 57 new wildlife refuges, designated more than a million acres of new national park land, and included the United States as a signatory to the Rio Convention on Climate Change.) Some of the participants at the workshop who had served in the Bush White House believed that this lack of recognition was a major factor in the Republican Party's subsequently giving up on the environmental vote, concluding Republicans would never win support from environmental interest groups no matter what policies they pursued. Others believed that the negative messages on the environment sent during the eight years of the Reagan Administration and the last two years of the Bush Administration, through the actions of the Council on Competiveness to delay and dilute implementation of the CAAA and other laws, had undermined the support gained through enactment of the 1990 CAAA.

Congress

Bush came into office confronting large Democratic majorities in both houses of Congress. Thus, all involved knew that legislation could not be enacted without considerable bipartisan support. Congress was, on balance, already strongly inclined toward strengthening air quality protections. The Senate Committee on Environment and Public Works had promoted acid-rain legislation for a decade, but it had never gone anywhere, in part because the Majority Leader of the Senate, Robert Byrd (D-West Virginia), represented a state with a high reliance on the mining of (high-sulfur) coal, and in part because the Committee had a history of reporting legislation not sufficiently centrist to attract filibuster-proof majorities in the Senate. But, in November 1988, George Mitchell (D-Maine) was elected Majority Leader, replacing Byrd; Maine was among the states most affected by acid rain.

While Mitchell enjoyed a Democratic majority in the Senate, his coalition was not sufficient to guarantee the 60 votes necessary to invoke cloture in the event of a filibuster against acid rain legislation, especially given disparate regional views within the Democratic Party itself. Thus, the new Majority Leader knew he had to negotiate with the new Bush Administration in order to secure enough votes to steer clean air legislation to passage in the Senate. In this way, both George H.W. Bush (because of his campaign promise and his concern about the economy) and George Mitchell (because of his need for a 60 vote majority) were motivated to negotiate with each other to win passage of a clean air bill acceptable to both parties. Observers at the time, and in the period since, have attributed passage of the CAAA in 1990 to leadership by "the two Georges."

The seminal moment in the debate came when President Bush sent a letter to the Majority Leader indicating that any clean air bill he would sign would have to meet "five tests of balance and reasonableness," the most important of which was that its compliance costs could not exceed $20 billion annually (plus or minus 5 percent). This led to a protracted negotiation between representatives of the Administration and members of the Senate, led by Senator Mitchell, to craft a bill that could achieve the desired environmental outcomes and pass those tests. After months of negotiation, the Administration and the Senate leadership announced an agreement that withstood challenge from both the political left and the political right on the Senate floor and led to passage of the CAAA in the Senate by the above-noted margin of 89-10, with an equal number of Republicans and Democrats voting against.

In the House, the range of competing interests involved in the acid rain debate was well represented in the Committee on Energy and Commerce, which included representatives from eastern (high-sulfur) coal-producing and coal-using states, several of the northeastern states that were most affected by acid rain, and several western low-sulfur coal-producing and -using states. The politics of the electric power industry was divided more along regional lines than along party or ideological lines, with coal-intensive districts in the Midwest concerned about stranded capital investments and districts in the West apprehensive of applying differential regulatory treatment to new and existing capital. On the broader topic of clean air, the Committee also represented a wide range of interests, even within parties. The diversity of views was best represented in the long-standing tension between the Chairman of the Committee, Rep. John Dingell (D-Michigan), who represented areas of Michigan in which the automobile industry was an important employer, and the Chairman of the Subcommittee on Health and the Environment, Rep. Henry Waxman (D-California), whose Los Angeles district suffered from the worst smog in the country.

In the 1970s and 1980s, representatives from the northeastern states and environmental advocates had put forth a steady stream of acid rain bills. But the coalitions needed to pass these bills had never been able to overcome the fault lines that formed on the basis of regional differences in mitigation costs. According to one workshop participant, members of the House Subcommittee on Energy and Power (the subcommittee with initial jurisdiction over the SO_2 trading proposal) were not reflexively opposed to environmental regulation as such, but were genuinely concerned about the impact of higher electricity rates in their districts. These representatives were in principle open to reducing SO_2 emissions as long as they could be confident that their constituents would receive a "fair" deal.

Policy Entrepreneurs

The proposal for what became the SO_2 allowance-trading system was part of a legislative package developed by the George H. W. Bush White House. But where did the White House get its ideas, and how did it develop them? In addition to elected officials, the environmental and academic communities played key roles. In 1960, University of Chicago Professor Ronald Coase laid the intellectual foundation in the *Journal of Law and Economics* (Coase 1960) for the notion of using markets to solve environmental problems. Then, U.S. economist Thomas Crocker (1966) and Canadian economist John Dales (1968) followed up by arguing that the best way to clean up air and water pollution would be with a market in rights to emit pollution. These arguments were made much more rigorous a few years later when David Montgomery—a workshop participant—demonstrated in the *Journal of Economic Theory* (Montgomery 1972) precisely how and why an emissions-trading system would be cost-effective. Prominent legal scholars also advocated emissions trading (Ackerman and Stewart 1985). These and other explorations in the academic world eventually led EPA to experiment with small-scale emissions-credit-trading systems in the 1970s and 1980s, including most importantly the phase out of leaded gasoline in vehicle fuel in the mid-1980s.

The design and implementation of a much larger-scale allowance-trading program required the participation of committed policy entrepreneurs. George H.W. Bush, as already noted, was one. Several of those later involved in the Bush Administration played key roles in formulating President Bush's campaign commitments on the environment. Robert Grady (a workshop participant), chief speechwriter and senior policy adviser on the 1988 campaign, joined the White House staff as Associate Director of the Office of Management and Budget in charge of Natural Resources, Energy, and Science. Robert Zoellick, issues director on the campaign, became Under Secretary of State and later White House Deputy Chief of Staff. C. Boyden Gray (a workshop participant), who had advised Vice President Bush earlier on the White House Competitiveness Council that oversaw the phase out of lead in gasoline, became White House Counsel.

Ironically, in light of the political dynamics of the recent climate debate, the main opposition to market-based environmental policies at the time came from environmental advocacy groups (with an important exception highlighted below) and from Democrats (with a few important exceptions, also highlighted below). Some of these advocates thought that a policy based on the principle that firms could "pay to pollute" was morally bankrupt; they worried that the very creation of tradable allowances implied that firms had a right or an entitlement to emit. In their view, the government should continue to regulate private-sector emissions through command-and-control regulation, in effect setting minimum control standards or technology requirements for each individual emissions source.

Among the major environmental advocacy groups, it was the Environmental Defense Fund (EDF) that set itself apart from its environmental brethren by backing market-based approaches to environmental protection, including for acid rain control. EDF was led then (as now) by Fred Krupp, another workshop participant. When EDF helped the Bush Administration design, and later announced its support of, the trading component of the CAAA, it was a "Nixon-in-China" moment and a turning point in the politics of market-based regulation. Several workshop participants from the Bush White House confirmed that the SO_2 trading program could not have won congressional support had EDF not provided the administration with the necessary credibility from within the environmental community.

Two policy entrepreneurs in the U.S. Senate, Timothy Wirth (D-Colorado, now President of the United Nations Foundation) and the late John Heinz (R-Pennsylvania), together created and chaired Project 88, which developed a compelling economic proposal for a market-based program to reduce SO_2 emissions through a cap-and-trade system (Stavins, 1988).[55] In 1988, shortly after the election and even before inauguration, C. Boyden Gray brought the director of the Heinz-Wirth Project 88 effort, Robert Stavins

55 See also the Heinz Family Philanthropies' web page for Project 88: www.heinzfamily.org/aboutus/project88.html.

(then a new assistant professor at the Harvard Kennedy School), to the White House, together with Fred Krupp and key members of the EDF staff. Gray also recruited emissions-trading advocate Richard Stewart, a law professor at Harvard, to serve as the top environmental lawyer at the Justice Department.

The development, adoption, and implementation of the Acid Rain Program—as any major innovation in public policy—can be attributed to a solid base of knowledge, sound strategy, and a certain amount of luck in placing effective policy entrepreneurs in important positions, in this case at the White House, EPA, the Department of Justice, the Congress, and environmental organizations.[56] These entrepreneurs, working together on the Acid Rain Program, made a break with the past with regard to environmental policy.

9. Conclusion

More than twenty years later, the introduction of the national SO_2 allowance-trading program as part of the Clean Air Act Amendments of 1990 remains widely regarded as a landmark step in the worldwide history of environmental regulation. The program, while not without flaws, is viewed as a success by almost all measures. Certainly it demonstrated that broad-based cap-and-trade systems can be used to achieve significant emissions reductions, that firms can navigate and regulators can enforce the compliance requirements of such systems, and that giving the private sector the flexibility to pursue a range of abatement options can simultaneously protect the environment, stimulate innovation and diffusion, and reduce aggregate costs.

The SO_2 allowance-trading program was enacted with large bipartisan majorities and was successful in reducing SO_2 emissions at a cost much less than a traditional-regulatory approach would have incurred (and less than had been predicted). The program was partially inspired by the belief that the shortcomings of earlier emissions-credit-trading programs could be overcome with a cap-and-trade design and strong monitoring. The program's subsequent success in turn inspired other market-based emissions-reductions programs, including the much larger European Union Emissions Trading System.

56 Other active and influential enthusiasts of market-based environmental instruments were: In the White House, Deputy Counsel John Schmitz, Domestic Policy Adviser Roger Porter, Council of Economic Advisers (CEA) Member Richard Schmalensee, and CEA Senior Staff Economist Robert Hahn. (All except Schmitz were workshop participants.) At EPA, Administrator William Reilly enjoyed valuable credibility with environmental advocacy groups; Deputy Administrator Henry Habicht and Assistant Administrator for Air and Radiation William Rosenberg were key, early supporters of market-based instruments. At EDF, in addition to Fred Krupp, Senior Economist Daniel Dudek and Staff Attorney Joseph Goffman worked closely with the White House to develop the initial allowance-trading proposal.

The broad political consensus on the CAAA of 1990 was hard-won. A number of influential stakeholders engaged in a decade of often contentious deliberation and negotiation—including intense discussion about the Title IV provisions—before Congress passed the Amendments. Divergent views on the CAAA largely reflected regional differences in the distribution of coal-fired power plants and coal types. But the advent of the proposed allowance-trading program facilitated the consensus that emerged among leaders in the Bush Administration, lawmakers in Congress, and many affected corporations and business associations (Joskow and Schmalensee 1998). Thus, the SO_2 allowance-trading program made it possible to focus on how one could achieve the agreed public policy goal (in this case, reducing acid rain pollution) in a manner that would simultaneously minimize costs and provide regulated entities with the flexibility embodied in markets.

The recent climate debate has taken place in a political context that is much different than that of the CAAA of 1990. Deep ideological division dominates today's dialogue in Washington; the two major political parties were much less ideologically polarized in 1990. A convergence of the creative vision and the large bipartisan majorities of 1990 appears much less likely today. Recent hostility toward cap and trade in U.S. climate legislation may reflect the broader political environment of the climate debate more than it reflects the substantive merits (or demerits) of market-based regulation. In other words, congressional hostility toward greenhouse-gas cap and trade appears to have been collateral damage in a wider set of policy and ideological battles.

Ironically, the cap-and-trade model seems especially well suited to addressing the problem of climate change, in that emitted GHGs are evenly distributed throughout the world's atmosphere. Emissions reductions anywhere make identical contributions to helping alleviate the problem, and there are no pollutant concentration hot-spots. The sheer number and variety of GHG-emissions sources heightens the practical difficulty of developing a comprehensive and effective command-and-control approach and magnifies the cost savings that could be achieved by enlisting the market to find the least costly abatement options.

It is difficult to achieve an international agreement to limit GHG emissions, however, for precisely the same reasons—many countries, hosting many emissions sources, must agree to take action. Given the complexities of either developing a domestic U.S. cap-and-trade system for GHGs or obtaining congressional approval for an international system in which the United States participates, it is likely that at least as much bipartisan collaboration would be required as was evident in the CAAA process. Instead, we have much less.

The stakes for a broad-based GHG policy—economic, political, and environmental—are much higher than they were for SO_2 policy in 1990. While the debate over federal policy to address climate change is currently in hiatus, the lessons of the SO_2 allowance-trading program will prove useful and relevant to future deliberations about climate change policy when the time arrives for serious reflection.

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