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What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading

Robert N. Stavins

Economists consistently have urged the use of "market-based" or "economic-incentive" instruments—principally pollution taxes and systems of tradeable permits—to address environmental problems, rather than so-called "command-and-control" instruments, such as design standards, which require the use of particular technologies, or performance standards, which prescribe the maximum amount of pollution that individual sources can emit. At least in theory, a well-designed pollution tax (Pigou, 1920) or tradeable permit system (Crocker, 1966; Dales, 1968; Montgomery, 1972) will minimize the aggregate cost of achieving a given level of environmental protection (Baumol and Oates, 1988), and provide dynamic incentives for the adoption and diffusion of cheaper and better pollution control technologies (Milliman and Prince, 1989).

Despite such advantages, market-based environmental instruments have been used far less frequently than command-and-control standards. In particular, while taxes have been imposed on certain products that are linked to pollution, like gasoline and chemicals, this has typically been done as a way of raising revenue, such as with gas taxes to fund highway construction or chemical taxes to fund cleanup of Superfund toxic waste sites, rather than as incentive devices intended to reduce externalities (Barthold, 1994). But over the past 25 years, the political process has gradually become more receptive to market-oriented environmental tools. Beginning in the 1970s, the Environmental Protection Agency (EPA) offered states the option of employing variants of tradeable permits for the control of localized air pollutants. Tradeable-permit systems were used in the 1980s to phase leaded gasoline out of the

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market and to phase out ozone-depleting chlorofluorocarbons (CFCs). But by far the most ambitious application of these instruments has been for the control of acid rain under Title IV of the Clean Air Act amendments of 1990, which established a sulfur dioxide (SO_2) allowance trading program intended to cut nationwide emissions of SO_2 by 50 percent below 1980 levels by the year 2000.

This essay seeks to identify lessons that can be learned from this grand experiment in economically-oriented environmental policy. Since the SO_2 allowance trading program became binding only in 1995, it might seem premature to search for lessons for future policy. This would be true, were one to consider this policy experiment in isolation. But the SO_2 allowance trading program did not emerge into a policy vacuum; rather, it is but one step in the evolution of market-based environmental policies. Considered in this context, the time is ripe not only for an interim appraisal, but for reflection on what we have learned.

I begin with a brief description of the SO_2 allowance trading system and its performance, relying on the accompanying article by Richard Schmalensee and his colleagues to provide details. I then address questions of positive political economy; for example, given the historical support for command-and-control environmental policy instruments, why was allowance trading adopted for acid-rain control in 1990? Subsequently, I consider normative lessons for the design and implementation of market-oriented environmental policies, and offer some conclusions.

The SO_2 Allowance Trading System and Its Performance

Title IV of the Clean Air Act amendments of 1990 sought to reduce SO_2 emissions by 10 million tons from 1980 levels. The first phase of SO_2 emissions reductions was achieved in 1995, with a second phase of reduction to be accomplished by the year 2000.[1] In Phase I, individual emissions limits were assigned to the 263 most SO_2-emissions intensive generating units at 110 electric utility plants operated by 61 electric utilities, and located largely at coal-fired power plants east of the Mississippi River. EPA allocated each affected unit, on an annual basis, a specified number of allowances related to its share of heat input during the baseline period from 1985–87, plus bonus allowances available under a variety of provisions. After January 1, 1995, these units could emit sulfur dioxide only if they had adequate allowances to cover their emissions. Under Phase II of the program, beginning January 1, 2000, almost all fossil-fuel electric power plants will be brought within the system.

Cost-effectiveness is promoted by permitting allowance holders to transfer their permits among one another, so that those who can reduce emissions at the lowest cost have an incentive to do so and sell their allowances to those for whom reducing

[1] The law also sought to reduce nitrogen oxide (NO_x) emissions by 2 million tons annually from 1980 levels. A proposal for trading between SO_2 and NO_x was eliminated by Congress.

the cost would be greater. Allowances can also be "banked" for later use. The anticipated result is that marginal abatement costs will be equated across sources, thus achieving aggregate abatement at minimum total cost. In addition to the private market for bilateral trades, an annual auction of allowances withheld from utilities (about 3 percent of total allowances) was established by EPA, with revenues distributed to utilities on the basis of their original allocations. Also, utilities can offer allowances for sale at the annual government-sponsored auction. Finally, compliance is encouraged by a penalty of $2,000 per ton of emissions that exceed any year's allowances, along with a requirement that such excesses be offset the following year.

The SO_2 allowance trading program has performed successfully. Targeted emissions-reductions have been achieved and exceeded; in fact, because of excess reductions in 1995 and 1996 (and because of bonus allowances distributed by the government), utilities have built up an allowance bank of more than six million tons (U.S. Environmental Protection Agency, 1997). Total abatement costs have been significantly less than what they would have been in the absence of the trading provisions. Trading volume has increased over the life of the program, with EPA having recorded more than four million tons of allowance transfers in 1996 among economically unrelated parties (U.S. Environmental Protection Agency, 1997). This robust market has resulted in cost savings of up to $1 billion annually, compared with the cost of command-and-control regulatory alternatives that were considered by Congress in prior years (Kennedy, 1986).

Prospective analysis in 1990 suggested that the program's benefits would approximately equal its costs (Portney, 1990), but recent analysis indicates that benefits will exceed costs by a very significant margin (Burtraw, Krupnick, Mansur, Austin and Farell, 1997). Although the original motivation of the acid-rain control program was to reduce acidification of forest and aquatic ecosystems, the bulk of the benefits result from reduced human risk of premature mortality through reduced exposure to sulfates.

Positive Political Economy Lessons

To understand why the SO_2 allowance trading system was adopted in its particular form in 1990, it is useful to examine first the factors that led to the dominance of command-and-control over market-based instruments in the previous 20 years. To do this, I consider the demand for environmental policy instruments by individuals, firms, and interest groups, and their supply by the legislature and regulatory agencies. This "political market" framework is developed by Keohane, Revesz and Stavins (1997).

Why Have Command-and-Control Instruments Dominated Environmental Regulation?

The short answer is that command-and-control instruments have predominated because all of the main parties involved had reasons to favor them: af-

fected firms, environmental advocacy groups, organized labor, legislators, and bureaucrats.

On the regulatory demand side, affected firms and their trade associations tended to prefer command-and-control instruments because standards can improve a firm's competitive position, while often costing a firm less than pollution taxes or tradeable permits. Command-and-control standards are inevitably set up with extensive input from existing industry and trade associations, which frequently obtain more stringent requirements for new sources and other advantages for existing firms. In contrast, auctioned permits and pollution taxes require firms to pay not only abatement costs to reduce pollution to some level, but also regulatory costs associated with emissions beyond that level, in the form either of permit purchases or tax payments. Because market-based instruments focus on the quantity of pollution, not on who generates it or the methods used to reduce it, these instruments can make the detailed lobbying role of trade associations less important.

For a long time, most environmental advocacy groups were actively hostile towards market-based instruments, for several reasons. A first reason was philosophical: environmentalists frequently portrayed pollution taxes and tradeable permits as "licenses to pollute." Although such ethical objections to the use of market-based environmental strategies have greatly diminished, they have not disappeared completely (Sandel, 1997). A second concern was that damages from pollution—to human health and ecological well-being—were difficult or impossible to quantify and monetize, and thus could not be summed up in a marginal damage function or captured by a Pigovian tax rate (Kelman, 1981). Third, environmental organizations have opposed market-based schemes out of a fear that permit levels and tax rates—once implemented—would be more difficult to tighten over time than command-and-control standards. If permits are given the status of "property rights," then any subsequent attempt by government to reduce pollution levels further could meet with demands for compensation.[2] Similarly, increasing pollution tax rates may be unlikely because raising tax rates is always politically difficult. A related strategic issue is that moving to tax-based environmental regulation would shift authority from environment committees in the Congress, frequently dominated by pro-environment legislators, to tax-writing committees, which are generally more conservative (Kelman, 1981).[3]

Finally, environmental organizations have objected to decentralized instruments on the grounds that even if emission taxes or tradeable permits reduce overall levels of emissions, they can lead to localized "hot spots" with relatively high levels of ambient pollution. In cases where this is a reasonable concern, it can be

[2] This concern was alleviated in the SO_2 provisions of the Clean Air Act Amendments of 1990 by an explicit statutory provision that permits do not represent property rights.

[3] These strategic arguments refer, for the most part, to pollution taxes, not to market-based instruments in general. Indeed, as I discuss later, one reason some environmental groups have come to endorse the tradeable permits approach is that it promises the cost savings of taxes, without the drawbacks that environmentalists associate with tax instruments.

addressed, in theory, through the use of "ambient permits" or through charge systems that are keyed to changes in ambient conditions at specified locations (Revesz, 1996). Despite the extensive theoretical literature on such ambient systems going back to Montgomery (1972), they have never been implemented, with the partial exception of a two-zone trading system in Los Angeles under the new RECLAIM program.

Organized labor has also been active in some environmental policy debates. In the case of restrictions on clean air, organized labor has taken the side of the United Mine Workers, whose members are heavily concentrated in eastern mines that produce higher-sulfur coal, and have therefore opposed pollution-control measures that would increase incentives for using low-sulfur coal from the largely non-unionized (and less labor-intensive) mines in the Powder River Basin of Wyoming and Montana. In the 1977 debates over amendments to the Clean Air Act, organized labor fought to include a command-and-control standard that effectively required scrubbing, thereby seeking to discourage switching to cleaner western coal (Ackerman and Hassler, 1981). Likewise, the United Mine Workers opposed the SO_2 allowance trading system in 1990 because of a fear that it would encourage a shift to western low-sulfur coal from non-unionized mines.

Turning to the supply side of environmental regulation, legislators have had a number of reasons to find command-and-control standards attractive. First, many legislators and their staffs are trained in law, which predisposes them to favor legalistic regulatory approaches. Second, standards tend to help hide the costs of pollution control (McCubbins and Sullivan, 1984), while market-based instruments generally impose those costs more directly. Compare, for example, the tone of public debates associated with proposed increases in gasoline taxes with those regarding commensurate increases in the stringency of the Corporate Average Fuel Economy standards for new cars.

Third, standards offer greater opportunities for symbolic politics, because strict standards—strong statements of support for environmental protection—can readily be combined with less visible exemptions or with lax enforcement measures. As one recent example of this pattern (albeit from the executive rather than the legislative branch), the Clinton administration announced with much fanfare in June 1997 that it would tighten regulations of particulates and ambient ozone, but the new requirements do not take effect for eight years! Congress has frequently prescribed administrative rules and procedures to protect intended beneficiaries of legislation by constraining the scope of executive intervention (McCubbins, Noll and Weingast, 1987). Such stacking of the deck is more likely to be successful in the context of command-and-control legislation, since market-based instruments leave the allocation of costs and benefits up to the market, treating polluters identically.[4] Of course, the underlying reason why symbolic politics works is that voters

[4] But the Congress has nevertheless tried. Joskow and Schmalensee (1998) examine Congressional attempts along these lines in the SO_2 allowance trading program.

have limited information, and so respond to gestures, while remaining relatively unaware of details.

Fourth, if politicians are risk averse, they will prefer instruments that involve more certain effects.[5] The flexibility inherent in market-based instruments creates uncertainty about distributional impacts and local levels of environmental quality. Typically, legislators in a representative democracy are more concerned with the geographic distribution of costs and benefits than with comparisons of total benefits and costs. Hence, aggregate cost-effectiveness—the major advantage of market-based instruments—is likely to play a less significant role in the legislative calculus than whether a politician is getting a good deal for constituents (Shepsle and Weingast, 1984). Politicians are also likely to oppose instruments that can induce firms to close and relocate, leading to localized unemployment. Although there will be winners as well as losers from such relocation, potential losers are likely to be more certain of their status than potential gainers.

Finally, legislators are wary of enacting programs that are likely to be undermined by bureaucrats in their implementation. And bureaucrats are less likely to undermine legislative decisions if their own preferences over policy instruments are accommodated. Bureaucratic preferences—at least in the past—were not supportive of market-based instruments, on several grounds: bureaucrats were familiar with command-and-control approaches; market-based instruments do not require the same kinds of technical expertise that agencies have developed under command-and-control regulation; and market-based instruments can imply a scaled-down role for the agency by shifting decision-making from the bureaucracy to the private sector. In other words, government bureaucrats—like their counterparts in environmental advocacy groups and trade associations—might be expected to oppose market-based instruments to prevent their expertise from becoming obsolete and to preserve their human capital. More recently, however, this same incentive has helped lead EPA staff involved in the SO_2 trading program to become strong proponents of trading for other air pollution problems.

Why Has the Chosen Form of Market-Based Approach Always Been Freely-Allocated Tradeable Permits?

Economic theory suggests that the choice between tradeable permits and pollution taxes should be based upon case-specific factors, but when market-based instruments have been adopted in the United States, they have virtually always taken the form of tradeable permits rather than emission taxes. As already noted, taxes that are related to sources of pollution, like gasoline taxes, serve primarily as revenue-raising instruments, rather than environmental taxes designed to reduce

[5] "Legislators are likely to behave as if they are risk averse, even if they are personally risk neutral, if their constituents punish unpredictable policy choices or their reelection probability is nearly unity" (McCubbins, Noll and Weingast, 1989, p. 22).

an externality.[6] Moreover, the initial allocation of such permits has always been through free initial distribution, rather than through auctions, despite the apparent economic superiority of the latter mechanism in terms of economic efficiency (Fullerton and Metcalf, 1997; Goulder, Parry, and Burtraw, 1997; Stavins, 1995). The EPA does have an annual auction of SO_2 allowances, but this represents less than 2 percent of the total allocation (Bailey, 1996). While the EPA auctions may have helped in establishing the market for SO_2 allowances, they are a trivial part of the overall program (Joskow, Schmalensee and Bailey, 1996).

Again, many actors in the system have reasons to favor freely allocated tradeable permits over other market-based instruments. On the regulatory demand side, existing firms favor freely allocated tradeable permits because they convey rents to them. Moreover, like stringent command-and-control standards for new sources, but unlike auctioned permits or taxes, freely allocated permits give rise to entry barriers, since new entrants must purchase permits from existing holders. Thus, the rents conveyed to the private sector by freely allocated tradeable permits are, in effect, sustainable.

Environmental advocacy groups have generally supported command-and-control approaches, but given the choice between tradeable permits and emission taxes, these groups strongly prefer the former. Environmental advocates have a strong incentive to avoid policy instruments that make the costs of environmental protection highly visible to consumers and voters; and taxes make those costs more explicit than permits.[7] Also, environmental advocates prefer permit schemes because they specify the quantity of pollution reduction that will be achieved, in contrast with the indirect effect of pollution taxes. Overall, some environmental groups have come to endorse the tradeable permits approach because it promises the cost savings of pollution taxes, without the drawbacks that environmentalists associate with environmental tax instruments.

Freely allocated tradeable permits are easier for legislators to supply than taxes or auctioned permits, again because the costs imposed on industry are less visible and less burdensome, since no money is exchanged at the time of the initial permit allocation. Also, freely allocated permits offer a much greater degree of political control over the distributional effects of regulation, facilitating the formation of majority coalitions. Joskow and Schmalensee (1998) examined the political process of allocating SO_2 allowances in the 1990 amendments, and found that allocating

[6] This pattern holds in Europe, as well. There, environmental taxes have been far more prevalent than tradeable permits, but the taxes employed have typically been too low to induce pollution abatement (Cansier and Krumm, 1997).

[7] For this same reason, private industry may strategically choose to endorse a pollution tax approach, in the hope that consequent public opposition will result in the setting of a less stringent environmental goal. This may seem farfetched, but it appears to be precisely what happened in the closing days of the 1990 Clean Air Act debate in the U.S. Senate. When it had become clear that a 10 million ton SO_2 allowance trading system was about to be passed, electric utilities suddenly proposed an SO_2 emissions tax as an alternative policy instrument.

permits on the basis of prior emissions can produce fairly clear winners and losers among firms and states. An auction allows no such political maneuvering.

Why Was a Market-Based Approach Adopted for SO_2 Emissions in 1990?

By the late 1980s, there had already been a significant shift of the political center toward a more favorable view of using markets to solve social problems. The Bush administration, which proposed the SO_2 allowance trading program and then championed it through an initially resistant Democratic Congress, deserves much of the credit here. The ideas of "fiscally responsible environmental protection" and "harnessing market forces to protect the environment" fit well with its quintessentially moderate Republicanism. (The Reagan administration enthusiastically embraced a market-oriented ideology, but demonstrated little interest in employing actual market-based policies in the environmental area.) More broadly, support for market-oriented solutions to various social problems had been increasing across the political spectrum as early as the Carter administration, as evidenced by deliberations and action regarding deregulation of the airline, telecommunications, trucking, railroad, and banking industries. Indeed, by 1990, the phrase "market-based environmental policy" had evolved from being politically problematic to politically attractive. Even leading liberal environmental advocates like Rep. Henry Waxman began to characterize their clean air proposals as using "economic-incentive mechanisms," even if the actual proposals continued to be of the conventional, command-and-control variety.

Given the historical opposition to market-oriented pollution control policies, how can we explain the adoption of the SO_2 allowance trading program in 1990? More broadly, why has there been increased openness to the use of market-based approaches?

For economists, it would be gratifying to believe that increased understanding of market-based instruments had played a large part in fostering their increased political acceptance, but how important has this really been? In 1981, Steven Kelman surveyed Congressional staff members, and found that Republican support and Democratic opposition to market-based environmental policy instruments was based largely on ideological grounds, with little awareness or understanding of the advantages or disadvantages of the various instruments. What would happen if we were to replicate Kelman's (1981) survey today? My hypothesis is that we would find increased support from Republicans, greatly increased support from Democrats, but insufficient improvements in understanding to explain these changes.[8] So what else has mattered?

One factor has surely been increased pollution control costs, which have led to greater demand for cost-effective instruments. By 1990, U.S. pollution control costs had reached $125 billion annually, nearly a tripling of real costs from 1972

[8] But there has been some increased understanding of market-based approaches to environmental protection among policymakers and their staffs, due in part to the economics training that is now common in law schools, and the proliferation of schools of public policy.

levels (U.S. Environmental Protection Agency, 1990). In the case of SO_2 control, it was well known that utilities faced very different marginal abatement costs and would want to use varying abatement methods, because of differences in the ages of plants and their proximity to sources of low-sulfur coal. EPA estimates in the late 1980s were that a well-functioning tradeable-permit program would save 50 percent on costs that would otherwise exceed $6 billion annually if a dictated technological solution were implemented (ICF, 1989).

A second factor that was important in the 1990 Clean Air Act debates was strong and vocal support for the SO_2 allowance trading system from parts of the environmental community, particularly the Environmental Defense Fund (EDF), which had already become a champion of market-based approaches to environmental protection in other, less nationally prominent domains, such as water marketing in California. By supporting allowance trading, EDF solidified its reputation as a pragmatic environmental organization willing to adopt new strategies involving less confrontation with private industry, and distinguished itself from other groups (Keohane, Revesz and Stavins, 1997). When the memberships (and financial resources) of other environmental advocacy groups subsequently declined with the election of the environment-friendly Clinton-Gore administration, EDF continued to prosper and grow (Lowry, 1993).

A third key factor in 1990 was the fact that the SO_2 allowance trading program was designed to reduce emissions, not simply to reallocate them cost-effectively. In 1990, EDF was able to make powerful arguments for tradeable permits on the grounds that the use of a cost-effective instrument would make it politically feasible to achieve greater reductions in SO_2 emissions than would otherwise be possible. Market-based instruments are most likely to be politically acceptable if they can achieve environmental improvements which otherwise are not politically or economically feasible. It is not coincidental that the earlier (and successful) lead and chlorofluorocarbon permit trading programs also aimed at reducing emissions, while EPA's attempts to reform local air quality regulation through its Emissions Trading Program without incremental improvements in air quality have been troubled and halting.

Fourth, many of the economists involved in the deliberations regarding the SO_2 allowance system took the approach of accepting—implicitly or otherwise—a political goal of reducing SO_2 emissions by 10 million tons. Rather than debating the costs and benefits of that goal, they simply focused on the cost-effective means of achieving it. Separating the benefit-cost calculation about the goals from the instruments used to achieve the goal was important to avoid splintering support for an SO_2 trading program. As evidenced by the failed Republican attempts at "regulatory reform" in 1996, the notion of using explicit benefit-cost calculations as the basis for judging regulations remains highly controversial in political circles. Of course, even if the strategy worked out well in the SO_2 case, there are limitations to the wisdom of separating ends and means: one risks designing a fast train to the wrong station.

Fifth, it is important to note that acid rain was effectively an unregulated prob-

lem until the SO_2 allowance trading program of 1990. Hence, there were no existing constituencies for the status quo approach, because there *was* no status quo approach. The demand for a market-based instrument is likely to be greatest and the political opportunity costs of legislators providing support are likely to be least when the status quo instrument is essentially nonexistent. This implies that we should be more optimistic about introducing such market-based instruments for "new" problems, such as global climate change, than for existing, highly regulated problems, such as abandoned hazardous waste sites.

Finally, a caveat is in order. The adoption of the SO_2 allowance trading program for acid rain control—like any major innovation in public policy—can partly be attributed to a healthy dose of chance that placed specific persons in key positions, in this case at the White House, EPA, the Congress, and environmental organizations. Within the White House, among the most active and influential enthusiasts of market-based environmental instruments were Counsel Boyden Gray and his Deputy John Schmitz; Domestic Policy Adviser Roger Porter; Council of Economic Advisers (CEA) Member Richard Schmalensee; CEA Senior Staff Economist Robert Hahn; and Office of Management and Budget Associate Director Robert Grady. At EPA, Administrator William Reilly—a "card-carrying environmentalist"—enjoyed valuable credibility with environmental advocacy groups; Deputy Administrator Henry Habicht was a key supporter of market-based instruments; and Assistant Administrator William Rosenberg was an early convert. In the Congress, Senators Timothy Wirth and John Heinz provided high-profile, bipartisan support for the SO_2 allowance trading system and, more broadly, for a variety of market-based instruments for environmental problems through their "Project 88" (Stavins, 1988). Within the environmental community, EDF Executive Director Fred Krupp, Senior Economist Daniel Dudek, and Staff Attorney Joseph Goffman worked closely with the White House to develop the allowance trading proposal.

Normative Lessons

Within the context of 30 years of federal environmental regulation, characterized by sporadic but increasing reliance on market-based policy instruments, I consider normative lessons from the design and implementation of the SO_2 allowance trading system for design and implementation of tradeable permit systems, analysis of prospective and adopted systems, and identification of new applications.

Lessons for Design and Implementation of Tradeable Permit Systems

The performance of the SO_2 allowance trading system to date provides valuable evidence for environmentalists and others who have been resistant to these innovations that market-based instruments can achieve major cost savings while accomplishing their environmental objectives (Ellerman et al., 1997; U.S. General Accounting Office, 1995). Likewise, we have seen that the system can be implemented

without a surge of lawsuits, partly because it was well designed (Burtraw and Swift, 1996) and partly because issues of distributional equity were handled through a congressionally imposed allocation. The system's performance also offers lessons about the importance of flexibility, simplicity, the role of monitoring and enforcement, and the capabilities of the private sector to make markets of this sort work.

In regard to flexibility, tradeable permit systems should be designed to allow for a broad set of compliance alternatives, in terms of both timing and technological options. Allowing flexible timing and intertemporal trading of the allowances—that is, "banking" allowances for future use—has played a very important role in the program's performance (Ellerman et al., 1997), much as it did in the lead rights trading program a decade earlier (Kerr and Maré, 1997). The permit system was based on emissions of SO_2, as opposed to sulfur content of fuels, so that both scrubbing and fuel-switching were feasible options. Moreover, one of the most significant benefits of the trading system was simply that technology standards requiring scrubbing of SO_2 were thereby avoided. This allowed midwestern utilities to take advantage of lower rail rates (brought about by railroad deregulation) to reduce their SO_2 emissions by increasing their use of low-sulfur coal from Wyoming and Montana, an approach that would not have been possible if scrubber requirements had been in place. Also, a less flexible system would not have led to the technological change that may have been induced in scrubber performance and rail transport (Burtraw, 1996; Ellerman and Montero, 1996; Bohi and Burtraw, 1997). Likewise, the economic incentives provided by the trading system have led to induced process innovations in the form of bundling of allowances with coal supplies (Doucet and Strauss, 1994) and the installation of emission reduction technology in exchange for generated allowances (Dudek and Goffman, 1995). The flexibility of the allowance trading system accommodates the dynamic market changes that are occurring because of electric utility deregulation, allowing shifts in industry structure and production methods while assuring that total emissions do not increase.

In regard to simplicity, a unique formula for allocating permits based upon historical data is relatively difficult to contest or manipulate. More generally, trading rules should be clearly defined up front, without ambiguity. For example, there should be no requirements for prior government approval of individual trades. Such requirements hampered EPA's Emissions Trading Program in the 1970s, while the lack of such requirements was an important factor in the success of lead trading (Hahn and Hester, 1989). In the case of SO_2 trading, the absence of requirements for prior approval has reduced uncertainty for utilities and administrative costs for government, and contributed to low transactions costs (Rico, 1995).

Considerations of simplicity and the experience of the SO_2 allowance system also argue for using absolute baselines, not relative ones, as the point of departure for tradeable permit programs. The difference is that with an absolute baseline (so-called "cap-and-trade"), sources are each allocated some number of permits (the total of which is the "cap"); with a relative baseline, reductions are credited from an unspecified baseline. The problem is that without a specified baseline, reduc-

tions must be credited relative to an unobservable hypothetical—what the source would have emitted in the absence of the regulation. A hybrid system—where a cap-and-trade program is combined with voluntary "opt-in provisions"—creates the possibility for "paper trades," where a regulated source is credited for an emissions reduction (by an unregulated source) that would have taken place in any event (Montero, 1997). The result is a decrease in aggregate costs among regulated sources, but this is partly due to an unintentional increase in the total emissions cap (Atkeson, 1997). As was experienced with EPA's Emissions Trading Program, relative baselines create significant transaction costs by essentially requiring prior approval of trades as the authority investigates the claimed counterfactual from which reductions are calculated and credits generated (Nichols, Farr and Hester, 1996).

The SO_2 program has also brought home the importance of monitoring and enforcement provisions. In 1990, environmental advocates insisted on continuous emissions monitoring (Burtraw and Swift, 1996), which helps build market confidence (McLean, 1995). The costs of such monitoring, however, are significant. On the enforcement side, the Act's stiff penalties have provided sufficient incentive for the very high degree of compliance that has been achieved.

Another normative lesson is linked with positive issues. Above we emphasized the political advantages of freely allocated permit systems, as employed with SO_2. But the same characteristic that makes such allocation attractive in positive political economy terms—the conveyance of scarcity rents to the private sector—also makes free allocation problematic in normative, efficiency terms (Fullerton and Metcalf, 1997). Goulder, Parry, and Burtraw (1997) estimate that the costs of SO_2 allowance trading would be 25 percent less if permits were auctioned rather than freely allocated, because auctioning yields revenues that can be used to finance reductions in pre-existing distortionary taxes. Furthermore, in the presence of some forms of transaction costs, the post-trading equilibrium—and hence aggregate abatement costs—are sensitive to the initial permit allocation (Stavins, 1995). For both reasons, a successful attempt to establish a politically viable program through a specific initial permit allocation can result in a program that is significantly more costly than anticipated.

Finally, the SO_2 program's performance demonstrates that the private sector can fulfill brokerage needs, providing price information and matching trading partners, despite claims to the contrary when the program was enacted. Entrepreneurs have stepped in to make available a variety of services, including private brokerage, electronic bid/ask bulletin boards, and allowance price forecasts. The annual EPA auctions may have served the purpose of helping to reveal market valuations of allowances, but bilateral trading has also informed the auctions (Joskow, Schmalensee and Bailey, 1996).

Lessons for Analysis of Tradeable Permit Systems

When assessing trading programs, economists have typically employed some measure in which gains from trade are estimated for moving from conventional

standards to marketable permits. Aggregate cost savings are the best yardstick for measuring success, not number of trades or total trading volume (Hahn and May, 1994).

The challenge for analysts is to compare realistic versions of both tradeable permit systems and "likely alternatives," not idealized versions of either. It is not enough to analyze static gains from trade (Hahn and Stavins, 1992). For example, the gains from banking allowances should also be modeled (unless this is not permitted in practice). It can also be important to allow for the effects of alternative instruments on technology innovation and diffusion (Milliman and Prince, 1989; Jaffe and Stavins, 1995; Doucet and Strauss, 1994; Dudek and Goffman, 1995), especially when permit trading programs impose significant costs over long time horizons (Newell, Jaffe and Stavins, 1997).

More generally, it is important to consider the effects of the pre-existing regulatory environment. The level of pre-existing factor taxes can affect the total costs of regulation (Goulder, Parry and Burtraw, 1997). Also, because SO_2 is both a transboundary precursor of acid rain and a local air pollutant regulated under a separate part of the Clean Air Act, "local" environmental regulations have sometimes prevented utilities from acquiring allowances rather than carrying out emissions reductions (Conrad and Kohn, 1996). Moreover, because electricity generation and distribution have been regulated by state commissions, a prospective analysis of SO_2 trading should consider the incentives these commissions may have to influence the level of allowance trading.[9]

A set of theoretical arguments suggests that state public utility commissions may have incentives to erect such barriers. Coal interests in some midwestern and eastern states, where high-sulfur coal is mined, were opposed to the concept of allowance trading because it would permit utilities to switch to cleaner western coal. Hence, it is reasonable to suspect that those same interests would pressure state regulatory commissions to erect direct or indirect barriers to trading (Bohi and Burtraw, 1992; Burtraw, 1996). However, the only rigorous analysis that has been carried out of this contention suggests that such pressures have not, if applied, been effective (Bailey, 1996). In any event, it is clear that state regulatory commissions have not encouraged utilities to engage in allowance trading, either (Bohi, 1994). The commissions have been reactive, rather than proactive in terms of accounting and tax treatment of allowance transactions (Rose, 1997), restricting themselves to reviewing and approving plans submitted by utilities. Only the Georgia Public Service Commission has actively ordered utilities in its jurisdiction to monitor the allowance market and purchase allowances when prices are below compliance costs.

It has also been suggested that many electric utilities have been reluctant to consider new options, which is consistent with their reputation as firms that seek to minimize risk, rather than cost (Rose, 1997), but this may change due to the

[9] Also, rate-of-return regulation that employs capital investments as a baseline might be expected to lead electric utilities to bias their SO_2 compliance choices toward investments in scrubbers, for example, and away from allowance transactions (Averch and Johnson, 1962).

heightened role of competition brought about by electricity deregulation. Also, long-term contractual precommitments have tied many utilities to plans conceived before allowance trading was an option (Coggins and Swinton, 1996). Finally, some utilities may be reluctant to make serious investments in allowances in the face of future regulatory uncertainty (U.S. Energy Information Administration, 1997).

Issues such as these must be taken into account in the analysis of any pollution control program, whether it is market-oriented or command-and-control in nature.

Lessons for Identifying New Applications

Market-based policy instruments are now considered for each and every environmental problem that is raised, ranging from endangered species preservation to what may be the greatest of environmental problems, the greenhouse effect and global climate change. Our experiences with SO_2 trading—and with the earlier programs of lead and chlorofluorocarbon trading—offer some guidance to the conditions under which tradeable permits are likely to work well, and when they may face greater difficulties.

First, SO_2 trading is a case where the cost of abating pollution differs widely among sources, and where a market-based system is therefore likely to have greater gains, relative to conventional, command-and-control regulations (Newell and Stavins, 1997). It was clear early on that SO_2 abatement cost heterogeneity was great, because of differences in ages of plants and their proximity to sources of low-sulfur coal. But where abatement costs are more uniform across sources, the political costs of enacting an allowance trading approach are less likely to be justifiable.

Second, the greater the degree to which pollutants mix in the receiving airshed or watershed, the more attractive a tradeable emission permit (or emission tax) system will be, relative to a conventional uniform standard. This is because taxes or tradeable permits can lead to localized "hot spots" with relatively high levels of ambient pollution. This is a significant distributional issue. Some acid-rain receiving states have attempted to erect barriers to those trades that could increase deposition within their borders.[10] It can also become an efficiency issue, if damages are nonlinearly related to pollutant concentrations.

Third, the efficiency of a tradeable permit system will depend on the pattern of costs and benefits. If uncertainty about marginal abatement costs is significant, and if marginal abatement costs are quite flat and marginal benefits of abatement fall relatively quickly, then a quantity instrument, such as tradeable permits, will be more efficient than a price instrument, such as an emission tax (Weitzman, 1974). Furthermore, when there is also uncertainty about marginal benefits, and marginal benefits are positively correlated with marginal costs (which, it turns

[10] For example, as recently as the summer of 1997, legislation emerged in the New York State legislature that would penalize utilities for selling allowances to companies "accused of exacerbating New York's acid rain problem" (*Boston Globe*, June 26, 1997, on-line). Under the legislation, if a trade were found to be "detrimental to environmentally sensitive areas," the Public Service Commission would be directed to impose a fine three times the value of the trade.

out, is a relatively common occurrence for a variety of pollution problems), then there is an additional argument in favor of the relative efficiency of quantity instruments.[11]

Fourth, tradeable permits will work best when transaction costs are low, and the SO_2 experiment shows that if properly designed, private markets will tend to render transaction costs minimal. Finally, considerations of political feasibility point to the wisdom of proposing trading instruments when they can be used to facilitate emissions reductions, as was done with SO_2 allowances and lead rights trading. Policy instruments that appear impeccable from the vantage point of Cambridge, Massachusetts, but consistently prove infeasible in Washington, D.C., can hardly be considered "optimal."

Many of these issues can be illuminated by considering a concrete example: the current interest in applying tradeable permits to the task of cutting carbon dioxide (CO_2) emissions to reduce the risk of global climate change. It is immediately obvious that the number and diversity of sources of CO_2 emissions due to fossil fuel combustion are vastly greater than in the case of SO_2 emissions as a precursor of acid rain, where the focus can be placed on a few hundred electric utility plants (Environmental Law Institute, 1997).

Any pollution-control program must face the possibility of "emissions leakage" from regulated to unregulated sources. This could be a problem for meeting domestic targets for CO_2 emissions reduction, but it would be a vastly greater problem for an international program, where emissions would tend to increase in non-participant countries. This also raises serious concerns with provisions in the Kyoto Protocol for industrialized countries to participate in a CO_2 cap-and-trade program, while non-participant (developing) nations retain the option of joining the system on a project-by-project basis, an approach commonly known as "joint implementation." As emphasized earlier, provisions in tradeable permit programs that allow for unregulated sources to "opt in" can lower aggregate costs by substituting low-cost for high-cost control, but may also have the unintended effect of increasing aggregate emissions beyond what they would otherwise have been. This is because there is an incentive for adverse selection: sources in developing countries that would reduce their emissions, opt in, and receive "excess allowances" would tend to be those that would have reduced their emissions in any case.

To the limited degree that any previous trading program can serve as a model for the case of global climate change, some attention should be given to the tradeable-permit system that accomplished the U.S. phaseout of leaded gasoline. The currency of that system was not lead oxide emissions from motor vehicles, but the lead content of gasoline. So too, in the case of global climate, great savings in monitoring and enforcement costs could be had by adopting *input* trading linked to the carbon content of fossil fuels. This is reasonable in the climate case, since—

[11] One generator of stochastic shocks that frequently affects both marginal benefits and marginal costs—with the same sign—is the weather. For further explanation and specific examples, see Stavins (1996).

unlike in the SO_2 case—CO_2 emissions are roughly proportional to the carbon content of fossil fuels and scrubbing alternatives are largely unavailable, at least at present. On the other hand, natural sequestration of CO_2 from the atmosphere by expanding forested areas is available (even in the United States) at reasonable cost (Stavins, 1997) and is explicitly counted toward compliance with the targets of the Kyoto Protocol. Hence, it will be important to combine any carbon trading (or carbon tax) program with a carbon sequestration program, possibly denominated by forested areas.

In terms of carbon permit allocation mechanisms, auctions would have the advantage that revenues could be used to finance reductions in distortionary taxes. Although free allocation of carbon permits might meet with less political resistance, such free allocation could increase regulatory costs enough that the sign of the efficiency impact would be reversed from positive to negative net benefits (Parry, Williams and Goulder 1997).

Finally, developing a tradeable permit system in the area of global climate change would surely bring forth an entirely new set of economic, political, and institutional challenges, particularly with regard to enforcement problems (Schmalensee, 1996; Stavins, 1998). But it is also true that the diversity of sources of CO_2 emissions and the magnitude of likely abatement costs make it equally clear that only a market-based instrument—some form of carbon rights trading or (probably revenue-neutral) carbon taxes—will be capable of achieving the domestic targets that may eventually be forthcoming from international agreements.

Conclusion

Given that the SO_2 allowance-trading program became fully binding only in 1995, we should be cautious when drawing conclusions about lessons to be learned from the program's development or its performance. A number of important questions remain. For example, little is known empirically about the impact of trading on technological change. Also, much more empirical research is needed on how the pre-existing regulatory environment affects the operation of permit trading programs. Moreover, all the successes with tradeable permits have involved air pollution: acid rain, leaded gasoline, and chlorofluorocarbons. Our experience (and success rate) with water pollution is much more limited (Hahn, 1989), and in other areas, we have no experience at all. Even for air pollution problems, the tremendous differences between SO_2 and acid rain, on the one hand, and the combustion of fossil fuels and global climate change, on the other, indicate that any rush to judgement regarding global climate policy instruments is unwarranted.

Despite these and other uncertainties, market-based instruments for environmental protection—and, in particular, tradeable permit systems—now enjoy proven successes in reducing pollution at low cost. Such cost effectiveness is the primary focus of economists when evaluating public policies, but the political system clearly gives much greater weight to distributional concerns. In the Congressional

deliberations that led up to the Clean Air Act amendments of 1990, considerable pressures were brought to bear to allow less switching from high-sulfur to low-sulfur coal to benefit regions dependent on high-sulfur coal mining. Such provisions would have increased compliance costs for midwestern coal-burning utilities (U.S. Congressional Budget Office, 1986), encouraged political pressures for nationwide cost sharing, and greatly reduced the cost-effectiveness of the system. In this way, individual constituencies, each fighting for its own version of distributional equity, negate efficiency and cost effectiveness. In the pursuit of obtaining nicely shaped pieces of the proverbial pie, we all too often end up with a systematically smaller pie. That this did not happen in 1990 was the exception, not the rule.

There are sound reasons why the political world has been slow to embrace the use of market-based instruments for environmental protection, including the ways economists have packaged and promoted their ideas in the past: failing to separate means (cost-effective instruments) from ends (efficiency); and treating environmental problems as little more than "externalities calling for corrective taxes." Much of the resistance has also been due, of course, to the very nature of the political process and the incentives it provides to both politicians and interest groups to favor command-and-control methods instead of market-based approaches.

But despite this history, market-based instruments have moved center stage, and policy debates look very different from the time when these ideas were characterized as "licenses to pollute" or dismissed as completely impractical. Of course, no single policy instrument—whether market-based or conventional—will be appropriate for all environmental problems. Which instrument is best in any given situation depends upon characteristics of the specific environmental problem, and the social, political, and economic context in which the instrument is to be implemented.

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[Footnotes]

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[5] **Structure and Process, Politics and Policy: Administrative Arrangements and the Political Control of Agencies**

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