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Lessons Learned from SO_2 Allowance Trading

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The most ambitious application yet undertaken of a market-based instrument for environmental protection has been for the control of sulfur dioxide (SO_2) emissions in the context of acid rain reduction under Title IV of the Clean Air Act amendments of 1990. That Act established an allowance trading program to cut SO_2 emissions by 10 million tons from 1980 levels—a 50% reduction. In this article, I identify lessons that can be learned from this grand experiment in economically oriented environmental policy.

The System and Its Performance

In Phase I of the allowance trading program, emissions allowances were assigned to the 263 most SO_2-emissions-intensive generating units at 110 power plants operated by 61 electric utilities, located largely at coal-fired power plants east of the Mississippi River. After January 1, 1995, these utilities could emit SO_2 only if they had adequate allowances to cover their emissions. The US Environmental Protection Agency (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 (1985-87) plus bonus allowances available under a variety of special provisions. Cost-effectiveness was promoted by permitting allowance holders to transfer their permits among one another and bank them for later use. Under Phase II of the program, which began on January 1, 2000, almost all electric power generating units were brought within the system. Certain units are exempted to compensate for potential restrictions on growth and to reward units that were already unusually clean.

The SO_2 allowance trading program has performed successfully. Targeted emissions reductions have been achieved and exceeded, and 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 (Figure 1), and the robust market has resulted in an estimated 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, representing a 30–50% cost savings.

The allowance trading program has had exceptionally positive welfare effects, with estimated benefits being as much as ten times greater than costs. It is notable that the majority of the benefits of the program are due mainly to the positive human health impacts of decreased local SO_2 and particulate concentrations, not to the ecological impacts of reduced long-distance transport of acid deposition. This contrasts with what was assumed at the time of the program's enactment in 1990.

Lessons for Design and Implementation of Tradable Permit Systems

The performance of the SO_2 allowance trading system provides valuable evidence for environmentalists and others who have been resistant to these innovations. It shows that market-based instruments can achieve major cost savings while accomplishing environmental objectives. The system's performance also offers lessons about the importance of flexibility and 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, tradable permit experience indicates that 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, much as it did in EPA's lead rights trading program a

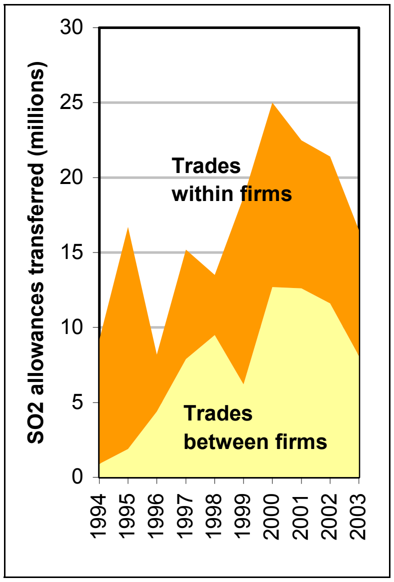

Figure 1. Trading volume in the SO_2 Allowance Trading Program.
Source: Based on data from USEPA "Trading Activity Breakdown" (see http://www.epa.gov/airmarkets/trading/so2market/transtable.html).

decade earlier. 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—an approach that would not have been possible if scrubbers had been required.

In regard to simplicity, simple formulas for allocating permits based upon historical data have proven to be difficult to contest or manipulate. More generally, experience shows 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 the EPA's Emissions Trading Program for local air pollutants in the 1970s, while the lack of such requirements was an important factor in the success of lead trading in the 1980s. In the case of SO_2 trading, the absence of requirements for prior approval reduced uncertainty for utilities and administrative costs for government and contributed to low enforcement and other program implementation (transactions) costs.

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 tradable 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 a hypothetical baseline—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"—can also be undesirable because it would create 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. Relative baselines would have complicated the program and could have led to an unintentional increase in the total emissions cap.

The SO_2 program has also brought home the importance of monitoring and enforcement provisions. In 1990, environmental advocates insisted on continuous emissions monitoring, which helps build market confidence. The costs of such monitoring, however, are significant. On the enforcement side, the Act's stiff penalties—$2,000 per ton of excess emissions, a value more than 10 times that of marginal abatement costs—have provided sufficient incentive for the very high degree of compliance that has been achieved.

Another lesson involves permit allocation procedures. There are obvious political advantages of allocating permits without charge, as was done for the SO_2 program. But the same characteristic that makes such allocations politically attractive—the conveyance of valuable allowances to the private sector—also makes free allocations problematic. It has been estimated that the costs of SO_2 allowance trading would be 25% lower if permits were auctioned rather than freely allocated, because auctioning yields revenues that can be used to finance cuts in preexisting distortionary taxes. Furthermore, in the presence of some forms of transaction costs, the post-trading distribution of emissions—and hence aggregate abatement costs—are sensitive to the initial permit allocation. 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 once a tradable system is established, the private sector can then step in to make it work. In the SO_2 context, despite claims to the contrary when the program was enacted, entrepreneurs provided brokerage needs, developed price information, matched trading partners, developed electronic bid/ask bulletin boards, and made available 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.

Lessons for Judging Effectiveness of Tradable Permit Systems

When examining the effectiveness of 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 yardstick best used for measuring success.

The challenge is to compare realistic versions of both tradable permit systems and likely alternatives, not idealized versions of either. It is not enough to analyze the cost savings in any year. For example, the gains from banking allowances should be considered (unless this is not permitted in practice). It can also be important to allow for the effects on technology innovation and diffusion, especially when permit trading programs impose significant costs over long time horizons.

More generally, it is important to consider the effects of the preexisting regulatory environment. The level of preexisting taxes can affect the total costs of regulation, as emphasized above. 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. 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.

Lessons for Identifying New Permit Trading Applications

Market-based policy instruments are now considered for almost every environmental problem, ranging from endangered species preservation to global climate change. Experiences with SO_2 trading offer some guidance as to when tradable permits are likely to work well and when they may face greater difficulties.

First, permit trading is likely to work best where there are wide differences in the cost of abating emissions. SO_2 trading is such a case. Initially, SO_2 abatement cost heterogeneity was great because of differences in ages of generating equipment and their proximity to sources of low-sulfur coal. When 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 of mixing of pollutants in the receiving airshed or watershed, the more attractive will be a tradable emission permit (or emission tax) system, relative to a conventional uniform standard. This is because taxes or tradable permits can lead to localized "hot spots" with relatively high levels of ambient pollution. This is a significant local or regional issue, and it can become an issue of overall consequence, as well, if damages rise more than proportionally with increases in pollutant concentrations.

Third, economic theory has taught us that the efficiency of a tradable 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 relatively constant, but the benefits of abatement fall relatively quickly at higher levels of abatement, then a quantity instrument (such as tradable permits) will be more efficient than a price instrument (such as an emission tax). The advantage of tradable permits is reinforced when there is uncertainty about both the marginal costs and the marginal benefits of pollution reductions, and these are positively correlated.

Fourth, tradable permits will work best when marketing and brokerage costs are low, and the SO_2 experiment shows that if properly designed, private markets will tend to render such 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—as opposed to using these instruments only to lower the costs of achieving status quo emissions.

What about Greenhouse Gas Trading?

Many of these issues can be illuminated by considering the current interest in applying tradable permits to the task of cutting greenhouse gas emissions—largely carbon dioxide (CO_2) emissions—to reduce the risk of global climate change (for more on why this might occur, see the Fall 2004 issue of *Choices*). It is 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 electrical utility plants.

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 nonparticipant 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 nonparticipant (developing) nations retain the option of joining the system on a project-by-project basis. As emphasized earlier, provisions in tradable 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 really serve as a model for the case of global climate change, attention should surely be given to the tradable-permit system that accomplished the US phaseout of leaded gasoline in the 1980s. The currency of that system was not lead oxide emissions from motor vehicles, but rather 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, because—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—such as by expanding forested areas—is available at a reasonable cost (even in the United States), and is explicitly counted toward compliance under the Kyoto Protocol. Hence, it could be important to combine any carbon trading (or carbon tax) program with a carbon sequestration program.

Developing a tradable 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. 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 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 performance. But despite the uncertainties, market-based instruments for environmental protection—tradable permit systems in particular — now enjoy proven successes in reducing pollution at low cost.

Market-based instruments have moved to 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.

For More Information

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