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**Are cap-and-trade programs more environmentally effective  
than conventional regulation?**

**by  
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# **Are cap-and-trade programs more environmentally effective than conventional regulation?**

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## **Introduction**

Market-based instruments (MBI's) are advocated because of their presumed lower economic cost in comparison with conventional regulatory instruments. The environmental effectiveness of the MBI is typically assumed to be the same as that of the conventional alternative (Crocker, 1966; Dales, 1968; Montgomery, 1972). Recent experience with cap-and-trade systems has confirmed the economic advantages of MBI's (Ellerman et al., 2000; Carlson et al., 2000; Ellerman et al., 2003) and failed to find a degradation of environmental performance (Burtraw and Mansur, 1999; Swift, 2000). As a result, MBI's, and especially cap-and-trade systems, have become widely accepted in the policy community. Recognizing this circumstance, opponents of the use of MBIs tend to attack the assumption that the environmental performance is equal (Clear the Air, 2002; Moore, 2002). Their argument is that, while the economic performance may be better, the environmental performance is worse, and that the increased environmental damages outweigh the savings in abatement cost.

This paper makes the contrary argument that the experience with the cap-and-trade programs suggests that at least this form of MBI may be more environmentally effective than the usual command-and-control alternatives, in addition to being more economically efficient. The evidence rests mainly on the SO<sub>2</sub> cap-and-trade system created by Title IV of the 1990 Clean Air Act Amendments (also known as the Acid Rain Program), but corroborating evidence emerges from the Northeastern NO<sub>x</sub> Budget Program and the RECLAIM programs for trading NO<sub>x</sub> and SO<sub>2</sub> emissions in the Los

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Angeles Basin. Despite the small sample, the reasons for the observed better performance appear to be capable of more general application.

Two definitional issues must be discussed first. The alternative to a cap-and-trade program is commonly described as command-and-control regulation. If ever economists have managed a semantic triumph, it is command-and-control, for it is hard to imagine a less appealing term for the latter part of the 20<sup>th</sup> century and the beginning of the 21<sup>st</sup> century. Command-and-control is also not a very precise term for identifying the essential difference between the contending instruments for the requirement to surrender allowances can be seen as a command that will control aggregate emissions. The important distinction is that the command does not extend to the production decisions of individual firms and applies only to the aggregate level of emissions. An instruction is given to each individual firm, namely to surrender an allowance, but it is no different than the practical (and legal) requirement to pay for any other input into production. The firm is not faced with a regulatory prescription concerning how much to emit or what control equipment to use, only a requirement to pay for emissions whatever their level. Accordingly, I have adopted the less value-laden and, I believe, more accurate term, prescriptive regulation, to describe the conventional alternative to cap-and-trade systems and more generally MBI's. As pointed out presciently by Shabman, Stevenson, and Shobe (2002), the essential distinction concerns who makes the abatement decision, the regulator or the firm, not whether some command exists.

The second definitional clarification concerns environmental effectiveness. By this term, I mean the proximate environmental goal, not the underlying environmental problem, which the proximate goal is presumed to solve. The relation between proximate goal and underlying environmental problem is a matter of program design and program design must figure in any broad definition of environmental effectiveness. Nevertheless, there would appear to be no tight link between instrument choice and good program design, which can be faulty as easily for MBI's as it can for alternative prescriptive measures. While some instruments may lend themselves more readily to the adoption of appropriate proximate goals, the focus of this paper is the achievement of the proximate goal that I assume to be well chosen for the underlying environmental objective.

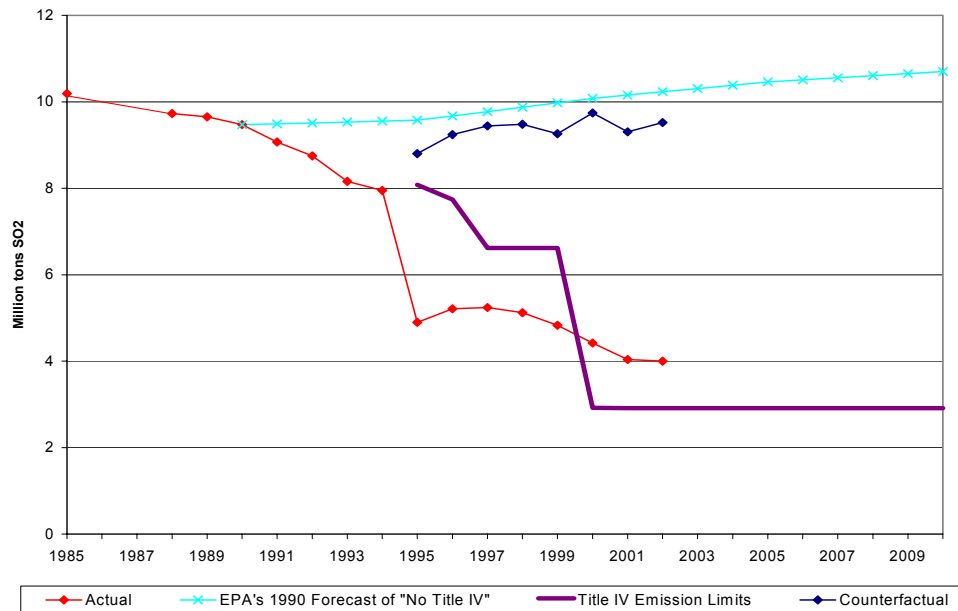
## The Title IV Story<sup>2</sup>

### ***Four environmentally advantageous features***

Four features describe the environmental performance of the Acid Rain Program. First, a large reduction of emissions was accomplished relatively quickly—in the fifth year following passage of the enabling legislation. Second, the schedule of emission reduction was accelerated significantly as a result of banking. Third, no exemptions, exceptions, or relaxations from the program’s requirements were granted. Four, the “hot spots” that were feared to result from emissions trading have not appeared.

The first two features are illustrated in Figure One which shows the relationship between the cap, actual emissions, and several estimates of what emissions would have been absent Title IV for those units required to be subject to Title IV beginning in 1995, the “big dirties” as they are sometimes called.

**Figure 1: Title IV in Historical Perspective: Phase I Units**



Source: Ellerman et al. (2000) as amended with data for more recent years based on EPA’s annual compliance reports.

<sup>2</sup> The more comprehensive research on the Acid Rain Program is Ellerman et al. (2000). For a more recent assessment, see Ellerman (2003).

The story shown by this picture is remarkable in two respects. The program caused a significant reduction of SO<sub>2</sub> emissions in the fifth year following enactment of the 1990 Clean Air Act Amendments and the first year in which the program was effective. Moreover, most of the reduction observed in 1995 was due to banking, which was not mandated, but a form of voluntary, early action on the part of program participants. Banking implies that the early “over-compliance” will be followed by later “under-compliance,” as can be observed in the first three years of Phase II; however, if a positive discount rate is attached to the timing of the benefits of emission reduction, this behavior constitutes a net environmental gain. During the entire five years of Phase I, emissions were reduced by twice as much as was required to meet the Phase I cap. On a yearly basis, the annual emission reduction has increased steadily from 3.9 million tons in the first year, 1995, to 4.4 million tons in 1999, the last year of Phase I, and to 6.9 million tons in 2002, a 77% increase in abatement by the eighth year.

EPA often notes that Title IV has achieved 100% compliance.<sup>3</sup> This curious statement requires some interpretation since US environmental regulation is not characterized by widespread legal violations of statute or regulation. What is meant is that the program was implemented without the granting of the exemptions, exceptions, or relaxations of the regulatory requirement that are typically issued to avoid the undue hardship that can result when a more or less uniform mandate is imposed on sources exhibiting cost heterogeneity. Since the sources incurring less onerous costs never step forward to request more stringent regulation and the regulator does not have the information or will to impose a compensating tightening of the standard on these units, deviations from the presumed performance are all in one direction. The Acid Rain Program avoided this loosening bias through the trading mechanism, which automatically provided compensating reductions and made them cheaper than seeking some form of regulatory exemption.

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<sup>3</sup> See for instance any of the annual compliance reports for 1995 through 1999. In both 2000 and 2001, very small amounts of emissions were out of compliance: 54 tons in 2000 and 11 tons in 2001 out of more than 10 million tons. Fines were assessed and an equivalent number of the next vintage allowances were deducted from the unit accounts of these non-complying units. For all practical purposes, the compliance rate has been 100% for all years.

The term “hot spots” refers to the possibility that with emissions trading the emission reductions might be avoided by the sources who contribute the most to environmental damage. A well-designed trading program would make hot spots impossible, but the practical requirements of program design and implementation will often allow this possibility. In the Acid Rain Program, the fear was that the required emission reductions would not be made in the Midwest, which was the source of the emissions most responsible for acidification in the Northeast, but in other areas such as the Southeast. As it turned out, most of the emission reductions did take place in the Midwest. Sources in the eight main Midwestern states (PA, WV, OH, IN, IL, KY, TN, MO) have provided about 80 % of the nationwide emission reduction achieved by Title IV while accounting for about 50% of current emissions and about 60% of what emissions would have been absent Title IV.

It is hard to imagine an alternative command-and-control program that would have had equal environmental performance, even assuming that such a program could have achieved the legislative consensus accorded to Title IV after nearly a decade of stalemated proposals that would have mandated scrubbers and other prescriptive standards. Although there is surprisingly little ex post evaluation of the performance of conventional prescriptive regulations, they are typically not characterized by quick implementation with significant emission reductions relatively soon after enactment, nor by voluntary actions that have the effect of accelerating required emission reductions. More usually, implementation occurs only after a long period of regulatory rulemaking, administrative proceedings, and litigation as participants seek to shape the rules and to gain some form of relaxation and competitive advantage over other firms.

### ***Reasons for Better Environmental Effectiveness***

Only one of the four aspects of environmental performance noted above can be attributed to a specific design feature: the acceleration of the required emission reduction, which is clearly due to the banking provisions of Title IV (Ellerman and Montero, 2002). The remaining environmental features—quick implementation, 100% compliance, and the absence of hot spots—reflect the more fundamental characteristics of the program, namely, a flexible, decentralized, property rights system.

Quick implementation occurred because there was comparatively little for EPA to do in the way of regulatory implementation once the statute was enacted.<sup>4</sup> More typically, EPA must translate general Congressional intent into specific, concrete and enforceable objectives that can be applied to specific sources. In the case of the SO<sub>2</sub> allowance trading program, all that EPA needed to do, after Congress had established a system of freely tradable emission rights and distributed those rights, was to set up the reporting and accounting system needed to ensure adequate enforcement. While very important, this task is much less demanding and time-consuming than what is usually required. More importantly perhaps, the radical redefinition of EPA's role greatly reduced affected firms' interest in EPA's administrative proceedings. Since regulatory implementation did not involve prescribing the abatement and the costs individual sources will incur, the economic interest of affected firms was much less engaged and there was much less administrative involvement, political intervention, and litigation than normally characterizes the implementation of Congress' intent in environmental matters. The issue that had the most impact on individual firms' profits, the allowance allocation had been decided and the rest depended on an impersonal and inscrutable market and how well the firm used the allowances it had been allocated. Furthermore, it is quite a different matter to sue Congress than it is to sue the EPA Administrator for alleged arbitrary and capricious action. It is revealing that the most significant litigation in the implementation of Title IV concerned the one area in which EPA had some discretion in allocating allowances: those for units that were voluntarily brought into the program in Phase I as substitution and compensation units.

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<sup>4</sup> Nat Keohane makes the valid and interesting point that the issue is when the "clock" starts. It could be argued that the highly visible scrap over rents that accompanies the allocation of grandfathered allowances takes longer than the enactment of legislation that simply states intent or grand goal and leaves the rest to EPA. If so, then the choice is between quick adoption with slow implementation or slow adoption with quick implementation. However, it is not obvious that rent-seeking behavior is more prevalent in the adoption of cap-and-trade programs than in the adoption of prescriptive regulation. Moreover, it can be argued that providing a ready currency to make the politically required pay-offs leads to faster adoption than concocting and agreeing upon special regulatory provisions to achieve the same ends. The enactment of Title IV is instructive. The legislative proposal embodying this program was introduced in July 1989 and enacted in October 1990, a very short time in comparison to the decade-long, deadlocked debate on several prescriptive acid rain control proposals that preceded the proposal embodying Title IV. Joskow and Schmalensee (1998) describe the "majoritarian consensus" that was achieved through the allocation of SO<sub>2</sub> allowances and which seems to have eluded earlier legislative proposals lacking this facilitating feature.

What EPA terms 100% compliance reflects another little noticed feature of the simple, property rights system that Congress established with Title IV. Compliance became cheaper than seeking the various forms of relaxation that characterize conventional regulatory programs. Firms facing relatively high costs of compliance in prescriptive programs can reduce those costs only by petitioning for and receiving some type of dispensation. This involves non-negligible transaction costs and a less than 100% probability of success. Consequently, the decision to seek some form of relaxation depends on a comparison of the abatement cost savings from a successful petition, its likelihood, and the cost of obtaining that dispensation.

This trade-off confronts the regulator with an unenviable choice in a conventional regulatory program. Lower transaction costs reduce the inequities involved in applying the rule, but they also encourage more petitions and less compliance with the original mandate. Conversely, higher transaction costs result in greater compliance, but also a more inequitable incidence of the regulatory requirement and greater political resistance. Cap-and-trade systems avoid this dilemma entirely. Where a market can be assumed, which has proven to be the case for the cap-and-trade systems in the United States, firms facing relatively high costs of abatement incur very low transaction costs in purchasing abatement by others. Thus, it becomes cheaper for these firms to comply than to seek some relaxation of the standard. Moreover, the existence of a market removes the primary reason for seeking relaxation: unique hardship due to the uniform application of a rule to source-specific circumstances. No one is uniquely disadvantaged in a market with many buyers and the highest cost is that of a permit. The happy result is a regulatory system in which compliance has been made cheaper than seeking some type of relaxation. While much is made of the ability of emissions trading to provide cheaper abatement options to firms facing relatively higher abatement costs, this compliance enhancing, environmentally beneficial feature of cap-and-trade systems has been little noticed.

The lack of hot spots in the Acid Rain Program might be seen as accidental in that the cheapest sources of abatement were also the sources of the most damaging emissions, but there is more to this correspondence than happenstance. It reflects the circumstance that the cheapest abatement is typically found where the largest sources are located and

these sources are usually the greatest contributors to the underlying environmental problem. Most deep abatement technology, like scrubbing, is capital intensive and the per-ton cost depends how many tons are removed per MW<sup>c</sup> of capacity. Higher utilization of the source and higher sulfur content of the combusted coal means more tons of abatement over which the fixed capital cost can be spread and lower total abatement cost per ton. Thus, where capital-intensive, deep-abatement technology is an option, market systems will direct abatement to relatively larger and more heavily utilized sources with relatively high emission intensities. And, if these sources are the most damaging from an environmental standpoint, the experience with Title IV suggests they will abate first. A further implication of this result is that broader markets can be formed where reason exists to believe that the pollution problem is caused mostly by the larger and more polluting sources.

## **Is Title IV an exception?**

Title IV's SO<sub>2</sub> emissions trading program is widely recognized as successful, and perhaps exceptional, so that the relevant question is always whether the results from this program can be generalized. Neither of the two other major cap-and-trade programs in the United States, the Northeastern NO<sub>x</sub> Budget Program, and the RECLAIM programs in the Los Angeles Basin, have been studied as extensively as the Acid Rain Program. Nevertheless, they do provide support, as discussed below, for the argument that cap-and-trade programs are more effective environmentally than alternative command-and-control programs. They also provide clearer evidence of a tendency for cap-and-trade approaches to supplant conventional prescriptive regulation, which is evident in the adoption of Title IV after years of stalemated legislative proposals to reduce SO<sub>2</sub> emissions by more conventional means. This tendency is the more remarkable in that, unlike the Acid Rain Program where Congressional action provided the required legal authority, these programs were implemented through administrative action by regulatory bodies that possessed the legal authority to impose command-and-control measures with equivalent environmental effect.

## ***The NO<sub>x</sub> Budget Program***<sup>5</sup>

The NO<sub>x</sub> Budget Program is a multi-state, regional program that was formed for the purpose of attaining the National Ambient Air Quality Standard (NAAQS) for ground-level ozone in the Northeastern United States. The 1990 Clean Air Act Amendments mandated a standard of reasonably available control technology (RACT) for all sources located in non-attainment areas beginning in 1995, and it also formed a Ozone Transport Commission (OTC) to coordinate action among the thirteen Northeastern and Mid-Atlantic states and the District of Columbia to end the persistent non-attainment along the Northeastern Corridor. Negotiations among these states led to a Memorandum of Understanding in 1994 that established a three-phase program of control of NO<sub>x</sub> emissions from electric utility and large industrial boilers. Phase 1 was a re-labeling of the RACT standard that took effect in 1995, but it was recognized that further NO<sub>x</sub> emission reductions would be required to achieve attainment. Phases 2 and 3, beginning in 1999 and 2003, consist of a progressively more stringent cap-and-trade program encompassing eleven of the fourteen jurisdictions during the ozone season (May through September) when the formation of ground-level ozone occurs.<sup>6</sup> Beginning in 2004, the third phase will be extended to cover most of the states east of the Mississippi River in what is known as the NO<sub>x</sub> SIP Call.

Although the phase 2 emissions trading program differs in important aspects from the Acid Rain Program—for instance in placing limits on the use of banked allowances—this phase has been successful in reducing NO<sub>x</sub> emissions in the Northeast. EPA compliance reports frequently note that ozone-season NO<sub>x</sub> emissions are 60% below 1990 baseline levels, but two-thirds of this reduction was accomplished in the first phase that did not involve emissions trading. A more accurate statement for the purpose of this paper would be that second phase cap has reduced emissions by about 30% over the level achieved by the earlier RACT requirement and that the third and final phase, which has started this year, will effect another 35% reduction. Thus, the Northeastern NO<sub>x</sub> cap-and-trade program will have reduced emissions by about 50% from what had been achieved

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<sup>5</sup> USEPA-OTC (2003) provides a convenient summary of this program.

<sup>6</sup> Virginia did not sign the Memorandum of Understanding and Maine and Vermont did not participate in the later phases because the few sources in these two states had already achieved the required emission levels with the RACT standard and other state rules.

under the prescriptive RACT standard. The level of emissions to be achieved in the aggregate and the basis for determining the cap and for allocating allowances is the level of emissions that would have resulted from the application of a relatively tight emission rate standard (0.15 lbs. NO<sub>x</sub>/mmBtu) to all sources in the 1990 baseline year.

The interesting question about this program is why a cap-and-trade mechanism was chosen for the later, more stringent phases instead of simply prescribing the more demanding 0.15 lbs. NO<sub>x</sub>/mmBtu standard for all affected units. A source-specific emission rate limit would have been more in keeping with well-established regulatory practice in the United States.

One explanation might be that environmental regulators were swept up with the enthusiasm for market-based instruments that characterized this time, but this is a group that is generally not suspected of such sentiment. A more likely explanation is that regulators had come to recognize the limits of the conventional prescriptive approach for controlling air emissions and that they turned to the most practicable alternative to achieve the desired reductions in sources of pollution. They may also have concluded that the costs of a conventional program would too high to be politically acceptable and been honest enough to admit that they did not possess the information to impose an efficient command-and-control program.

A further factor influencing the choice of cap-and-trade programs may have been a greater willingness to the part of the owners of affected sources to accept this type of market-based instrument when the allowances are distributed to them for free. Any form of MBI would have provided the flexibility to achieve the environmental goal at least cost, but only grandfathered permits would provide higher value rents to incumbents than they would receive under conventional regulatory programs, which convey similar rents, especially when new entrants face more stringent standards. The new rights have the advantage of being more secure than the contingent rights embodied in conventional programs, and they are separable from the facilities to which they are granted.<sup>7</sup>

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<sup>7</sup> Much of the regulatory intervention and litigation surrounding the implementation of command-and-control regulation can be seen as jockeying for the competitive advantage and associated rents created by these programs.

## ***The RECLAIM Programs***<sup>8</sup>

The RECLAIM NO<sub>x</sub> and SO<sub>2</sub> programs provide even clearer evidence of the tendency to supplant existing regulation with a cap-and-trade approach to achieve further increments of emission reduction. Like the NO<sub>x</sub> Budget Program, the RECLAIM programs are aimed at bringing a particular region, the Los Angeles Basin, into attainment with the NAAQS. In this case however, an explicit command-and-control program to bring the region into attainment by 2010—the 1989 Air Quality Management Plan—had already been developed, but its implementation, which would have involved 130 specific control measures, would have been costly and slow. Three years of negotiation between regulators and the regulated eventuated in agreement in late 1993 on two phased-in cap-and-trade programs, one for NO<sub>x</sub> and the other for SO<sub>2</sub>, that would achieve the desired level of aggregate emissions in ten years, or by 2003, seven years sooner than in the 1989 Plan. Facilities participating in these programs were then exempt from the prescriptive requirements contained in the 1989 Plan as concerns NO<sub>x</sub> and SO<sub>2</sub> emissions.

As was the case with the Northeastern NO<sub>x</sub> Budget Program, regulators seem to have realized that proceeding in the conventional manner would impose too high a cost to be politically practicable and that they lacked the information to devise an efficient command-and-control program. At the same time, RTCs, or RECLAIM Trading Credits as allowances were called in these programs, were granted to incumbent firms in perpetuity. The long and sometimes difficult negotiations concerning the allocation of these allowances indicates that firms were aware of the value being conveyed and it is reasonable to assume that this feature made them more willing to agree to the measures being proposed.

The environmental effectiveness of the RECLAIM programs has been comparable to those of the other cap-and-trade programs. As of 2001, both NO<sub>x</sub> and SO<sub>2</sub> emissions have been reduced by about 40% since the program's start in 1994. In 2003,

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<sup>8</sup> The material in this section is drawn largely from Harrison (2003) and SCAQMD (2003).

when fully phased in, the emission reduction from pre-program levels will be 50%.<sup>9</sup> The SO<sub>2</sub> cap has been met in each of the eight years since the program started. The NO<sub>x</sub> cap was exceeded in 2000 by 3,294 tons (16%) and in 2001 by 28 tons (0.25%) as a result of the electricity market problems in California in these years. The limited amount of banking and borrowing allowed through the use of overlapping cycles reduced the exceedences in each of these years by about half and those without sufficient RTC's on an individual facility basis paid a \$15,000/ton mitigation fee to fund off-system emission reductions and had the amount in exceedence deducted from future allowance allocations.

This exceedence of the NO<sub>x</sub> cap is unfortunate, but it must be placed in context. The events of 2000-01 in California's electricity market led to an extraordinary call on old generating plants in the Los Angeles Basin that were not equipped with NO<sub>x</sub> emission control devices because heretofore they have been dispatched for only a few hours a year to meet peak demand (Joskow, 2001). The unanticipated call on these units to meet electricity demand increased the demand for RTC credits to cover the resulting NO<sub>x</sub> emissions beyond what could be provided within the temporally constrained time period within which RTC credits are valid (one year with some banking and borrowing possible because of overlapping compliance cycles). The result was 1) unprecedented high prices (up to \$90,000/ton), 2) the establishment of the \$15,000/ton mitigation fee, 3) the temporary removal of electric utility units from the cap-and-trade system, and 4) the imposition of mandates on those units to retrofit NO<sub>x</sub> emission control devices. These units are now proposed for re-entry into the NO<sub>x</sub> cap effective January 1, 2004.

The relevant question in assessing this performance is how the command-and-control program that RECLAIM supplanted would have fared under the same circumstances. For one thing, the exceedences would not have been recognized, much less compensated. The only argument for better environmental performance by the alternative system is that it would have succeeded in having NO<sub>x</sub> abatement equipment installed, prior to the summer of 2000, on the generating units that were the source of the problem, thereby avoiding the large spike in emissions. The prior low utilization of these

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<sup>9</sup> The reduction in the number of RTCs distributed annually from 1994 through 2003 declined by 70% for NO<sub>x</sub> and 60% for SO<sub>2</sub>, but in both cases the annual caps were set intentionally to be initially non-binding. Since banking is not allowed, the early excess RTCs had no effect on eventual compliance.

units and the high cost of capital-intensive retrofits make such an assumption debatable at best. Also, given the high price of NO<sub>x</sub> allowances since the summer of 2000, it is hard to imagine that owners of these units would have resisted retrofitting these units, unless they expected the units to return to the earlier level of low utilization. Accordingly, mandating the retrofit of these generating units will have the effect either of prescribing what would have been done anyway in response to the higher prices and expected higher utilization, or of providing very high cost protection against future allowance price spikes.

## **Concluding Observations and Qualifications**

Critics of the use of market-based approaches will argue that the adoption of cap-and-trade programs reflects a public policy fad or, at least, public policy experimentation in an inappropriate domain. If so, then the decisions to adopt these programs were fortunate in revealing instruments that are not only less costly but also more environmentally effective. However, another explanation, less dependent on serendipity, is that conditions have changed. Today's environmental problems are not as obvious as before, and further increments of emissions reduction are more costly even when efficiently accomplished. Results-oriented environmental regulators have recognized that the familiar blunt instruments do not work as well in these new circumstances and that they do not have the information needed to design and administer conventional programs efficiently, assuming even that they can be adopted and implemented in the face of high costs. Moreover, changes in information technology have helped in making data-intensive monitoring and reporting of emissions and the tracking of allowances cheaper and feasible over a broader range of environmental applications (Kruger et al., 2000).<sup>10</sup> Finally, the political requirements for gaining meaningful agreement by all relevant parties, whether for Congressional enactment or administrative implementation, make cap-and-trade programs with initially grandfathered allowances an obvious choice among the array of MBIs.<sup>11</sup> All in all, the experience with these programs indicates a new

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<sup>10</sup> Rosenzweig and Varilek (2003) provide an insightful description of the problems of handling the required data for one of the first experiments in emissions trading, the lead-in-gasoline trading program.

<sup>11</sup> As reflected in current legislative proposals to effect further reductions in SO<sub>2</sub> and NO<sub>x</sub>, both ends of the political spectrum seem in agreement that some allowances will have to be grandfathered initially and that ultimately all allowances would be auctioned. The differences concern the initial share and the phase-out schedule with the Bush Administration's Clear Skies Proposal starting with 99% grandfathering and a 50-

pragmatism in which regulators have come to recognize the political and economic limits of their ability to prescribe source-specific emission reductions and the firms subject to the regulation have come to accept the costs involved in effecting emission reductions conditional on the receipt of improved rights to allowed emissions.

It is not surprising that this new pragmatism should lead to the emergence of an explicit property rights approach. By giving legal recognition to the right to emit that is conveyed by conventional regulation and in making that right separable from the regulated asset, legislators have enabled the emergence of markets that provide the incentive for recipients of these rights to comply and to use the information available to each to make efficient abatement choices. Whether they recognize it or not, legislators have adopted the simple rule, suggested a decade ago by Laffont and Tirole (1993), that does not place impossibly high informational demands on regulators and yet provides the incentive and flexibility for firms to do the right thing.<sup>12</sup>

The argument presented here is not that the extensive body of environmental regulation that has been developed and administered in the United States over the past three decades has been ineffective. Clearly, it has been effective. The issue is one of relative environmental effectiveness, just as is the usual argument for lower economic costs. Still, if the experience with the admittedly small sample of cap-and-trade programs can be generalized more broadly, the policy implications for choice of instrument are even stronger than is commonly assumed.

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year phase-out while some Congressional proposals would award incumbents with no more than 20% of the allowances initially and phase out the grandfathering over ten years.

<sup>12</sup> I am indebted to Paul Joskow for pointing out the implicit adoption of the model propounded by Laffont and Tirole.

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