Market-Based Environmental Policies: What Can We Learn from U.S. Experience (and Related Research)?

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MARKET-BASED ENVIRONMENTAL POLICIES: WHAT CAN WE LEARN FROM U.S. EXPERIENCE (AND RELATED RESEARCH)?

Robert Stavins[*]

This conference is premised on the notion that market-based instruments have been part of the environmental policy landscape in the United States for twenty years. Although such instruments were first introduced early in the 1970s[1] and the surge of high-level, national interest in this set of policy tools did not commence until late in the 1980s,[2] twenty years is a reasonable reference point to use to reflect on our experiences, and search for lessons from this set of experiments with economic-incentive approaches to public policy. In the intervening years, the concept of harnessing market forces to protect the environment seems to have evolved from being almost politically anathema to being close to politically correct.

For purposes of this paper, I define market-based instruments to be aspects of laws or regulations that encourage behavior through market signals, rather than through explicit directives regarding pollution control levels or methods. These policy instruments, such as tradable permits or pollution charges, can reasonably be described as "harnessing market forces,"[3] because if they are well designed and properly implemented, they encourage firms or individuals to undertake pollution control efforts that are in their own interests and that collectively meet policy goals.

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[1]Beginning in 1974, the U.S. Environmental Protection Agency (EPA) experimented with emissions trading as part of the Clean Air Act's program for improving local air quality through the control of volatile organic compounds (VOCs), carbon monoxide (CO), sulfur dioxide (SO_2), particulates, and nitrogen oxides (NO_x). EPA later codified this diverse set of initiatives (bubbles, netting, offsets, and banking) in its Emissions Trading Program in 1986. See: Tietenberg 1985; Hahn 1989; Foster and Hahn 1995.

[2]Among other developments during the late 1980s, U.S. Senators Timothy Wirth and John Heinz launched what they called, "Project 88: Harnessing Market Forces to Protect our Environment — Initiatives for the New President." In a series of reports, conferences, and briefings of White House officials and Congressional members and staff, Project 88 put forward a diverse set of market-based policy instruments for environmental protection and resource management (Stavins 1988, 1991). Of equal importance, the Environmental Defense Fund split from the rest of the environmental advocacy community and lent its enthusiastic support to the Bush White House's development of what subsequently became the SO_2 allowance trading program in the Clean Air Act amendments of 1990. See: Hahn 2000.

[3]See: Organization for Economic Cooperation and Development (1989, 1991, 1998); and U.S. Environmental Protection Agency (1991, 1992, 2001). Another strain of literature — known as "free market environmentalism" — focuses on the role of private property rights in achieving environmental protection (Anderson and Leal 1991).

By way of contrast, what may be thought of as conventional approaches to regulating the environment — frequently characterized as "command-and-control" approaches — allow relatively little flexibility in the means of achieving goals. Such policy instruments tend to force firms to take on similar shares of the pollution-control burden, regardless of the cost, sometimes by setting uniform standards for firms, the most prevalent of which are technology- and performance-based standards.

It is well known that holding all firms to the same target can be expensive and, in some circumstances, counterproductive. While standards may effectively limit emissions of pollutants, they typically exact relatively high costs in the process, by forcing some firms to resort to unduly expensive means of controlling pollution. Because the costs of controlling emissions may vary greatly among firms, and even among sources within firms, the appropriate technology in one situation may not be appropriate (cost-effective) in another.

Control costs can vary enormously due to a firm's production design, physical configuration, age of assets, or other factors. One frequently-cited survey of eight empirical studies of air pollution control found that the ratio of actual, aggregate costs of the conventional (command-and-control) approach to the aggregate costs of least-cost benchmarks ranged from 1.07 for sulfate emissions in the Los Angeles area to 22.0 for hydrocarbon emissions at all domestic DuPont plants (Tietenberg 1985). It is important not to misinterpret these numbers, however, since actual, command-and-control instruments were essentially contrasted with theoretical benchmarks of cost-effectiveness, that is, what a perfectly functioning market-based instrument would achieve in theory. A more interesting comparison among policy instruments might involve either idealized versions of both market-based systems and alternatives, or — better yet — realistic versions of both (Hahn and Stavins 1992).

In theory, if properly designed and implemented, market-based instruments allow any desired level of pollution cleanup to be realized at the lowest overall cost to society, by providing incentives for the greatest reductions in pollution by those firms that can achieve the reductions most cheaply.[4] Rather than equalizing pollution levels among firms (as with uniform emission standards), market-based instruments equalize the incremental amount that firms spend to reduce pollution — their marginal abatement cost (Montgomery 1972; Baumol and Oates 1988; Tietenberg 1995). Command-and-control approaches could — in theory — achieve this cost-effective solution, but this would require that different standards be set for each pollution source, and, consequently, that policy makers obtain detailed information about the compliance costs each firm faces. Such information is simply not available to government. By contrast, market-based instruments provide for a cost-effective allocation of the pollution control burden among sources without requiring the government to have this information.

[4]This paper focuses on policy instruments in the environmental realm, chiefly those instruments that reduce emissions or concentrations of pollution, as opposed to those that operate in the natural resources realm. This means, for example, that tradeable development rights, wetlands mitigation banking, and tradeable permit systems used to govern the allocation of fishing rights are not discussed. The distinction between environmental and natural resource policies is somewhat arbitrary, and some policy instruments that bridge the environmental and natural resource realms, such as removing barriers to water markets, are considered.

In addition, market-based instruments have the potential to bring down abatement costs over time (that is, to be dynamically cost effective) by providing incentives for companies to adopt cheaper and better pollution-control technologies. This is because with market-based instruments, most obviously with emission taxes, it pays firms to clean up a bit more if a sufficiently low-cost method (technology or process) of doing so can be identified and adopted (Downing and White 1986; Malueg 1989; Milliman and Prince 1989; and Jaffe and Stavins 1995).

In the next section of the paper, I briefly summarize a few highlights of the American experience with market-based instruments for environmental protection. Following that, I examine normative lessons that can be learned from these experiences, and then focus on positive political economy lessons. A final section offers some conclusions.

1. Highlights of Experience

Experiences in the United States with market-based environmental policy instruments have been both numerous and diverse.[5] It is convenient to consider them within four major categories: pollution charges; tradable permits; market friction reductions; and government subsidy reductions.

1.1 Charge Systems

Pollution charge systems assess a fee or tax on the amount of pollution that a firm or source generates (Pigou 1920). Consequently, it is worthwhile for the firm to reduce emissions to the point where its marginal abatement cost is equal to the tax rate. A challenge with charge systems is identifying the appropriate tax rate. For social efficiency, it should be set equal to the marginal benefits of cleanup at the efficient level of cleanup, but policy makers are more likely to think in terms of a desired level of cleanup, and they do not know beforehand how firms will respond to a given level of taxation.

An additional problem posed by pollution taxes is associated with their distributional consequences for regulated sources. Despite the fact that such systems minimize aggregate social costs, these systems may be *more* costly than comparable command-and-control instruments *for regulated firms*. This is because with the tax approach, firms pay both their abatement costs *plus* taxes on their residual emissions, whereas for the calculation of aggregate costs in a social benefit-cost or cost-effectiveness analysis, tax payments are simply transfers, and so are excluded from the calculations.

The conventional wisdom is that this approach to environmental protection has been ignored in the United States, but this is not really correct. If one defines charge systems broadly, a significant number of applications can be identified. The closest that any U.S. charge system comes to operating as a true Pigovian tax may be the *unit-charge* systems for financing municipal solid waste collection, where households and businesses are charged the incremental costs of collection and disposal. So-called "pay-as-you-throw" policies, where users pay in proportion to the volume of their waste, are

[5]For a detailed review of both U.S. and international experiences, see Stavins (2003).

now used in well over one thousand jurisdictions. The collective experience provides evidence that unit charges have been successful in reducing the volume of household waste generated.[6]

Another important set of charge systems implemented in the United States has been *deposit refund systems*, whereby consumers pay a surcharge when purchasing potentially polluting products, and receive a refund when returning the product to an approved center for recycling or proper disposal. A number of states have implemented this approach through "bottle bills" to control litter from beverage containers and to reduce the flow of solid waste to landfills, and the concept has also been applied to lead-acid batteries (Bohm 1981; Menell 1990).

In addition, there has been considerable use of *environmental user charges* in the United States, through which specific environmentally related services are funded. Examples include *insurance premium taxes*, such as those formerly used to fund partially the clean-up of hazardous waste sites through the Superfund program (Barthold 1994).[7] Another set of environmental charges are *sales taxes* on motor fuels, ozone-depleting chemicals, agricultural inputs, and low-mileage motor vehicles. Finally, *tax differentiation* has become part of a considerable number of Federal and state attempts to encourage the use of renewable energy sources.

1.2 Tradeable Permits

Tradable permits — in theory — can achieve the same cost-minimizing allocation of the control burden as a charge system,[8] while avoiding the problems of uncertain responses by firms and the distributional consequences of taxes.[9] Under a tradable permit system, an allowable overall level of pollution is established and allocated among firms in the form of permits. Firms that keep their

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[6]See: McFarland 1972; Wertz 1976; Stevens 1978; Efaw and Lanen 1979; Skumatz 1990; Lave and Gruenspecht 1991; Repetto, Dower, Jenkins, and Geoghegan 1992; Miranda, Everett, Blume, and Roy 1994; and Fullerton and Kinnaman 1996.

[7]The taxes that previously supported the Superfund trust fund — primarily excise taxes on petroleum and specified chemical feedstocks and a corporate environmental income tax — expired in 1995, and have not been reinstated.

[8]Thirty years ago, Crocker (1966) and Dales (1968) independently developed the idea of using transferable discharge permits to allocate the pollution-control burden among sources. Montgomery (1972) provided the first rigorous proof that such a system could provide a cost-effective policy instrument. A sizeable literature has followed, much of it stemming from Hahn and Noll (1982). Early surveys were provided by Tietenberg (1980, 1985). Much of the literature may be traced to Coase's (1960) treatment of negotiated solutions to externality problems.

[9]This assumes that the allocation is made without charge, but it could also be through sale or auction, in which case the distributional implications of a comparable tradeable permit program are similar to the emission tax previously described. Likewise, a revenue-neutral emissions tax, in which revenues are refunded to regulated firms (but not in proportion to their emissions levels), can resemble — in distributional terms — a comparable tradeable permit program in which the permits are allocated without charge. The simple tradeable permit program described above is a"cap-and-trade" system, but some systems operate as "credit programs," where permits or credits are assigned only when a source reduces emissions below what is required by source-specific limits.

emission levels below their allotted level may sell their surplus permits to other firms or use them to offset excess emissions in other parts of their operations.[10]

Applications have included: EPA's emissions trading program (Tietenberg 1985; Hahn 1989); the leaded gasoline phasedown; water quality permit trading (Hahn 1989; Stephenson, Norris, and Shabman 1998); CFC trading (Hahn and McGartland 1989); the sulfur dioxide (SO_2) allowance trading system for acid rain control; the RECLAIM program in the Los Angeles metropolitan region (Harrison 1999); and tradeable development rights for land use.[11] At least two of these programs — lead trading and the SO_2 allowance system — merit further comment.

The purpose of the *lead trading program*, developed in the 1980s, was to allow gasoline refiners greater flexibility in meeting emission standards at a time when the lead-content of gasoline was reduced to 10 percent of its previous level. In 1982, EPA authorized inter-refinery trading of lead credits, a major purpose of which was to lessen the financial burden on smaller refineries, which were believed to have significantly higher compliance costs. If refiners produced gasoline with a lower lead content than was required, they earned lead credits. In 1985, EPA initiated a program allowing refineries to bank lead credits, and subsequently firms made extensive use of this option. In each year of the program, more than 60 percent of the lead added to gasoline was associated with traded lead credits (Hahn and Hester 1989a), until the program was terminated at the end of 1987, when the lead phasedown was completed.

The lead program was successful in meeting its environmental targets, although it may have produced some (temporary) geographic shifts in use patterns (Anderson, Hofmann and Rusin 1990). Although the benefits of the trading scheme are more difficult to assess, the level of trading activity and the rate at which refiners reduced their production of leaded gasoline suggest that the program was relatively cost-effective (Kerr and Maré 1997; Nichols 1997). The high level of trading among firms far surpassed levels observed in earlier environmental markets. EPA estimated savings from the lead trading program of approximately 20 percent below alternative programs that did not provide for lead banking, a cost savings of about \$250 million per year (U.S. Environmental Protection Agency, Office of Policy Analysis 1985). Furthermore, the program appears to have provided greater incentives for cost-effective technology diffusion than did a comparable non-tradeable performance standard (Kerr and Newell 2001).

The most important application made of a market-based instrument for environmental protection has arguably been the *SO_2 allowance trading* program for acid rain control, established

[10]Furthermore, if command-and-control instruments take the form of technology standards or emission rate standards, they are likely to provide less certainly regarding the achievement of an aggregate emissions (or ambient concentration) target than a cap-and-trade program, because the former do not control for product output.

[11]In addition, the Energy Policy and Conservation Act of 1975 established Corporate Average Fuel Economy (CAFE) standards for automobiles and light trucks, requiring manufacturers to meet minimum sales-weighted average fuel efficiency for their fleets sold in the United States. A penalty is charged per car sold per unit of average fuel efficiency below the standard. The program operates like an intra-firm tradeable permit system, since manufacturers can undertake efficiency improvements wherever they are cheapest within their fleets. For reviews of the program's costs relative to "equivalent" gasoline taxes, see: Crandall, Gruenspecht, Keeler, and Lave 1986; Goldberg 1997; and National Research Council 2002. Light trucks, which are defined by the Federal government to include "sport utility vehicles," face weaker CAFE standards.

under the Clean Air Act Amendments of 1990, and intended to reduce SO_2 emissions by 10 million tons below 1980 levels (Ferrall 1991). A robust market of bilateral SO_2 permit trading gradually emerged, resulting in cost savings on the order of $1 billion annually, compared with costs under likely command-and-control regulatory alternatives. Although the program had low levels of trading in its early years (Burtraw 1996), trading increased significantly over time (Schmalensee *et al*. 1998; Stavins 1998; Burtraw and Mansur 1999; Ellerman *et al.* 2000).

Concerns were expressed early on that state regulatory authorities would hamper trading in order to protect their domestic coal industries, and some research indicates that state public utility commission cost-recovery rules provided poor guidance for compliance activities (Rose 1997; Bohi 1994). Other analysis suggests that this was not a major problem (Bailey 1996). Similarly, in contrast to early assertions that the structure of EPA's small permit auction market would cause problems (Cason 1995), the evidence now indicates that this had little or no effect on the vastly more important bilateral trading market (Joskow, Schmalensee, and Bailey 1998).

The allowance trading program apparently has had exceptionally positive welfare effects, with benefits being as much as six times greater than costs (Burtraw, Krupnick, Mansur, Austin, and Farrell 1998). The large benefits of the program are due mainly to the positive human health impacts of decreased local SO_2 and particulate concentrations, not the ecological impacts of reduced long-distance transport of acid deposition. This contrasts with what was understood and assumed at the time of the program's enactment in 1990. It appears that the Congress did the right thing for the wrong reason.

1.3 Market Friction Reduction

Market friction reduction can also serve as a policy instrument for environmental protection. Three types of policies stand out. First, in a number of cases, *markets have been created for inputs or outputs associated with environmental quality*. Examples include measures implemented over the past twenty years that facilitate the voluntary exchange of water rights and thus promote more efficient allocation and use of scarce supplies (Stavins 1983; Howe 1997). Second, *liability rules* have frequently been designed to encourage firms to consider the potential environmental damages of their decisions (Revesz 1997). One important example is the Comprehensive Environmental Response, Compensation, and Liability Act, which established liability for companies that are found responsible for the existence of sites contaminated with hazardous wastes.[12]

Third, since well-functioning markets depend, in part, on the existence of well-informed producers and consumers, *information programs* can help foster market-oriented solutions to environmental problems.[13] These programs have been of two types. *Product labeling requirements*

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[12]Retroactive liability provisions can of course provide incentive effects only for future actions which might be subject to liability rules. For economic analyses of the Superfund program, see, for example: Hamilton 1993; Gupta,Van Houtven, and Cropper 1996; and Hamilton and Viscusi 1999.

[13]For a comprehensive review of information programs and their apparent efficacy, see: Tietenberg 1997. The International Standards Organization's (ISO) benchmark, ISO 14001, provides standards for environmental management systems. To obtain certification, firms must commit to environmental performance targets. More than 8,000 plants worldwide obtained certification through 1999 (Wheeler 2000).

have been implemented to improve the information set available to consumers. There has been relatively little analysis of the efficacy of such programs, but limited empirical (econometric) evidence suggests that energy-efficiency product labeling has had significant impacts on efficiency improvements, essentially by making consumers and therefore producers more sensitive to energy price changes (Newell, Jaffe, and Stavins 1999).

Another set of information programs has involved *reporting requirements*. A prominent example is the U.S. Toxics Release Inventory (TRI), which was expanded significantly during the past decade, and which requires firms to make available to the public information on use, storage, and release of specific hazardous chemicals. Such information reporting may increase public awareness of firms' actions, and consequent public scrutiny may encourage firms to alter their behavior, although the evidence is mixed (U.S. General Accounting Office 1992; Hamilton 1995; Bui and Mayer 1997; Konar and Cohen 1997; Ananathanarayanan 1998; and Hamilton and Viscusi 1999).

1.4 Government Subsidy Reduction

Government subsidy reduction is the fourth and final category of market-based instruments. Subsidies are the mirror image of taxes and, in theory, can provide incentives to address environmental problems.[14] In practice, however, many subsidies promote economically inefficient and environmentally unsound practices. Unfortunately, assessing the magnitude, let alone the effects, of these subsidies is difficult. For example, because of concerns about global climate change, increased attention has been given to Federal subsidies that promote the use of fossil fuels (U.S. Energy Information Administration 1999, 2000). One EPA study indicated that eliminating these subsidies would have significant effects on reducing carbon dioxide (CO_2) emissions (Shelby *et al.* 1997), but a substantial share of these subsidies were enacted during previous "oil crises" to encourage the development of domestic energy sources and reduce reliance on imported petroleum.

2. Normative Lessons

Although there has been considerable experience in the United States with market-based instruments for environmental protection, this relatively new set of policy approaches has not replaced nor come anywhere close to replacing conventional, command-and-control policies. When and where these approaches have been used in their purest form and with some success, they have not always performed as anticipated. Therefore, I ask what lessons can be learned from our experiences. I consider normative lessons for design and implementation of market-based instruments, analysis of prospective and adopted systems, and identification of new applications.

2.1 Normative Lessons for Design and Implementation

The performance to date of market-based instruments for environmental protection provides compelling evidence that these approaches can achieve major cost savings while accomplishing their environmental objectives. The performance of these systems also offers lessons about the importance

[14]Although subsidies can advance environmental quality (see, for example, Jaffe and Stavins 1995), it is also true that subsidies, in general, have important and well-known disadvantages relatives to taxes (Baumol and Oates 1988); hence, I do not consider them as a distinct category of market-based instruments in this paper.

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, it is important that market-based instruments should be designed to allow for a broad set of compliance alternatives, in terms of both timing and technological options. For example, allowing flexible timing and intertemporal trading of permits — that is, banking allowances for future use — played a very important role in the SO_2 allowance trading program's performance (Ellerman *et al.* 1997), much as it did in the U.S. lead rights trading program a decade earlier (Kerr and Maré 1997). One of the most significant benefits of using market-based instruments may simply be that technology standards are thereby avoided. Less flexible systems would not have led to the technological change that may have been induced by market-based instruments (Burtraw 1996; Ellerman and Montero 1998; Bohi and Burtraw 1997; Keohane 2001), nor the induced process innovations that have resulted (Doucet and Strauss 1994).

In regard to simplicity, transparent formulae — whether for permit allocation or tax computation — are difficult to contest or manipulate. Rules should be clearly defined up front, without ambiguity. For example, requiring prior government approval of individual trades may increase uncertainty and transaction costs, thereby discouraging trading; these negative effects should be balanced against any anticipated benefits due to requiring prior government approval. 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 reduced uncertainty for utilities and administrative costs for government, and contributed to low transactions costs (Rico 1995).

While some problematic program design elements reflect miscalculations of market reactions, others were known to be problematic at the time the programs were enacted, but nevertheless were incorporated into programs to ensure adoption by the political process. One striking example is the "20% rule" under EPA's Emission Trading Program. This rule, adopted at the insistence of the environmental advocacy community, stipulates that each time a permit is traded, the amount of pollution authorized thereunder must be reduced by 20%. Since permits that are not traded retain their full quantity value, this regulation discourages permit trading and thereby increases regulatory costs (Hahn 1990).

Experience also argues for using absolute baselines, not relative ones, as the point of departure for credit programs. The problem is that without a specified baseline, reductions must be credited relative to an unobservable hypothetical — what the source would have emitted in the absence of the regulation. A combined 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 1999). 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. 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).

Experiences with market-based instruments also provide powerful reminders of the importance of monitoring and enforcement. These instruments, whether price or quantity based, do not eliminate the need for such activities, although they may change their character. In the programs where monitoring and/or enforcement have been deficient, the results have been ineffective policies. One counter-example is provided by the U.S. SO_2 allowance trading program, which includes (costly) continuous emissions monitoring of all sources. On the enforcement side, the Act's stiff penalties (much greater than the marginal cost of abatement) have provided sufficient incentives for the very high degree of compliance that has been achieved (Stavins 1998).

In nearly every case of implemented cap-and-trade programs, permits have been allocated without charge to participants. The same characteristic that makes such allocation attractive in positive political economy terms — the conveyance of scarcity rents to the private sector — makes allocation without charge problematic in normative, efficiency terms (Fullerton and Metcalf 1997). It has been estimated that the costs of SO_2 allowance trading would be 25 percent less if permits were auctioned rather than allocated without charge, because revenues can be used to finance reductions in pre-existing distortionary taxes (Goulder, Parry, and Burtraw 1997). 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.[15]

Improvements in instrument design will not solve all problems. One potentially important cause of the mixed performance of implemented market-based instruments is that many firms are simply not well equipped to make the decisions necessary to fully utilize these instruments. Since market-based instruments have been used on a limited basis only, and firms are not certain that these instruments will be a lasting component on the regulatory landscape, it is not surprising that most companies have not reorganized their internal structure to fully exploit the cost savings these instruments offer (Reinhardt 2000). Rather, most firms continue to have organizations that are experienced in minimizing the costs of complying with command-and-control regulations, not in making the strategic decisions allowed by market-based instruments.[16]

The focus of environmental, health, and safety departments in private firms has been primarily on problem avoidance and risk management, rather than on the creation of opportunities made possible by market-based instruments. This focus has developed because of the strict rules companies have faced under command-and-control regulation, in response to which companies have built skills and developed processes that comply with regulations, but may not help them benefit competitively from environmental decisions (Reinhardt 2000). Absent significant changes in structure and personnel, the full potential of market-based instruments will probably not be realized.

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[15]Also, for these same two reasons, auctioning of permits — rather than allocation without charge — is desirable on economic grounds in some situations.

[16]There are, of course, exceptions. See: Hockenstein, Stavins, and Whitehead 1997.

2.2 Normative Lessons for Analysis

When assessing market-based environmental programs, economists need to employ some measure by which the gains of moving from conventional standards to an economic-incentive scheme can be estimated. When comparing policies with the same anticipated environmental outcomes, aggregate cost savings may be the best yardstick for measuring success of individual instruments. The challenge for analysts is to make fair comparisons among policy instruments: either idealized versions of both market-based systems and likely alternatives; or realistic versions of both (Hahn and Stavins 1992).

It is not enough to analyze static cost savings. For example, the savings due to banking allowances should also be modeled (unless this is not permitted in practice). It can likewise 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), especially when programs impose significant costs over long time horizons (Newell, Jaffe, and Stavins 1999). More generally, it is important to consider the effects of the pre-existing regulatory environment. For example, the level of pre-existing factor taxes can affect the total costs of regulation (Goulder, Parry, and Burtraw 1997), as indicated above. Most broadly, changes in relative prices — whether exogenous or policy induced — can drive technological change and thereby differentially affect the performance of alternative policy instruments (Snyder, Miller, and Stavins 2003).

2.3 Normative Lessons for Identifying New Applications

Market-based policy instruments are considered today for nearly every environmental problem that is raised, ranging from endangered species preservation to what may be the greatest of environmental problems, global climate change.[17] Experiences with market-based instruments offer some guidance to the conditions under which such approaches are likely to work well, and when they may face greater difficulties.

First, where the cost of abating pollution differs widely among sources, a market-based system is likely to have greater gains, relative to conventional, command-and-control regulations (Newell and Stavins 2003). For example, 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 is the degree of mixing of pollutants in the receiving airshed or watershed, the more attractive will a market-based system be, relative to a conventional uniform standard. This is because taxes or tradeable permits, for example, can lead to localized "hot spots" with relatively high levels of ambient pollution. This is a significant distributional issue, and it can also become an efficiency issue if damages are non-linearly related to pollutant concentrations. In cases where this is a reasonable concern, the problem can be addressed, in theory, through the use of "ambient permits" or through charge systems that are keyed to changes in ambient conditions at specified

[17]See, for example, Goldstein 1991 and Bean 1997 on species protection; and Fisher *et al.* 1996, Hahn and Stavins 1995, Schmalensee 1996, and Stavins 1997 on applications to global climate change. More broadly, see: Ayres 2000.

locations (Revesz 1996). But 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 under Los Angeles' RECLAIM program.

Third, the efficiency of price-based (tax) systems compared with quantity-based (tradeable permit) systems depends 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 will be more efficient than a price instrument (Weitzman 1974). Furthermore, when there is also uncertainty about marginal benefits, and marginal benefits are positively correlated with marginal costs (which, it turns out, is not uncommon), then there is an additional argument in favor of the relative efficiency of quantity instruments (Stavins 1996). Likewise, when incomplete enforcement occurs in the presence of benefit and cost uncertainty, quantity instruments are anticipated to perform relatively better than equivalent price instruments (Montero 2002). On the other hand, the regulation of stock pollutants will often favor price instruments when the optimal stock level rises over time (Newell and Pizer 2003). It should also be recognized that despite the theoretical efficiency advantages of hybrid systems — non-linear taxes, or quotas combined with taxes — in the presence of uncertainty (Roberts and Spence 1976; Kaplow and Shavell 1997),[18] no hybrid systems have yet been adopted.

Fourth, the long-term cost-effectiveness of taxes versus tradeable permit systems is affected by their relative responsiveness to change. This arises in at least three dimensions. In the presence of rapid rates of economic growth, a fixed tax leads to an increase in aggregate emissions, whereas with a fixed supply of permits there is no change in aggregate emissions (but an increase in permit prices). In the context of general price inflation, a unit (but not an *ad valorem*) tax decreases in real terms, and so emissions levels increase; whereas with a permit system, there is no change in aggregate emissions. In the presence of exogenous technological change in pollution abatement, a tax system leads to an increase in control levels, that is, a decrease in aggregate emissions, while a permit system maintains emissions, with a fall in permit prices (Stavins and Whitehead 1992).

Fifth, tradeable permits will work best when transaction costs are low, and experience demonstrates that if properly designed, private markets will tend to render transaction costs minimal. Sixth, a potential advantage of tradeable permit systems in which allocation is without charge, relative to other policy instruments, is associated with the incentive thereby provided for pollution sources to identify themselves and report their emissions (in order to claim their permits).[19]

Seventh, it is important to keep in mind that in the absence of decreasing marginal transactions costs (essentially volume discounts), the equilibrium allocation and hence aggregate abatement costs of a tradeable permit system are independent of initial allocations (Stavins 1995). Hence, an important attribute of a tradeable permit system is that the allocation decision can be left to politicians, with limited normative concerns about the potential effects of the chosen allocation on

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[18]In addition to the efficiency advantages of non-linear taxes, they also have the attribute of reducing the total (although not the marginal) tax burden of the regulated sector, relative to an ordinary linear tax, which is potentially important in a political economy context.

[19]Although my focus is on U.S. experience, it is worth noting that such self-reporting incentives were empirically validated in a market-based program for particulate control in Santiago, Chile (Montero and Sanchez 2002).

overall cost-effectiveness. In other words, cost-effectiveness or efficiency can be achieved, while distributional equity is simultaneously addressed with the same policy instrument. This is one of the reasons why an international tradeable permit mechanism is particularly attractive in the context of concerns about global climate change. Allocation mechanisms can be developed that address legitimate equity concerns of developing countries, and thus increase the political base for support, without jeopardizing the overall cost-effectiveness of the system.[20]

Eighth and finally, considerations of political feasibility point to the wisdom (more likely success) of proposing market-based instruments when they can be used to facilitate cost-effective, aggregate emissions reductions (as in the case of the SO_2 allowance trading program in 1990), as opposed to cost-effective reallocations of the status quo burden.

3. Positive Political Economy Lessons

I now turn to a set of positive political economy questions that are raised by the increasing use of market-based instruments for environmental protection. First, why was there so little use of market-based instruments in the United States, relative to command-and-control instruments, over the 30-year period of major environmental regulation that began in 1970, despite the apparent advantages these instruments offer? Second, when market-based instruments have been adopted, why has there been such great reliance on tradeable permits allocated without charge, despite the availability of a much broader set of incentive-based instruments? Third, why has the political attention given to market-based environmental policy instruments increased dramatically in recent years? To address these questions, it is useful to consider the demand for environmental policy instruments by individuals, firms, and interest groups, and their supply by the legislature and regulatory agencies.[21]

3.1 Why Have Command-and-Control Instruments Dominated?

The short answer is that command-and-control instruments have predominated because all of the main parties involved had reasons to favor them: affected firms, environmental advocacy groups, organized labor, legislators, and bureaucrats.

On the regulatory demand side, affected firms and their trade associations have 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 (auctioned) 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-

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[20]See, for example, the proposal for "growth targets" by Frankel (1999).

[21]This "political market" framework was developed by Keohane, Revesz, and Stavins (1998), and these sections of the paper draw upon that work, and upon Hahn and Stavins 1991, and Stavins 1998.

based instruments focus on the quantity of pollution, not who generates it or the methods used to reduce it, these instruments can make the lobbying role of trade associations less important.

For a long time, most environmental advocacy groups were actively hostile towards market-based instruments. One reason was philosophical: environmentalists frequently perceived 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.[22] 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).[23] 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 — in theory — lead to localized "hot spots" with relatively high levels of ambient pollution.

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 had 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 Wyoming's and Montana's Powder River Basin. Thus, 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 may predispose 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, and deliberately make them explicit. Compare, for example, the nature and tone of public debates associated with proposed

[22]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.

[23]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.

increases in gasoline taxes with those regarding commensurate increases in the stringency of the Corporate Average Fuel Economy (CAFE) standards for motor vehicles.

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. 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. Of course, the underlying reason why symbolic politics works is that voters 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.[24] 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 his or her constituents (Shepsle and Weingast 1984).

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, that is, to preserve their human capital.[25]

3.2 Why Has There Been So Much Focus on Tradeable Permits Allocated Without Charge?

Economic theory suggests that the choice between tradeable permits and pollution taxes should be based upon case-specific factors, but when significant market-based instruments have been adopted in the United States, they have nearly always taken the form of tradeable permits rather than emission taxes. Moreover, the initial allocation of such permits has always been through initial

[24]Legislators tend to behave as if they are risk averse if their constituents punish unpredictable policy choices or their reelection probability is very high (McCubbins, Noll, and Weingast, 1989, p. 22).

[25]Subsequently, this same incentive led EPA staff involved in the acid rain program to become strong proponents of trading for a variety of other pollution problems.

distribution without charge, rather than through auctions,[26] despite the apparent economic superiority of the latter mechanism in terms of economic efficiency (Spulber 1985; Stavins 1995; Goulder, Parry, and Burtraw 1997; Fullerton and Metcalf 1997).

Again, many actors in the system have reasons to favor tradeable permits allocated without charge over other market-based instruments. On the regulatory demand side, existing firms favor tradeable permits allocated without charge because they convey rents to them. Moreover, like stringent command-and-control standards for new sources, but unlike auctioned permits or taxes, permits allocated without charge give rise to entry barriers, since new entrants must purchase permits from existing holders. Thus, the rents conveyed to the private sector by tradeable permits allocated without charge 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. 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, but without the drawbacks that environmentalists associate with tax instruments.

Tradeable permits allocated without charge 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, permits allocated without charge 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 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.[27]

3.3 Why Has the Attention Given to Market-Based Instruments Increased?

Given the historical lack of receptiveness by the political process to market-based approaches to environmental protection, why has there been a recent rise in the use of these approaches? 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 support and

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[26]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 1998).

[27]Given the strong (positive) political preference for tradeable permits relative to pollution taxes combined with the significant normative advantages of tax instruments, researchers have begun to ask whether flexible quantity-based instruments can be designed to mimic some of the more desirable features of price-based policies but without the financial transfers that such policies normally entail (Newell, Pizer, and Zhang 2003).

opposition to market-based environmental policy instruments was based largely on ideological grounds: Republicans, who supported the concept of economic-incentive approaches, offered as a reason the assertion that "the free market works," or "less government intervention" is desirable, without any real awareness or understanding of the economic arguments for market-based programs. Likewise, Democratic opposition was based largely upon ideological factors, with little or no apparent understanding of the real advantages or disadvantages of the various instruments (Kelman 1981). What would happen if we were to replicate Kelman's survey today? My refutable hypothesis is that we would find increased support from Republicans, greatly increased support from Democrats, but insufficient improvements in understanding to explain these changes.[28] So what else has mattered?

First, one factor has surely been increased pollution control costs, which have led to greater demand for cost-effective instruments. By the late 1980's, even political liberals and environmentalists were beginning to question whether conventional regulations could produce further gains in environmental quality. During the previous twenty years, pollution abatement costs had continually increased, as stricter standards moved the private sector up the marginal abatement-cost function. By 1990, U.S. pollution control costs had reached $125 billion annually, nearly a 300% increase in real terms from 1972 levels (U.S. Environmental Protection Agency 1990; Jaffe, Peterson, Portney, and Stavins 1995).

Second, a factor that became important in the late 1980's was strong and vocal support from some segments of the environmental community.[29] By supporting tradeable permits for acid rain control, the Environmental Defense Fund (EDF) seized a market niche in the environmental movement, and successfully distinguished itself from other groups.[30] Related to this, a third factor was that the SO_2 allowance trading program, the leaded gasoline phasedown, and the CFC phaseout were all designed to *reduce* emissions, not simply to *reallocate* them cost-effectively among sources. Market-based instruments are most likely to be politically acceptable when proposed to achieve environmental improvements that would not otherwise be feasible (politically or economically).

Fourth, deliberations regarding the SO_2 allowance system, the lead system, and CFC trading differed from previous attempts by economists to influence environmental policy in an important way: the separation of ends from means, that is, the separation of consideration of goals and targets from the policy instruments used to achieve those targets. By accepting — implicitly or otherwise — the politically identified (and potentially inefficient) goal, the ten-million ton reduction of SO_2 emissions, for example, economists were able to focus successfully on the importance of adopting

[28]But there has been some increased understanding of market-based approaches among policy makers. This has partly been due to increased understanding by their staffs, a function — to some degree — of the economics training that is now common in law schools, and the proliferation of schools of public policy (Hahn and Stavins 1991).

[29]But the environmental advocacy community is by no means unanimous in its support for market-based instruments. See, for example, Seligman 1994.

[30]When the memberships (and financial resources) of other environmental advocacy groups subsequently declined with the election of the environmentally-friendly Clinton-Gore Administration, EDF continued to prosper and grow (Lowry 1993). In 2003, the World Resources Institute was alone among environmental advocacy groups to support the George W. Bush administration's water quality trading policy.

a cost-effective means of achieving that goal. The risk, of course, was "designing a fast train to the wrong station."

Fifth, acid rain was an unregulated problem until the SO_2 allowance trading program of 1990; and the same can be said for leaded gasoline and CFC's. Hence, there were no existing constituencies — in the private sector, the environmental advocacy community, or government — for the *status quo* approach, because there was no *status quo* approach. We should be more optimistic about introducing market-based instruments for "new" problems, such as global climate change, than for existing, highly regulated problems, such as abandoned hazardous waste sites.

Sixth, by the late 1980's, there had already been a perceptible shift of the political center toward a more favorable view of using markets to solve social problems. The George H. W. Bush Administration, which proposed the SO_2 allowance trading program and then championed it through an initially resistant Democratic Congress, was (at least in its first two years) "moderate Republican;" and phrases such as "fiscally responsible environmental protection" and "harnessing market forces to protect the environment" do have the sound of quintessential moderate Republican issues.[31] But, beyond this, support for market-oriented solutions to various social problems had been increasing across the political spectrum for the previous fifteen years, as was evidenced by deliberations on deregulation of the airline, telecommunications, trucking, railroad, and banking industries. Indeed, by the mid-1990s, the concept (or at least the phrase), "market-based environmental policy," had evolved from being politically problematic to politically attractive.

Seventh and finally, 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.[32]

[31]The Reagan Administration enthusiastically embraced a market-oriented ideology, but demonstrated little interest in employing actual market-based policies in the environmental area. From the Bush Administration through the Clinton Administration, interest and activity regarding market-based instruments — particularly tradeable permit systems — continued to increase, although the pace of activity in terms of newly implemented programs declined during the Clinton years, when a considerable part of the related focus was on global climate policy (Hahn, Olmstead, and Stavins 2003).

[32]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; and Deputy Administrator Henry Habicht and Assistant Administrator for Air and Radiation William Rosenberg were key, early supporters of market-based instruments. In the Congress, Senators Timothy Wirth and John Heinz provided high-profile, bi-partisan support for the SO_2 allowance trading system and, more broadly, for a wide variety of market-based instruments for environmental problems through their "Project 88" (Stavins 1988). And, finally, in 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 initial allowance trading proposal.

4. Conclusions

Some eighty years ago, economists first proposed the use of corrective taxes to internalize environmental (and other) externalities. But it was a little more than a decade ago that the portfolio of potential economic-incentive instruments was expanded to include quantity-based mechanisms — tradeable permits — and these incentive-based approaches to environmental protection began to emerge as prominent features of the policy landscape.

Given that most experience with market-based instruments has been generated quite recently, one should be cautious about drawing conclusions from these experiences. Important questions remain. For example, relatively little is known empirically about the impact of these instruments on technological change. Also, much more empirical research is needed on how the pre-existing regulatory environment affects performance, including costs. Moreover, the great successes with tradeable permits have involved air pollution: acid rain, leaded gasoline, and chloroflourocarbons. Experience (and success) with water pollution is much more limited, and in other areas, there has been no experience at all. Even for air pollution problems, the differences between SO_2 and acid rain, on the one hand, and the combustion of fossil fuels and global climate change, on the other, suggest that a rush to judgement regarding global climate policy instruments is unwarranted.

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 today look very different from those twenty years ago, when these ideas were characterized as "licenses to pollute" or dismissed as completely impractical. Market-based instruments are considered seriously for each and every environmental problem that is tackled, ranging from endangered species preservation to regional smog to global climate change. It is reasonable to anticipate that market-based instruments will enjoy increasing acceptance in the years ahead. But no particular form of government intervention, no individual policy instrument — whether market-based or conventional — is appropriate for all environmental problems. Which instrument is best in any given situation depends upon characteristics of the environmental problem, and the social, political, and economic context in which it is being regulated.

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