

**ECONOMIC INCENTIVES FOR  
ENVIRONMENTAL PROTECTION:  
INTEGRATING THEORY AND PRACTICE**

**ROBERT W. HAHN**

**AND**

**ROBERT N. STAVINS**

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# **ECONOMIC INCENTIVES FOR ENVIRONMENTAL PROTECTION: INTEGRATING THEORY AND PRACTICE**

Robert W. Hahn and Robert N. Stavins\*

## **1. INTRODUCTION**

For decades, economists have been extolling the virtues of market-based or economic-incentive approaches to environmental protection. Some seventy years ago, Pigou (1920) suggested corrective taxes to discourage activities that generate externalities. A half century later, Dales (1968) showed how the introduction of transferable property rights could work to promote environmental protection at lower aggregate cost than conventional standards. From these two seminal ideas -- corrective taxes and transferable property rights -- a substantial body of research has developed.

In the last two decades, the pace of related research has increased dramatically, with economists seeking to determine how these ideas would work in theory and in practice. Until very recently, most analyses have focused on theory or on related simulations, due to the paucity of actual experiences with incentive-based environmental mechanisms. This began to change somewhat in the 1980's, with increasing use by governments of fees and tradeable permits to control pollution. This experience suggests that there is a large gap between the theory developed by economists and the application of these tools in practice.

Both environmental taxes and marketable permits are coming of age in the policy arena. Examples include the introduction of marketable permits in the U.S. to: reduce the leaded content of gasoline; limit the production and use of chlorofluorocarbons; and limit sulfur dioxide (SO<sub>2</sub>) emissions as a precursor of acid rain (Hahn and Stavins 1991). Charges have been used to limit air and water pollution, principally in European nations, while deposit-refund systems have been used for beverage containers in North America and for a more diverse set of products in Europe (Opschoor and Vos 1989). Beyond these existing applications, there are now numerous proposals, both in the U.S. and abroad, to apply incentive-based mechanisms to a host of other environmental problems, ranging from local hazardous waste to global climate change (Pearce, Markandya, and Barbier 1989; and Stavins, ed. 1991). While many of these proposals may remain theoretical curiosities, it is

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\*Mr. Hahn is a Resident Scholar at the American Enterprise Institute and an Adjunct Research Fellow at the John F. Kennedy School of Government, Harvard University. Mr. Stavins is an Assistant Professor of Public Policy and a Senior Research Associate, Center for Science and International Affairs, at the John F. Kennedy School of Government, Harvard University, and a University Fellow of Resources for the Future. This paper was prepared for presentation at the 1992 meetings of the American Economic Association. The comments of Richard Zeckhauser are gratefully acknowledged, but the authors alone are responsible for any remaining errors.

likely that there will be a significant increase in the use of market-based approaches during the coming decade.

The introduction of these tools on a large scale provides a unique opportunity to extend the frontiers of knowledge. This essay seeks to identify important issues that merit investigation. Section 2 examines some possible objectives of environmental regulation, the consequent criteria by which alternative policies can be judged, and the major categories of regulatory instruments available to policy makers. Section 3 focuses on opportunities for research in the area of policy design and evaluation, and Section 4 highlights what is known about how instruments are actually chosen. The major themes of the paper are summarized in Section 5 in terms of implications for environmental policy and the economics profession.

## **2. ALTERNATIVE POLICY INSTRUMENTS FOR ENVIRONMENTAL PROTECTION**

### *2.1 Objectives, Constraints, and Criteria for Instrument Selection*

Although some policy makers would claim that the singular objective of environmental regulation is to protect environmental quality, the decision problem actually faced by policy makers is more complex, involving tradeoffs among multiple objectives and real and frequently binding constraints. In the economist's usual version of public-policy heaven, the objective might be seen as one of aggregate welfare maximization, with the consequent criteria for good public policy being (potential) *Pareto efficiency* -- maximizing the net benefits (benefits minus costs) of environmental protection. Alternatively, one might apply a *cost-effectiveness* criterion, seeking to achieve a given level of environmental protection while minimizing the related costs of pollution control. Efficiency and cost-effectiveness, however, are by no means the only possible criteria by which environmental policies can or should be judged. In searching for public policies that provide real improvements over existing or alternative environmental regulations, consideration can also be given to: overall effectiveness; equity; information requirements; monitoring and enforcement capability and costs; political feasibility; and clarity to the general public (Lave 1981; Bohm and Russell 1985). Based on these and other criteria, alternative policy instruments can be considered and evaluated.<sup>1</sup>

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<sup>1</sup> Of course, it also makes a difference whether particular yardsticks are taken as objectives or constraints. For example, suppose the political feasibility of different projects could be assessed in terms of the likelihood they would be implemented. Then, a policy that maximized economic efficiency subject to having a certain likelihood of implementation would, in general, be different from a policy that maximized some combination of economic efficiency and political feasibility. Under special conditions, given well behaved functions, the two problems can be shown to be equivalent, however.

## *2.2 Categories of Available Instruments*

Economists frequently divide policy instruments for achieving environmental objectives into two broad categories: those that provide firms with relatively little flexibility in achieving goals -- so-called "command-and-control" approaches -- and those that provide firms with greater flexibility in making environmental progress along with incentives to look for more effective ways of making sustained environmental progress -- so-called market-based or incentive-based mechanisms.<sup>2</sup>

Comparisons between conventional command-and-control regulation (including technology standards and performance standards) and market-based approaches (including taxes and markets in pollution rights) have repeatedly noted that conventional regulations fail to achieve environmental objectives in the least costly manner. For example, acid rain could be reduced by a specified amount by requiring the largest twenty power plants emitting  $\text{SO}_2$  to install scrubbing devices -- an example of command-and-control. Because firms would thus be compelled to control to the same level of emissions, rather than to the same level of marginal control costs, the solution would not be cost-effective.

In contrast, well-designed market-based approaches provide an incentive for firms to equate abatement costs at the margin, thus achieving a given level of environmental quality at least cost. One market-based approach to the acid-rain problem would limit pollution from sulfur dioxide by defining a suitable number of emission rights, distributing these rights, and then allowing firms to trade them freely. A firm would not be legally allowed to emit unless it owned emission rights that equaled or exceeded its emissions. This approach can yield static cost savings due to the trading of the emission rights among sources (and can also yield dynamic incentives for firms to cut back their emissions even further by adopting cleaner and less costly production technologies). Indeed, in the case of reducing acid rain in the U.S., simulations indicate that approximately \$1 billion may be saved annually by substituting a market-based approach for a command-and-control approach. In theory, a similar result could be achieved through the introduction of an emission charge or tax.

The above comparison of command-and-control with marketable permits is intentionally simple, and thus obscures a number of subtleties, including the fact that both sets of instruments are typically embedded in complex regulatory systems. Not all systems are feasible in a technical, legal, economic, or political sense. Indeed, recent experience has shown that political constraints can serve to limit dramatically the range of instruments that are actually considered to protect or enhance environmental quality.

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<sup>2</sup> Several instruments of importance to policy makers do not fall conveniently within these two categories, including monitoring and enforcement techniques, use of the courts, and the use of information.

### 2.3 *The Search for Better Instruments for Environmental Protection*

There has been greatly heightened interest over the past two years in market-based approaches for environmental protection among all four sectors of the environmental policy community -- government, private industry, environmental organizations, and academia.<sup>3</sup> In the midst of this flurry of interest, there has been an unmistakable tendency to allow interest in popular policy instruments to take precedence over critical consideration of policy objectives.<sup>4</sup> While less attention is being paid to the economic desirability of particular objectives, the policy community now seems mesmerized by the possibility of using markets and other incentive-based approaches to achieve specific objectives. Thus, potential *means* (such as market-based instruments) of achieving policy objectives are often being -intentionally or unintentionally -- confused with objectives themselves (such as efficient or cost-effective environmental regulation). The danger is that analysts may come to ignore the selection of goals, and may focus exclusively on specific means for achieving these goals. Economic perspectives have important roles to play in both the selection of goals and the selection of means.

Economists have shown a marked preference for incentive-based instruments over command-and-control because these instruments typically provide a more cost-effective way of achieving a given level of environmental quality -- at least, in theory. In practice, the picture is less clear, particularly because these instruments are usually implemented in an intensely political environment. It is important for economists to keep an open mind about which instruments are likely to be most "economical;" that is, which instruments will actually achieve the greatest level of efficiency relative to some appropriate benchmark. Indeed, given political and technological constraints, there are some problems for which incentive-based approaches are poorly suited. In such cases, economists will want to focus on the design of other instruments, such as various kinds of standards, to meet particular objectives.

Another reason to broaden the range of instrument search is to accommodate legitimate objectives other than efficiency or cost effectiveness. These other objectives could reasonably include equity and administrative simplicity, for example. If market-based instruments are considered, then the investigation should include not only charges and tradeable permits, but also deposit-refund schemes, strategies to reduce government barriers to market activity, and means of eliminating or at least reducing problematic government subsidies.<sup>5</sup> Moreover, a host of other ("non-market") approaches should also be considered,

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<sup>3</sup> For an investigation of the causes of this increased interest, see: Hahn and Stavins 1991.

<sup>4</sup> For example, as part of the reauthorization process for the Clean Water Act, the U.S. Environmental Protection Agency (EPA) held public hearings for the purpose of "seeking ways to apply economic-incentive mechanisms to water-quality protection." See: Cooney 1991.

<sup>5</sup> The rather sudden interest by "mainstream economists" in environmental issues brought about by concerns regarding global climate change has manifested itself almost exclusively in investigations of carbon charges and other tax schemes. "Environmental economists" have also focused on tradeable permit systems. Neither group of analysts has moved beyond the usual charge/permit set of instruments.

such as different kinds of standards, strengthened monitoring and enforcement mechanisms, and the provision of information.

Whether any specific instrument is desirable depends on how it is designed and implemented. Thus, the economist's search for improved environmental policies -- even if relying exclusively on criteria of efficiency or cost-effectiveness -- should cover a much broader terrain than typically has been the case. This search should be driven by an understanding of what exists and what is truly feasible. Neither standards, nor tradeable permits, nor enforcement mechanisms, nor any other kind of policy instrument are homogeneous products; each exists in a multitude of forms and variations.

It is important to recognize that the nature of individual environmental problems can dramatically affect the choice of preferred policy instruments. Thus, for example, for highly localized pollution problems with threshold (non-linear) damage functions, source-specific standards may be appropriate, whereas for pollution problems characterized by more uniform mixing over larger geographic areas, market-based approaches may be particularly desirable. Likewise, especially high costs for monitoring emissions may mean that technology-specific standards are preferable on economic grounds.

Variations in technology, skills, and administrative resources can have important implications for policy design. In general, it is more appropriate to "fine-tune" policies when administrative agencies have the capability to implement them. Thus, for example, Los Angeles may be in a position to implement a market to reduce smog-causing emissions, which allows trading of emission reductions between vehicles and stationary sources. In contrast, Indonesia or Mexico might consider policies that are simpler to administer. One possibility would be to use an indirect instrument, such as a gasoline tax, or a more general fuel tax. The basic approach should be to try to tailor the tool to the problem and the institutional and cultural context. To date, there has been a great deal of study of how to design tools for highly sophisticated systems. A comparable level of study would be useful in defining the trade-offs in designing environmental policy tools where resources for management and control are severely limited, such as in developing countries.

This brief review of alternative instruments for environmental protection suggests: first, that economists' analyses would benefit significantly from expanding the set of instruments under consideration; and, second, that the set of preferred instruments will vary not only with the criteria adopted but also with the problems being addressed.

### 3. POLICY DESIGN AND EVALUATION

Increased interest in economic criteria for environmental policy and increased interest in market-based approaches both imply potentially critical roles for economists in the design and evaluation of environmental policies and programs. In this section, we identify some prominent issues which merit investigation. While recognizing the validity of the broad set of criteria mentioned in the previous section, we follow the general thrust of the existing literature by focusing our attention on issues of efficiency.

#### 3.1 Static Efficiency and Cost Effectiveness

Some measure of static efficiency is typically used in most economic analyses of alternative policy instruments. In some cases, the measure may include explicit calculations of the benefits of pollution control, but in most cases, a cost-effectiveness measure is utilized. Conventional standards are frequently compared with some market-based system, and potential gains from trade in permits or efficiency gains from charging a pollution fee are simulated. This approach requires estimation of pollution control costs, along with specification and estimation of the cost of *status quo* regulations.

As implemented, this approach tends to exhibit several significant problems. First, it is important that the existing regulatory environment be considered when new (additional) policies are being designed and evaluated. Failure to do so can be highly problematic. For example, the new SO<sub>2</sub> tradeable allowance program for acid rain control was codified in the 1990 amendments to the Clean Air Act, but no statutory provision was made (nor apparently seriously considered) to ensure that state public utility commissions would adopt or consider regulations that would give appropriate incentives to electrical utilities to participate in the trading program.<sup>6</sup>

Although empirical analyses have begun to examine the outcomes of actual applications of market-based policy mechanisms, there is a pressing need for rigorous tests of hypotheses regarding these and other mechanisms. In carrying out such analyses, it is essential to use the appropriate benchmark for counterfactual analysis. For example, Tietenberg (1985) assimilated the results from ten analyses of the costs of air pollution control, and in a frequently cited table, indicated the ratio of cost of the actual command-and-control program to a least-cost benchmark for each case. Unfortunately, the resulting ratios (which ranged from 22.0 to 1.1) have been taken by others to indicate the potential gains from adopting specific ("cost effective") mechanisms such as tradeable emission permits. A more realistic comparison would be between actual command-and-control policies and either actual trading programs (such as EPA's bubble policy) or a *reasonably constrained* theoretical permit or charge program.

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<sup>6</sup> If regulated utilities cannot retain some fraction of the benefits from trading, they will have little or no incentive to engage in trades.



A special case of this problem is that economists typically estimate the gains from trade in moving to a market-based system in *which* there are no transactions costs, even though previous work on actual applications suggests that transactions costs in tradeable-permit markets can be substantial. Far too often, the response of economists to politicians' nearly exclusive focus on allocation issues has been to assert that the equilibrium allocation of marketable permits (subsequent to exchange) will be independent of the initial allocation. With transaction cost functions of the form experienced in practice, however, the quantity of transactions, the equilibrium allocation of permits, and hence the aggregate costs of control (degree of relative cost effectiveness) are indeed sensitive to the initial permit allocation.

Given the observed importance of transactions costs in trading, statistical analysis is needed of the effects of transaction costs on market activity in actual applications, such as the phasedown in leaded gasoline through the trading of rights among refineries. Also, the consequences of alternative trading rules on actual permit markets merits empirical analysis. In general, quantitative investigations are needed of our experiences with existing market-based and conventional policies. In the former case, attention should be given both to the use of tradeable permits in the U.S. and various kinds of charge systems in European nations.

A particularly challenging area that has received little attention in the empirical literature on incentive-based approaches is the impact of differential monitoring and enforcement capabilities on efficiency. For example, if there is an international agreement limiting greenhouse gas emissions, countries are likely to vary in terms of their desire and ability to monitor and enforce such an agreement. This could have a dramatic impact on efficiency as well as how such an agreement is structured.

A further problem affecting empirical analyses is that serious attempts are rarely made to note the quantitative consequences of uncertainties. In part, this is due to the difficulty of developing meaningful error distribution estimates for control cost functions. In most applications, estimated cost functions are taken as true cost functions. This has important implications for estimating gains from trade in moving to alternative systems. Estimates of the potential savings of markets over command-and-control could be quite different if the stochastic nature of cost-function estimates were taken into account. Furthermore, while some analyses have included uncertainty in stylized ways, most have failed to deal adequately with the problem of designing robust policies -- ones that have a high probability of leading in the direction of a particular desired result, even if that result is not achieved (Hahn, McRae, and Milford 1988). Robust policies can be particularly useful in situations where substantial uncertainty is associated with pollution-transmission or damage mechanisms or with the implementation costs of selected policy instruments.<sup>7</sup>

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<sup>7</sup> Robust policies move the system under study in the desired direction, regardless of the outcome of current uncertainties. For example, there is great uncertainty associated with the impacts on regional precipitation patterns of greenhouse-induced global warming. Some models indicate, for instance, that the flow of the Colorado River will increase; others indicate a net decrease in annual flow. One robust greenhouse policy, then, would be a mechanism -- such as provision for market-oriented voluntary water transfers or elimination of water

Over the next decade, there will be a unique opportunity to carry out empirical analyses of a variety of new approaches to environmental improvement. Examples include the new SO<sub>2</sub> allowance trading system in the U.S. for acid-rain control and the carbon dioxide (CO<sub>2</sub>) taxes, which are just now being initiated in a number of European nations. Such analyses could provide important insights into the conditions under which alternative instruments perform relatively well, and these analyses could also provide clues regarding the feasibility of implementing better environmental policy mechanisms.<sup>8</sup>

### 3.2 *Dynamic Incentives*

In the long run, the effect of public policies on technological change may be among the most important determinants of success in environmental protection. For example, much of the policy discussion regarding the threat of global climate change has centered on alternative means of increasing energy efficiency -- whether in production or consumption. Economists, of course, have a simple answer of how to achieve the efficient level of diffusion of any energy-efficient technology -- set the prices correctly, such as through carbon taxes, and let the market do the rest. Engineers, lawyers, and most politicians do not see it quite this way; they tend to be more interested in using energy-efficiency standards, whether for motor vehicles, home appliances, or home construction.

The debate has until now rested largely on theory. Economists continue to claim that market-based policies will not only be cost-effective (in a static sense), but will also provide dynamic incentives for the development and adoption of improved pollution-control technologies. In the absence of empirical research, this remains largely an untested hypothesis. This need not be the case. By drawing upon our experiences with market-based and command-and-control policies and by investigating some "natural experiments" with changing energy prices, it is possible to investigate empirically the relative effectiveness of these two categories of policy mechanisms in terms of their relative impacts on the diffusion of improved technology (Jaffe and Stavins 1991).

It should also be recognized that the standard theory of factors affecting dynamic efficiency may need to be revised in the light of political constraints. For example, it is not clear that governments are capable of making the type of long-term credible commitments under markets that would be required to encourage affected firms to adopt new and improved technologies. Even in the case of the market for sulfur oxides to reduce acid rain, there are significant questions about whether Congress will change the rules governing the market in midstream. The statute clearly states that a tradeable permit (called an

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subsidies -- which would make the agricultural economy (the choice of crops) more *sensitive* (via the price mechanism) to changes in water availability.

<sup>8</sup> For example, the auctions developed in the acid rain portion of the Clean Air Act are based, in part, on the idea of a zero-revenue auction developed by Hahn and Noll (1982). If implemented, the performance of these auctions can be compared with results from laboratory experiments (Franciosi, Isaac, Pingry, and Reynolds 1990).

"allowance") "does not constitute a property right,"<sup>9</sup> thus giving some cause for concern. The real challenge is to compare paths of technological change under political institutions that use standards with other feasible regimes that use market-based instruments (Milliman and Prince 1989).

### 3.3 Other Criteria for Policy Evaluation

Given the broad range of criteria by which environmental policies can be evaluated, it is important that economists begin to move beyond their traditional reliance upon efficiency and cost effectiveness for judging the efficacy of alternative means of reaching policy goals. Whether singly or in combination, other legitimate criteria of success should be considered, principal among these being the relative distributional equity or fairness associated with specific policies. It is becoming clear that alternative notions of "equity" may mean the difference between life and death for new policy proposals in the political realm.<sup>10</sup> For example, one of the major challenges in developing a substantive agreement for controlling greenhouse gas emissions will be to define *de facto* emission rights in such a way as to satisfy a sufficient number of the parties to such an agreement (Grubb and Sebenius 1991).

## 4. WHY ENVIRONMENTAL POLICY INSTRUMENTS ARE CHOSEN

In contrast with the substantial amount of work that has been done by economists on designing market-based approaches to environmental protection, relatively little effort has been devoted to developing or testing a positive theory of instrument choice. Without understanding the conditions under which various instruments are likely to be feasible, it is difficult to develop meaningful comparisons among those instruments. Relatively little is known about why particular instruments are selected, despite the fact that Buchanan and Tullock (1975) developed an argument as to why standards might be preferred to taxes, and subsequent work by Maloney and McCormick (1982) developed a more general positive theory of environmental regulation, based on the notion of rent seeking.

One problem with current theoretical models of instrument choice is that they lack the detail required to provide guidance in specific policy situations. Moreover, they do not

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<sup>9</sup> Public Law 101-549, November 15, 1990, Clean Air Act, S403f p.202, 104 STAT 2591, 42 USC 7651b.

<sup>10</sup> Under certain circumstances, consideration should therefore be given to second-best policies, which provide for specific forms of compensation of "losers" from the social gains due to use of cost-effective instruments (Burtraw and Portney 1991). This is arguably what was done in the case of the add-rain tradeable allowance program in the 1990 amendments to the Clean Air Act. In separate legislation, a program was established to provide job-training and other forms of compensation for workers displaced by the new law, at an estimated cost of \$50 million per year over five years. As indicated above, the tradeable permit program itself is expected to yield savings of \$1 billion per year. See: Schneider 1990.

help distinguish among the array of instruments that are actually applied. For example, there are a large variety of standards and subsidies, but there is little understanding of why particular ones are selected. To begin developing such a theory, it would be useful to focus initially on the incentives faced by key decision makers and the institutions and environments in which they function.

Some work has been done on the impact of procedures and rules implemented by Congress (McCubbins, Noll, and Weingast 1989), but neither the House of Representatives nor the Senate is a key player in defining the details of many environmental policies. Indeed, a striking feature of many Federal environmental policies is the extent to which program staff within EPA play a central role in developing and advancing options (Hahn and Stavins 1991). A closer look at the bureaucracy is needed to gain a deeper understanding of instrument choice (Wilson, ed.1980). Moreover, the relationship between the bureaucracy, the White House, and the Congress deserves further exploration. Finally, it is necessary to include the role of environmental organizations in any comprehensive model of instrument choice, since these groups play an increasingly important role in shaping national policy (Hahn 1990).

A more refined positive theory of instrument choice could lead to useful insights. For example, the level of transactions costs may be affected by the degree to which there is consensus over the underlying distribution of property rights. EPA's emissions trading program was characterized by high transactions costs whereas the lead trading program had relatively low transactions costs. This difference in costs can be explained in part by the underlying consensus over the *de facto* ownership of the property rights. Thus, while there may be some flexibility in designing market-based approaches with relatively low transactions costs, this flexibility is likely to be limited by the political environment.

A more careful and comprehensive articulation of a positive theory of instrument choice will lead to a richer statement of available alternatives. This point is illustrated by the recent negotiation over legislation to reduce acid-rain emissions by implementing a market-based approach. Environmentalists seized this opportunity to require that power plants install continuous emission monitors, which yield measurements that are far more accurate than those required under traditional standards-based approaches. Thus, the political choice of markets versus standards also depends on other aspects of policy design - - in this case, the nature of monitoring and enforcement.

As in most any area, theoretical modeling is necessary but not sufficient for full understanding of economic phenomena. A variety of hypotheses merit empirical examination. It has been hypothesized (Hahn and Stavins 1991) that the following factors favor a more positive reception by the policy community of market-based environmental-protection strategies:

- (1) increasing marginal costs of pollution control and consequent concern regarding cost effectiveness;

- (2) macroeconomic concerns about domestic productivity and international competitiveness;
- (3) government budgetary concerns and consequent reluctance to attack existing environmental problems simply by spending more on monitoring and enforcement of existing approaches;
- (4) existence of "new" environmental problems that have not been addressed by previous policies (and hence lack constituencies for the *status quo* approach);
- (5) changing political realities generally more sympathetic to market-based approaches to various social problems;
- (6) separation of means from ends (cost-effectiveness), avoiding questions of efficiency that raise controversial benefit-cost issues;
- (7) absence of concentrated losers (who are politically vocal); and
- (8) potential of market-based policies to improve environmental quality while sustaining private industry profits, compared with available alternatives.

These and other hypotheses need to be examined by rigorous methods of analysis, including but not limited to statistical approaches.

The positive theory of instrument choice can be complemented with an analysis of emerging institutions designed to address environmental problems, particularly those of a regional or global nature. The nature of these institutions and their participants will limit the range of feasible instruments. In the case of acid rain regulation in the U.S., the market in tradable allowances was an integral part of the package that included the 10 million ton reduction in sulfur oxides emissions. In contrast, in the case of the Montreal Protocol aimed at protecting the ozone layer, countries were given a great deal of discretion over the instruments they could select to implement the Protocol. One critical challenge is to identify the range of politically feasible institutions for addressing global and regional problems and describe how these institutions could affect the available choice of instruments.

## **5. IMPLICATIONS FOR PUBLIC POLICY AND THE PROFESSION**

The decade of the 1990's may be remembered as a full-employment period for environmental economists; one of the key factors fueling the demand for services will likely be continued experimentation with a variety of market-based approaches for environmental protection. Although economists have developed some useful insights regarding marketable permits and effluent fees for environmental management, it is time to move to a more

realistic statement of the problems that need to be solved. This can best be accomplished by allowing theory to be guided by experience.

Theory and experimentation can be useful in the design and evaluation of market-based instruments. It is clearly unlikely, for example, that the tradeable-permit program adopted in the recent Clean Air Act amendments would have even been considered had economists and others not developed and refined the idea over the previous decade. Thus, there remains a need for economists to develop and refine new instruments that may prove useful for future policy makers. This search for new instruments should recognize that appropriate mechanisms will vary depending on the relevant government agency's resources and capabilities. Much of the work on markets and emission taxes assumes that there is a reasonably sophisticated environmental control agency that can administer incentive-based programs. This may be a reasonable assumption for many industrialized nations, but is probably the exception, rather than the rule, in developing countries. The design of incentive-based instruments that require less administrative expertise and fewer resources to implement could facilitate more and better applications.

The most worthwhile research agenda will link theory and empirical work. Even in the case of normative theorizing, relevance can be increased by carefully articulating political constraints on institutional design and facilitating the development of more realistic institutional comparisons. Such comparisons should exploit what is known about institutions, while at the same time, being careful to recognize the limitations of our knowledge.

The research agenda of environmental economics can do a better job of informing the quest for better public policies. It should be recognized, however, that most of what is already known about the design of market-based approaches for environmental improvement has yet to be assimilated by policy makers. This assimilation is unlikely to occur unless economists become more aware of the environmental policy process, since such awareness is a prerequisite for more relevant research. At present, however, the incentive structure faced by most academic economists works against such concerns. This is unfortunate, since environmental economics *can* make a real difference in the world in which we live.

## REFERENCES

- Bohm, Peter and Clifford S. Russell. "Comparative Analysis of Alternative Policy Instruments." *Handbook of Natural Resource and Energy Economics, Volume I*, eds. Allen V. Kneese and James L. Sweeney, pp. 395-460. Amsterdam: North-Holland, 1985.
- Buchanan, James and Gordon Tullock. "Polluters' Profits and Political Response: Direct Controls Versus Taxes." *American Economic Review* 65 (1975):139-147.
- Burtraw, Dallas and Paul R. Portney. "Implementing Market-Based Environmental Policies: The Role of Compensation." Paper presented at the John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts, April 24, 1991.
- Cooney, Catherine. "EPA Drafts Permit Trading Scheme for Water Pollution." *Environment Week*, March 21, 1991, page 6.
- Dales, J. *Pollution, Property and Prices*. Toronto: University Press, 1968.
- Franciosi, Robert, Mark Issac, David Pingry, and Stanley Reynolds. "Marketable Add Rain Emissions Permits: An Investigation of Revenue Neutral Auctions." Department of Economics, University of Arizona, Tucson, Arizona, 1990.
- Grubb, Michael and James K. Sebenius. "Participation, Allocation and Adaptability in International Tradeable Emission Permit Systems for Greenhouse Gas Control." Paper Prepared for OECD Workshop on Tradeable Greenhouse Gas Permits, Paris, France, June 1991; amended September 10, 1991.
- Hahn, Robert W. "The Political Economy of Environmental Regulation: Towards a Unifying Framework." *Public Choice* 65(1990):21-45.
- Hahn, Robert W., Gregory J. McRae, and Jana B. Milford. "Coping with Complexity in the Design of Environmental Policy." *Journal of Environmental Management* 27 (1988):109-125.
- Hahn, Robert W. and Roger Noll. "Designing a Market in Tradable Emissions Permits." *Reform of Environmental Regulation*, ed. Wesley Magat, pp. 119-146. Cambridge: Ballinger, 1982.
- Hahn, Robert W. and Robert N. Stavins. "Incentive-Based Environmental Regulation: A New Era from an Old Idea?" *Ecology Law Quarterly* 18(1991):1-42.
- Jaffe, Adam B. and Robert N. Stavins. "The Energy Paradox and the Diffusion of Conservation Technology: Modelling the Effectiveness of Economic Incentives and Direct Regulation." Paper prepared for the National Bureau of Economic Research Conference on Economics of the Environment, Cambridge, Massachusetts, December 13, 1991.
- Lave, Lester. *The Strategy of Social Regulation*. Washington, D.C.: The Brookings Institution, 1981.
- Maloney, Michael T. and Robert E. McCormick. "A Positive Theory of Environmental Quality Regulation." *Journal of Law and Economics* 25(1982):99-123.
- Milliman, Scott R. and Raymond Prince. "Firm Incentives to Promote Technological Change in Pollution Control." *Journal of Environmental Economics and Management* 17(1989):247-265.

McCubbins, Matthew, Roger Noll, and Barry Weingast. "Structure and Process, Politics and Policy: Administrative Arrangements and the Political Control of Agencies." *Virginia Law Review* 75(1989):431-482.

Opschoor, J. B. and Hans B. Vos. *Economic Instruments. for Environmental Protection*. Paris: Organization for Economic Cooperation and Development, 1989.

Pearce, David, Anil Markandya, and Edward B. Barbier. *Blueprint for a Green Economy*. London: Earthscan Publications, 1989.

Pigou, A. C. *The Economics of Welfare*, first edition. London: Macmillan & Co., Ltd., 1920.

Schneider, Keith. "Lawmakers Reach an Accord on Reduction of Air Pollution." *New York Times*, October 23, 1990, pp. A1, A18.

Stavins, Robert N., ed. *Project 88 -- Round II: Incentives for Action: Designing Market-Based Environmental Strategies*. A Public Policy Study sponsored by Senator Timothy E. Wirth, Colorado, and Senator John Heinz, Pennsylvania. Washington, D.C., May 1991.

Tietenberg, T. H. *Emissions Trading: An Exercise in Reforming Pollution Policy*. Washington, D.C.: Resources for the Future, 1985.

Wilson, James Q., ed. *The Politics of Regulation*. New York: Basic Books, Inc., 1980.