Marketable Permits: Lessons for Theory and Practice

Robert W. Hahn*
Gordon L. Hester**

INTRODUCTION

One of the central tenets of industrial organization theory is that the allocation and definition of property rights can have important implications for market performance. When ownership is not attached to a particular individual, but rather to a group of unrelated users, the problem of the "commons" arises; users of a common resource do not fully internalize the costs of resource depletion. The result is that a resource is "overused" relative to what might have occurred with individual private ownership or even public ownership.¹

Many environmental problems have been analyzed using the framework suggested by the commons problem. The basic insight from this work is that environmental protection systems could be designed more efficiently if the government were willing to define a system of tradable property rights.² Until recently, however, governments did not heed this insight. Instead, they chose to regulate environmental problems by imposing fixed emissions limits on individual sources—the so-called command-and-control approach.³ In many cases, regulatory authorities issued standards effectively specifying the actual technology that was required to achieve compliance.⁴ This approach has been criticized by economists and lawyers as being unnecessarily wasteful. Only in rare instances will authorities possess the information to identify standards

1. See generally Hardin, The Tragedy of the Commons, 162 SCIENCE 1243 (1968).
2. See generally J. Dales, Pollution, Property and Prices (1968).
and technologies that minimize the costs of achieving a particular environmental target.\textsuperscript{5}

Therefore, economists have given increasing attention to policy instruments that have the potential of using fewer resources to achieve environmental targets than do conventional standards-based approaches. Notable among these instruments are marketable permits.\textsuperscript{6} While there seems to be a trend toward increased use of marketable permits in designing environmental policies,\textsuperscript{7} most attempts to implement them seem to be only distantly related to the prescriptions suggested by efficiency enthusiasts.\textsuperscript{8}

This Article chronicles the use of marketable permits, providing a detailed comparative analysis of the application of marketable permits to environmental problems. We have three objectives: first, to provide an assessment of the performance of environmental programs that employ marketable permits; second, to analyze these programs in light of their immediate political and institutional environment, so that individual factors that influence the design and evolution of these programs can be identified; and third, to provide a framework for considering future research in the design and performance of these programs.

Economists have long been intrigued by the potential of market mechanisms to control environmental problems efficiently, but the rest of the world has been slow to catch on. This Article sheds light on both the benefits of marketable permit programs and the difficulties that may be encountered in their design and implementation. Current approaches to the analysis of marketable permits are examined in Part I. Part II critically reviews four environmental regulatory programs in which marketable permits do or could play a major role. Based on the analysis of existing systems, Part III suggests a political economy framework for understanding market performance and identifies important lessons to be gleaned from existing applications. Finally, Part IV summarizes our major conclusions and suggests areas for future research.

\textsuperscript{5} See T. Tietenberg, supra note 3, at 14-16; Ackerman & Stewart, Reforming Environmental Law, 37 Stan. L. Rev. 1333, 1337 n.11 (1985).


\textsuperscript{7} See Environment Comm., Group of Economic Experts, Organization for Economic Cooperation and Development, Use of Economic Instruments for Environmental Protection: Discussion Paper, ENV/ECO/86.16, at 18-22 (1986) [hereinafter Economic Instruments].

I

APPROACHES TO THE STUDY OF MARKETABLE PERMITS

The implementation of marketable permits involves several steps. First, a target level of environmental quality is established. Next, this level of environmental quality is defined in terms of total allowable emissions. Permits, which are essentially limited property rights, are then allocated to firms. Each permit enables the owner to emit a specified amount of pollution. Firms are allowed to trade these permits among themselves. Assuming firms minimize their total production costs and the market for these environmental permits is competitive, it can be shown that the overall cost of achieving the environmental standard will be minimized.9

A. Normative Research

Most research on marketable permits has been normative. This literature can be divided into two parts—theoretical and applied. Normative theory attempts to define markets and permit systems that produce more efficient results.10 The general conclusion emerging from the theory is that marketable permits represent a cost-effective way of limiting the overall level of emissions.11

The applied normative literature on marketable permits attempts to examine the potential cost savings that could accrue under different permit systems. To gauge the potential cost savings associated with the use of various systems, economists have performed a series of mathematical simulations linking cost and environmental quality.12 Typically, the cost of a system of uniform standards applied across many sources is compared with an optimal system that could, in theory, be reached through the use of marketable permits or emission fees. The conclusion of this research is that, in many applications, the costs of achieving environmental quality goals could be significantly reduced if marketable permits were used. For example, a review of several studies examining the potential for marketable permits found that control costs could be reduced by more than ninety percent in some cases.13

11. J. DALES, supra note 2; Montgomery, supra note 9. For a comprehensive review of the theory, see W. BAUMOL & W. OATES, supra note 6, at 5-10.
12. E.g., T. TIETENBERG, supra note 3, at 40-45 (comparing several such studies).
13. Id. at 43-44.
Some scholars have questioned the assumption that these policy instruments will perform well in the real world. For example, domination of the market by a single firm or small handful of firms might adversely influence the effectiveness of a marketable permit system.\textsuperscript{14} However, even in such cases, a market still may have significant advantages over a system in which no trading is allowed between firms. This conclusion is based on the assumption that firms engage in trading permits only if they can save money doing so. The ability of some firms to exercise market power can be expected to influence the distribution of gains in trading, but total cost savings may still be significant. However, if firms attempt to use a marketable permit system as a means of deterring entry into an industry by other firms, significant problems may result. Much of the recent literature on marketable permits addresses such fundamental design issues involved in organizing a market.\textsuperscript{15}

High transaction costs will also affect market performance. Because firms are assumed to engage in trading only when cost savings are possible, a protracted and expensive permitting process would diminish or extinguish the value of some trades.

Economists have devised various methods to test the theoretical properties of marketable permits and emissions charges. In addition to mathematical simulations, economists have also performed controlled experiments that use human subjects to test how these instruments might work in practice. The idea behind these experiments is to provide subjects with conditions similar to those that firms might face under an emissions charge or marketable permit approach and then to examine how these approaches perform relative to some baseline. Work by Plott\textsuperscript{16} and Hahn\textsuperscript{17} reveals that this laboratory setting shows marked increases in efficiency over traditional forms of regulation, such as setting standards on a source-by-source basis.

In summary, the normative case for marketable permits has strong theoretical support. Moreover, simulations and laboratory experiments provide further support for the view that these approaches have the po-

\textsuperscript{14} See Hahn, Market Power and Transferable Property Rights, 99 Q.J. ECON. 753, 754-59 (1984). It is also uncertain that market power is sufficient in itself to influence outcomes in the permit market. Id. at 754-58, 764.
\textsuperscript{15} Much of the recent literature on marketable permits attempts to address these fundamental design issues involved in actually organizing a market. See, e.g., Hahn & Noll, Designing a Market for Tradable Emissions Permits, in REFORM OF ENVIRONMENTAL REGULATION 119 (W. Magat ed. 1982); Hahn, supra note 10; Krupnick, Oates & Van de Verg, On Marketable Air Pollution Permits: The Case for a System of Pollution Offsets, 10 J. ENVTL. ECON. & MGMT. 233 (1983).
tential to make environmental policy much more efficient. To capture this potential, it is necessary to pay attention to the aspects of regulatory design that affect the transaction costs of participating in a market and the relative power of different market participants.\(^{18}\)

**B. Positive Research**

Positive research in marketable permits attempts to explain the actual performance of environmental markets. This method is still in its infancy.\(^{19}\) The positive theory most germane to the use of marketable permits addresses broader questions in instrument choice. For example, Buchanan and Tullock\(^{20}\) explore the relative merits of standards and emissions taxes from the viewpoint of the firm. They argue that firms will prefer emission standards to emission taxes because the former serve as a barrier to entry to new firms, thus raising the profits of existing firms. Taxes, on the other hand, do not inhibit entry by new firms, and they also represent an additional cost to existing firms. This argument is based on the view that industry is able to exert its preference for a particular instrument because it is more likely to be well organized than are consumers.\(^{21}\) The basic insight of this work is that the argument that standards will be preferred to taxes depends crucially on the precise nature of the policy instruments being compared.

Another study of instrument choice was conducted by Campos, albeit in an agricultural rather than environmental context.\(^{22}\) Campos examined the motivation underlying the choice of price supports or quotas in agriculture. From this examination he develops a model that views the instrument choice as being controlled by legislators.\(^{23}\) He finds that the preference for a particular instrument will depend, in general, on

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18. Recently, there have been several applications of market-based incentive systems in developed countries. See generally Economic Instruments, supra note 7; R. Hahn, supra note 8; see also R. Hahn & A. McGartland, The Political Economy of Instrument Choice: An Examination of the U.S. Role in Implementing the Montreal Protocol 6-13 (Carnegie Mellon Univ. School of Urban and Public Affairs Working Paper 88-34, 1988) (forthcoming in N.W.U.L. REV.). In Europe, charge systems—which have included effluent fees—have predominated over marketable permit systems. R. Hahn, supra note 8, at 6-7.

19. Indeed, there is no published literature, to our knowledge, that attempts to construct a theory about the relative performance of different market-based approaches to environmental problems.


21. Id. at 142. Since this seminal article, several authors have explored the instrument choice problem using this basic framework. See, e.g., Coelho, Polluters' Profits and Political Response: Direct Control Versus Taxes: Comment, 66 AM. ECON. REV. 976 (1976); Yohe, Polluters' Profits and Political Response: Direct Control Versus Taxes: Comment, 66 AM. ECON. REV. 981 (1976); see also Dewees, Instrument Choice in Environmental Policy, 21 ECON. INQUIRY 53 (1983).


23. Id. at 4-7.
both the demand for the commodity and the nature of the constituency support that the legislator attempts to nurture.\textsuperscript{24}

Hahn applies a similar framework in examining how the tradeoff between employment and environmental quality affects instrument choice.\textsuperscript{25} He argues that incentive-based mechanisms will be less likely to be implemented where employment concerns are of paramount importance.\textsuperscript{26}

The formal results of positive and normative theory are elegant. Unfortunately, they are not immediately applicable to many issues of instrument choice encountered in the real world. One reason is that they are overly simplistic. None of the real world systems examined below exhibits the purity of the instruments that are the subject of theoretical inquiry. Moreover, instruments that are viewed as equivalent on the basis of existing theory actually have quite different performance characteristics. For example, as discussed in Part II, trading of lead rights in the United States appears to have resulted in much greater efficiency than does the trading that occurs under the emissions trading policy. A more careful examination of the actual application of market-based approaches will suggest important lessons for extending existing theory and designing new applications.

II

PERFORMANCE OF MARKETABLE PERMIT PROGRAMS

Only a handful of applications of market-based approaches to environmental problems have actually been implemented, but the future promises greater reliance on such approaches. EPA is considering market-based approaches for a wide variety of problems.\textsuperscript{27} The recently

\begin{itemize}
  \item \textsuperscript{24} Id. at 10-17. Campos also argues that technological change will have an impact on the instrument chosen. \textit{Id.} at 17-21.
  \item \textsuperscript{26} Id. at 302-05.
  \item \textsuperscript{27} EPA continues to experiment with market-based approaches for a wide variety of problems. The agency now has a limited pilot program for manufacturers of light trucks and diesel automobiles to engage in internal trading in particulate emissions. EPA, Revision of Particulate Emission Standards for Certain 1987 and later Model Year Light-Duty Diesel Trucks, 53 Fed. Reg. 43,870 (1988). A similar program for trading between nitrogen oxides emissions and particulate matter is being developed for heavy duty truck engines. Telephone interview with Willard Smith, Senior Economist, Office of Policy Analysis, EPA (Apr. 6, 1989). The program would also include internal averaging and banking. \textit{Id.} EPA has been under pressure to produce a rule that would allow trading and banking of emission credits associated with heavy duty engine emissions. Recently, the Agency put forth a rule that would allow markets to evolve in rights to produce chlorofluorocarbons as their use is phased out. EPA, Protection of Stratospheric Ozone, 52 Fed. Reg. 47,486, 47,498-503 (1987) (final rule), codified at 40 C.F.R. pt. 82 (1988); see R. Hahn & A. McGartland, \textit{supra} note 18, at 7-13. A similar market approach has been proposed for the phaseout of asbestos. OMB Memorandum, Barriers to Innovation: Alternative Approaches to Regulation 12 (Dec. 12, 1988).
\end{itemize}
completed Project 88 report recommends the application of market-based approaches to a wide variety of environmental programs.\textsuperscript{28} This widespread increasing interest in these innovative regulatory alternatives suggests that a careful examination of how existing market-based approaches actually perform is timely.

This Part provides a detailed examination of the four most important marketable permit programs in the United States. The best known of these is EPA's emissions trading program, which has been in existence for over ten years and is still active.\textsuperscript{29} A second, more recent, market-based program was implemented by EPA, which allowed petroleum refiners to trade in rights to add lead to gasoline. This program began in 1985, and expired at the end of 1987.\textsuperscript{30} Finally, two programs have been initiated at the state and local levels. In 1981, the Wisconsin Department of Natural Resources began a program under which rights to discharge water pollutants into the Fox River could be traded.\textsuperscript{31} Another program aimed at preserving water quality was implemented at Dillon Reservoir in Colorado in 1984, using transferable rights as a mechanism for limiting the amount of phosphorous discharged into the reservoir.\textsuperscript{32}

We will describe and evaluate the performance of each of these four programs. We will measure performance both by cost savings and by impact on environmental quality. Where cost savings cannot be identified specifically, volume of trading activity will be used as a proxy.

In addition to describing the structure and performance of each program, this Part identifies characteristics common to each program that significantly affected performance. We examine two broad categories of program characteristics in detail. The first category consists of restrictions on trading: specifically, who can trade, and the extent to which trading is constrained by regulatory requirements. For example, there are strict requirements on new air emissions sources that cannot be met through emissions trading.\textsuperscript{33} This limits the potential cost savings from

\textsuperscript{28} Project 88, Harnessing Market Forces to Protect Our Environment: Initiatives for the New President (Report sponsored by Senators Timothy Wirth and John Heinz, Dec. 1988).

\textsuperscript{29} For the most recent comprehensive description of this program, see EPA, Emissions Trading Policy Statement, 51 Fed. Reg. 43,814 (1986) (final policy statement) [hereinafter EPA Trading Policy].


\textsuperscript{32} 5 COLO. CODE REGS. § 1002-17 (1984).

The second category consists of administrative requirements that increase transaction costs associated with trading. These requirements differ dramatically across programs. For example, a firm may have to acquire a substantial amount of new information about its past and present emissions before a regulatory agency will consider its application for an emissions trade. In contrast, trades of lead rights for gasoline did not even have to be approved individually; firms simply reported their transactions at the end of each quarter of the calendar year. Thus, the transaction costs that firms incur when participating in emissions trading are relatively high compared to that of lead trading.

The performance of a new program can be affected by the existing regulatory system. Each marketable permit program examined here relies heavily on an existing regulatory program based on standards and permits. In each case, the permit program is designed to give firms more flexibility in controlling emissions or discharges than the prior program so that total control costs can be reduced. Many of the restrictions on trading and the administrative requirements for trading are closely linked to aspects of existing programs. Salient features of the existing regulatory structure will be identified when they are thought to have a marked effect on the performance of market-based approaches.

The identification of the regulatory context in which market-based approaches are implemented, along with key factors affecting program performance, will help set the stage for developing a richer theory of instrument choice. In contrast to existing theories of instrument choice, the theory developed here will exploit the differences in performance characteristics exhibited by various marketable permit programs. A key contribution of this paper will be to suggest how political, economic, and technological factors help explain market performance.

A. Emissions Trading

Emissions trading is intended to provide greater flexibility to firms in meeting the requirements of the Clean Air Act. It was the first attempt in the United States to use market mechanisms in environmental regulation and remains the most ambitious in scope. Emissions trading encompasses four distinct elements or activities that firms may engage in, called “offsets,” “netting,” “bubbles,” and “banking.” Banking allows firms to retain emissions rights for future use. The other three elements involve the trading of rights to emit air pollutants. While each of these
activities is authorized by EPA regulations, states are not required to allow them within their jurisdictions. However, virtually all states do allow some of these emissions trading activities.

The property rights traded under emissions trading are rights to emit specific kinds of air pollutants. These rights are initially created when a state regulatory agency issues a permit to an emission source. A source can trade away its rights only when it is not producing as large a volume of emissions as is allowed by its permit. The difference between permitted emissions and actual emissions is referred to as an emission credit, which represents the tradable right.

Emissions trading can be internal or external. Internal trades are trades between sources in the same plant or facility. External trades are trades between sources in different plants. External trades are usually between two different firms, though they need not be. As will be seen later, the distinction between internal and external trading is important for gaining insights into both the potential for and limitations on existing trading activities.

The Clean Air Act itself makes two additional distinctions that often restrict or prohibit potential trades. First, the Act distinguishes between new, modified, and existing sources. Second, it distinguishes between sources in attainment areas and sources in nonattainment areas. The relationship between these distinctions and emissions trading is shown in Table 1.

The Clean Air Act refers to sources that existed when emissions were first inventoried in the mid-1970's as "existing sources." Sources that have been built since that time are termed "new sources." "Modified sources" refer to alterations of existing sources that lead to significant increases in emissions. These three source types are shown in the first column of Table 1. The differentiation between these source types is

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38. Id. at 43,830-31; see 40 C.F.R. §§ 51.24-52.21 (1988) (PSD bubbles); id. § 60.14 (defining modification).
39. EPA Trading Policy, supra note 29, at 43,831.
41. EPA Trading Policy, supra note 29, at 43,831-32.
42. Id. at 43,831.
46. The information for Table 1 is derived from EPA's explanation of the basic elements of emissions trading. EPA Trading Policy, supra note 29, at 43,830-31. See generally R. Liroff, Reforming Air Pollution Regulation: The Toil and Trouble of EPA's Bubble 1-59 (1986).
TABLE 1  RELATION OF EMISSION LIMITS BY SOURCE TYPE AND AREA CLASS TO EMISSIONS TRADING

<table>
<thead>
<tr>
<th>SOURCE TYPE</th>
<th>AREA CLASS</th>
<th>EMISIONS TRADING OPTIONS</th>
<th>OPTIONAL OR MANDATORY</th>
<th>APPLICABLE EMISSION LIMIT</th>
<th>CAN LIMIT BE AVOIDED BY TRADING?</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEW</td>
<td>ATTAINMENT</td>
<td>OFFSETS</td>
<td>OPTIONAL</td>
<td>BACT</td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td>NON-ATTAINMENT</td>
<td>OFFSETS</td>
<td>MANDATORY</td>
<td>LAER</td>
<td>NO</td>
</tr>
<tr>
<td>MODIFIED</td>
<td>ATTAINMENT</td>
<td>NETTING</td>
<td>OPTIONAL</td>
<td>BACT</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>NON-ATTAINMENT</td>
<td>NETTING</td>
<td>MANDATORY</td>
<td>LAER</td>
<td>YES</td>
</tr>
<tr>
<td>EXISTING</td>
<td>ATTAINMENT</td>
<td>BUBBLES</td>
<td>OPTIONAL</td>
<td>STATE LIMITS</td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>NON-ATTAINMENT</td>
<td>BUBBLES</td>
<td>OPTIONAL</td>
<td>STATE LIMITS</td>
<td>NOT</td>
</tr>
<tr>
<td></td>
<td>BANKING</td>
<td>OPTIONAL</td>
<td>RACT</td>
<td>YES</td>
<td>APPLICABLE</td>
</tr>
<tr>
<td></td>
<td>BANKING</td>
<td>OPTIONAL</td>
<td>RACT</td>
<td>NOT</td>
<td>APPLICABLE</td>
</tr>
</tbody>
</table>

Notes:

1 Of these limits, LAER (Lowest Achievable Emission Rate) is the most stringent, Clean Air Act § 171(3), 42 U.S.C.A. § 7501(3); BACT (Best Available Control Technology) is the next most stringent, id. § 169(3), 42 U.S.C.A. § 7479(3); and RACT (Reasonably Available Control Technology) is the least stringent, id. § 172(3), 42 U.S.C.A. § 7502(3). Modified sources that use netting are exempted from BACT or LAER, but may be subject to other limits called NSPS (New Source Performance Standards) that are typically approximately equivalent to BACT. For stringency of state limits, see note 3 below.


3 There are no specific federally defined emission limits that states must apply to existing sources in attainment areas. However, states are required to institute measures that assure the maintenance of air quality in attainment areas. Clean Air Act § 107(a), 42 U.S.C.A. § 7407(a). To do so, states usually employ a permit system as they do in nonattainment areas and impose emission limits on existing sources through that system. While the resulting state limits can vary widely, they are typically no more stringent than RACT, and may be less stringent.

4 Applicable emission limits are used to calculate emission credits for banking, but the use of banking does not, in itself, enable firms to avoid emission limits. See EPA, Emissions Trading Policy Statement, 51 Fed. Reg. 43,814, 43,835 (1986). The use of their banked credits in other emissions trading activities may enable firms to avoid applicable emission limits, however.
important because new and modified sources generally must comply with more stringent emission limits than existing sources, as shown in Column 5 of Table 1. In addition, new sources are not allowed to use trading to meet their emission limits, as shown in lines 1 and 2. These restrictions limit the potential economic gains that will result from emissions trading.

The second distinction is geographic. Under the Clean Air Act, the United States is divided into 247 areas for purposes of controlling air quality. An attainment area is one that meets the air quality standard for a specified pollutant, as opposed to an area that does not meet a particular ambient standard, called a nonattainment area. This distinction is reflected in Column 2 of Table 1. Emission limits are designed to bring nonattainment areas up to standard, and to maintain air quality in attainment areas. Column 5 of the table shows that sources in nonattainment areas are generally subject to more stringent emission limits than are sources in attainment areas.

To understand why different elements of emissions trading vary widely in their performance, it is important to have a working knowledge of what they enable firms to do. As the following summary reveals, the four elements differ dramatically: elements vary in their provision for external trades, in the types of sources that can participate, and in the locus of administrative control.

Neting allows a modified source to avoid the most stringent emission limits that would be applied to the modification by reducing emissions from another source within the same plant. Thus, netting necessarily involves internal trading only. This reduces the net emission increase to a level below that which is considered significant—hence the term, netting. Netting can result in small net increases in emissions because the cutoff level for treating an emission increase as significant is greater than zero. Netting is controlled at the state level and—subject to individual state restrictions—may be used in attainment and nonattainment areas.

Offsets are used by new and modified sources in nonattainment areas

51. R. LIROFF, supra note 46, at 21.
53. This description glosses over some subtleties in the legislation. It is sufficient, however, for understanding the broad structure of the Act. For a more detailed discussion of the impact that the structure of the Act has on emissions trading, see Hahn & Hester, supra note 43, at 113-18. See generally R. LIROFF, supra note 46.
56. EPA Trading Policy, supra note 29, at 42,380.
and by certain specified sources in attainment areas. The Clean Air Act specifies that no new emission sources would be allowed in areas that did not meet the original 1975 air quality deadlines. Concern that this provision would stifle economic growth prompted EPA to institute the offset rule in 1976. This rule requires new and modified emission sources in these areas to obtain emission credits from sources in the same area to offset their new emissions. The sources are still subject to the most stringent emission limits. Offsets may be obtained through internal or external trades. Like netting, offset transactions are controlled at the state level.

**Bubbles**, first allowed in 1979, are used by existing sources in attainment or nonattainment areas. The name derives from the concept of placing an imaginary bubble over a multi-source plant. The levels of emission controls applied to different sources in a bubble may be adjusted to reduce control costs so long as the aggregate limit is not exceeded. In effect, emission credits are created by some sources within the plant and used by others. Originally, all bubbles had to be submitted by the states to EPA for approval. In 1981 EPA began to approve “generic bubble rules” that enabled states to approve bubbles. Several states now have such rules.

**Banking**, which was first allowed in 1979, provides a mechanism for firms to save emission credits for future use. EPA has established guidelines for banking programs, but states must set up and administer the rules governing banking.

As the third column in Table 1 shows, different types of sources,
classified according to type and location, have different emissions trading options available to them. New sources have the fewest options; the only activity they may engage in is offsets, and the use of offsets is mandatory in nonattainment areas.\textsuperscript{70} The stringent emission limits that apply to these sources cannot be avoided through trading.\textsuperscript{71} Modified sources are faced with similar requirements, except that they may use netting, thus avoiding the most stringent emission limits.\textsuperscript{72} Existing sources in nonattainment areas may use bubbles or banking; the former can be used to avoid emission limits that otherwise would apply to individual sources.\textsuperscript{73}

These differences in options are crucial to understanding the performance of emissions trading. New and modified sources have the greatest incentive to use emissions trading since they are subject to the most stringent emission limits; however, under the program only modified sources can avoid the stringent emission requirements by doing so. Existing sources enjoy the most flexibility in using emissions trading but have less incentive to do so since they are subject to less stringent emission limits.

Table 2 summarizes estimated activity in emissions trading. It presents measures of activity for each program in terms of estimated cost savings for firms, environmental quality impact, and number of trades. In each case, the estimates are for the life of the program through 1985.

As Table 2 shows, levels of activity in the three programs have varied widely. More netting transactions have taken place than any other type, but all of these have necessarily been internal. The wide range of this estimate—5,000 to 12,000 transactions\textsuperscript{74}—reflects uncertainty about the precise level of this activity. An estimated 2,000 offset transactions have taken place, of which only about ten percent have been external.\textsuperscript{75} Fewer than 150 bubbles have been approved, only two of which are known to have involved external trades.\textsuperscript{76} About twice as many bubbles have been approved by states under generic rules than have been approved at the federal level. In fact, the general pattern seems to be that programs controlled at the state level are much more active than those controlled at the federal level. Banking, however, was not received well by either state regulators or firms. The figures listed for banking are an

\textsuperscript{71} See, e.g., EPA Trading Policy, supra note 29, at 43,833 (credits from existing sources cannot be used to meet technology-based requirements applicable to new sources).
\textsuperscript{72} Id. at 43,830 (discussing netting for new sources).
\textsuperscript{73} Id.
\textsuperscript{74} Because states do not systematically record or report netting transactions, a more precise estimate is not possible.
\textsuperscript{75} Dudek and Palmisano estimate that 2500 offset transactions have taken place. Dudek & Palmisano, Emissions Trading: Why is this Thoroughbred Hobbed?, 13 COLUM. J. ENVTL. L. 217, 233 (1988).
\textsuperscript{76} R. LIROFF, supra note 46, at 73-74, 112.
TABLE 2 SUMMARY OF EMISSIONS TRADING PERFORMANCE*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cost Savings (millions)</th>
<th>Environmental Quality Impact</th>
<th>Number of Trades</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUBBLES¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EPA¹</td>
<td>$300</td>
<td>Neutral</td>
<td>42</td>
</tr>
<tr>
<td>State²</td>
<td>$135</td>
<td>Neutral</td>
<td>90</td>
</tr>
<tr>
<td>OFFSETS¹</td>
<td>Not Applicable</td>
<td>Neutral</td>
<td>2000</td>
</tr>
<tr>
<td>NETTING³</td>
<td>$525-12,000</td>
<td>Slightly</td>
<td>5000-12,000</td>
</tr>
<tr>
<td>BANKING⁴</td>
<td>Very Small</td>
<td>Very Slightly</td>
<td>100</td>
</tr>
</tbody>
</table>

* The estimates in this table are drawn from data compiled by the authors in 1986 from the sources listed in notes 1-4 below. The method used to translate the diverse data relating to trades into cost savings is described in Hahn & Hester, supra note 43, at 118-36.

¹ Regulatory Innovations Staff, EPA, Individual Bubble Applications Approved or Pending 1981-1986 (July 1986) (EPA internal computer database, printout on file with authors).
² Regulatory Innovations Staff, EPA, State Summaries (July 1986) (EPA internal reports, copies on file with authors).
³ Office of Air Quality Planning and Standards, EPA (July 1986) (EPA internal computer database, printout on file with authors); telephone interview with John Palmisano, President, AER*X Corp. (Dec. 1985). Information on this program was available for the year 1984 only. Estimates of activity for the period 1981-1985 were extrapolated by the authors from this 1984 data, as described in Hahn & Hester, supra note 43, at 119-22.
⁴ Regulatory Innovations Staff, EPA, State Summaries (July 1986) (EPA internal reports, copies on file with authors); telephone interview with Victor Morales, Bay Area [San Francisco, California] Air Quality Management District (Sept. 18, 1986); Wendy Sims, Oregon Dept. of Environmental Quality (Sept. 18, 1986); Paul Wilhite, Lane County (Oregon) Regulatory Air Quality Auth. (Sept. 18, 1986); Doug McDay, Rhode Island Air Quality Management Agency (Sept. 18, 1986); John Anderson, Puget Sound (Washington) Air Pollution Control Agency (Sept. 8, 1986); Michael DeBusschere, Jefferson County (Kentucky) Pollution Control Dist. The estimate of the number of times firms have withdrawn banked credits for sale or use. There has been little such activity.

Cost savings among the four programs also vary widely. Savings from netting and bubbles are substantial. The greatest cost savings resulted from netting, with an estimated total of between $525 million and $12 billion from both permitting and emissions control cost savings. The wide range of this estimate reflects uncertainty about the number of netting transactions and the cost savings per transaction. Federally approved bubbles have resulted in savings estimated at $300 million, while state bubbles have resulted in an estimated $135 million in cost savings.⁷⁷ The average savings per transaction from bubbles are higher than those

⁷⁷ All cost savings figures are for the lives of the different programs, and are not adjusted for inflation. It is interesting to note that although more state bubbles have been approved than federal, the average cost savings for federal bubbles is much higher. See generally Hahn & Hester, supra note 43, at 123-29.
from netting because of the differences in design of the bubble and netting programs. Firms using bubbles can derive savings from several emissions sources in a single transaction,\(^78\) while firms using netting save costs by avoiding new source preconstruction requirements for a single new modification. Unlike netting and bubbles, offsets result in no direct emission control cost savings because the use of offsets does not allow a firm to avoid any emission limits.\(^79\) However, since a firm using offsets is allowed to locate major new emission sources in nonattainment areas,\(^80\) presumably there is some economic advantage to the firm, or it would locate in an attainment area where offsets are not required. The willingness of firms to go to the expense of obtaining offsets indicates that they derive some net gain from doing so, but the extent of this gain cannot be estimated. Cost savings from banking also cannot be estimated, but are necessarily small given the number of transactions that have occurred.

For each of the four elements of emission trading, the effects on environmental quality have been, on the whole, insignificant. While there have been some small emissions increases from individual sources involved in netting transactions,\(^81\) the overall effect has been inconsequential. Offsets, which require trading ratios greater than 1:1, will naturally lead to reduced emissions. For bubbles, the lack of systematic data collection leaves the question of effects on environmental quality unresolved, but early reports indicated that aggregate effects may be slightly positive.\(^82\) Emission credits for a few of these transactions have been created by lowering permitted emission levels, but not making any actual reduction in emissions.\(^83\) Such transactions have an adverse environmental effect in the sense that emission reductions that would otherwise have been required were foregone. However, their aggregate effect on air quality in local areas is thought to be inconsequential. Banking has probably had a very slight positive effect, since banked credits represent emission reductions that have not been used to offset emission increases. However, because there has been little banking activity, this effect is also very small.

The performance evaluation of emissions trading activities reveals a mixed bag of accomplishments and disappointments. The program has

\(^{78}\) See EPA Trading Policy, supra note 29, at 43,830.

\(^{79}\) Id.

\(^{80}\) EPA Emission Offset Interpretative Ruling of Dec. 21, 1976, supra note 58.

\(^{81}\) Id. at 43,830.

\(^{82}\) See R. Liroff, supra note 46, at 140-43 (discussing EPA’s 1984 evaluation of state and regional experience with emissions trading). EPA has retained this favorable outlook. See EPA Trading Policy, supra note 29, at 43,822 (bubbles meeting special progress requirements predicted to produce net reductions in emissions levels).

\(^{83}\) Dames & Moore, An Investigation of Prevention of Significant Deterioration (PSD) and Emission Offset Permitting Process 4-74 to -75 (1980) (prepared for the National Commission on Air Quality).
clearly afforded many firms flexibility in meeting emission limits. This flexibility has resulted in significant aggregate cost savings—in the billions of dollars—without significantly affecting environmental quality. However, these cost savings have been realized almost entirely from internal trading.\textsuperscript{84} They fall far short of the potential savings that could be realized if there were more external trading.\textsuperscript{85}

A variety of factors affect the performance of emissions trading. High transaction costs are the single most important determinant of program performance. A large part of these costs result from regulatory restrictions on trading and from administrative requirements that prolong the approval of trades.

\section{Regulatory Restrictions and Emissions Trading Activity}

Regulatory restrictions imposed on new and modified sources are a major factor that has limited trading. Although they are subject to more stringent emission control requirements than are existing sources, new and modified sources cannot meet or avoid these requirements through external trading. Many existing sources, which generally have lower marginal emission control costs than do new sources, would be in a position to sell credits to new sources to their mutual benefit, but the requirements established for new sources under the Clean Air Act preclude much of this trading.\textsuperscript{86} These requirements effectively preserve the differences in marginal emission control costs between new and old sources, thus sustaining inefficiencies that could be corrected through emissions trading under existing rules. However, these restrictions on trading make netting a more attractive alternative for modified sources, because sources using netting are exempt from the more stringent emission limits placed on new major sources.\textsuperscript{87} Thus, while the general effect of limits on trading by new and modified sources is to restrict trading below the level that would lead to the greatest efficiency gains, netting is actually increased by the restrictions.

A second regulatory restriction on emissions trading results from the application of different trading ratios. These ratios specify the units of emission credits that must be acquired for a buyer to increase emissions by one unit. Thus, trading ratios effectively set the terms of trade for emissions trading. Trading ratios are adverse for offsets because they

\textsuperscript{84} See Table 2.
\textsuperscript{85} See Hahn & Hester, \textit{supra} note 43, at 137.
\textsuperscript{86} Interestingly, some of the trading requirements for new sources may be relaxed a bit. EPA has approved a bubble between two new sources owned by a utility that would enable one of those sources to exceed the emission limits that would otherwise apply to it. EPA, Standards of Performance for New Stationary Sources: Fossil-Fuel-Fired Steam Generators, 52 Fed. Reg. 28,946 (1987) (final rule).
\textsuperscript{87} EPA Trading Policy, \textit{supra} note 29, at 43,830.
are always greater than unity.88 This provision, which is intended to make emissions trading a tool for improving air quality in nonattainment areas, clearly restricts trading and reduces the number of potentially advantageous trades. Curiously, in the case of netting, overall emissions can increase, so the effective trading ratio is less than unity.89 Thus, the differences in trading ratios used in emissions trading provide another incentive for modified sources to use netting rather than offsets whenever they have a choice. Offsets are mandatory for new sources in nonattainment areas.90

2. Administrative Requirements and Emissions Trading Activity

Administrative requirements that increase the transaction costs of trading also affect program performance. One of the most significant requirements is the need to establish the quantities of emission credits that a seller is entitled to trade away and that a buyer must acquire.91 The resulting transaction costs incurred by firms are the costs of acquiring information that must be provided to regulatory agencies. This information is necessary largely because the emission limits contained in permits are technology-based.92 Firms commonly achieve compliance by installing the technology on which the permitted emission level is based. Although this approach may be adequate for regulation of sources that do not trade, it is not well-suited to those firms that do trade, because it does not provide accurate information on actual emission levels for the purposes of establishing the quantities of property rights being traded. To create emission credits, a source must calculate its reductions in emissions,93 a process that often requires the source to develop costly new information. The same problem is experienced by the source's purchase of emission credits, since it must establish the quantity by which it falls short of meeting its emission limits in order to know the quantity of emission credits it must acquire.94 For both buyer and seller, the cost of acquiring new information in order to establish their property rights can be avoided most readily by choosing not to engage in emissions trading.

Another factor that has a major influence on the transaction costs

88. EPA, Emission Offset Interpretive Ruling, supra note 61, at 3,274-76.
89. In most cases the net increase in emissions from netting, if any, is small or negligible.
90. EPA Trading Policy, supra note 29, at 43,830.
92. That is, the limits are set by reference to a specific emission control technology identified by EPA. See Clean Air Act § 111(a), 42 U.S.C. § 7411(a)(1) (1982).
93. EPA Trading Policy, supra note 29, at 43,817, 43,832 (general guidance on determining baseline emissions).
94. See, e.g., U.S. GAO, A MARKET APPROACH TO AIR POLLUTION CONTROL COULD REDUCE COMPLIANCE COSTS WITHOUT JEOPARDIZING CLEAN AIR GOALS 38-41 (1982) (noting increased transaction costs required to reconcile estimates of emission reductions at offsetting plants). This report contains several case studies that describe the difficulty firms have encountered in establishing quantities of emissions for emissions trading purposes.
associated with emissions trading is the degree of regulatory oversight of individual trades. Generally, greater oversight means greater scrutiny of trades, a more lengthy approval process, increased information requirements, and less certainty about whether a given trade will be approved. Each of these will result in increased transaction costs.

The transaction costs associated with regulatory oversight are affected by several variables. One important consideration is the number of levels of bureaucracy at which a trade must be reviewed. The more levels, the greater the scrutiny and thus the greater the expected transaction costs. For example, bubbles approved at the federal level are reviewed by the state, by EPA regional offices, and by EPA headquarters.95 Other trades, including state bubbles, are reviewed only by the states.96 This variation in oversight results in a substantial difference in transaction costs for the two bubble programs.

Whether a trade is internal or external will also influence the transaction costs associated with regulatory oversight. Internal trades involve only one firm, whereas external trades involve two or more firms. From a regulatory perspective, external trades are more complex, and thus should be subject to greater oversight. Regulators also pay closer attention to external trades because such trades are not widely accepted as a legitimate regulatory activity.97 Therefore, internal trades save the cost of this additional oversight. Opponents of trading tend to view external trades as more harmful or offensive than internal trades, and they are more likely to protest external trades.98 Finally, the costs of communicating with outside parties relying on uncertain information may be too high.99 From the standpoint of the firm, then, transaction costs associated with external trading will typically be much higher than those associated with internal trading.

Another type of transaction cost associated with administrative requirements results from the possibility that the property rights exchanged in emissions trading will be confiscated in the future. As noted previously, these property rights are vested in firms when they receive state permits for emissions sources.100 Although the life of a permit is usually not limited, the emission limits the permit sets are subject to re-

95. E.g., R. LIROFF, supra note 46, at 48 (describing the time required for EPA to approve bubbles as of 1981).
96. EPA Trading Policy, supra note 29, at 43,823, 43,833-34 (allowing state approval of certain bubbles).
97. See, e.g., U.S. GAO, supra note 94, at 83-92 (describing the obstacles to negotiating external offsets for meeting air quality standards in Los Angeles).
98. See, e.g., EPA Trading Policy, supra note 29, at 43,820 (describing opposition of environmental groups to permitting bubbles in nonattainment areas).
99. See, e.g., U.S. GAO, supra note 94, at 40-41 (describing a possible scenario of pollution entitlement hoarding based on inadequate information).
100. See text accompanying supra notes 37-41.
production in the future if air quality goals are not met.\textsuperscript{101} Both state and federal emission trading regulations are quite vague about the treatment of past emission trades in the event reductions have to be made.\textsuperscript{102} One possibility is that rights that have been traded away would continue to be recognized; another is that rights might be effectively confiscated by imposition of additional emissions reduction requirements. The probability of this type of confiscation will be affected by two variables. First, confiscation is more likely in nonattainment areas because state regulators are required to find ways to meet air quality standards in these areas.\textsuperscript{103} Second, rights are more likely to be confiscated if the conditions of a trade are violated by one of the trading firms.\textsuperscript{104} To the extent that future confiscation is probable, the value of rights is reduced and fewer advantageous trades can be made.\textsuperscript{105} Thus, firms will prefer internal trading because they can retain control over all sources involved in a trade.

To summarize, the factors identified above reveal a variety of incentives and disincentives that affect the pattern of trading activities. The stringent emission limits applied to new sources, which cannot be met through trading, create incentives for new sources to use netting rather than offsets whenever possible. Trading ratios greater than unity serve as a disincentive for using offsets, while effective trading ratios less than unity provide an incentive for using netting. The cost of obtaining information necessary to establish property rights for trading constitutes a transaction cost, which is a disincentive for all trading, but especially for external trades. Differences in degrees of regulatory oversight imply that transaction costs for external trades will typically be higher than those for internal trades, and that transaction costs associated with federal bubbles will be especially high. Finally, the possibility of future confiscation of traded rights serves as a disincentive for engaging in trading in nonattainment areas, and especially for external trading in those areas.

Is this pattern of incentives consistent with the pattern of emissions trading activity observed? Empirically, the question is difficult to answer because there are more variables affecting the performance of these activities than there are activities. Nonetheless, three observations lend sup-


\textsuperscript{102} EPA has recognized that credit-terminating actions following trades may discourage trading firms from taking early, environmentally beneficial steps. EPA, Emissions Trading Technical Document, 51 Fed. Reg. 43,837, 43,847 n.48 (1986).


\textsuperscript{104} For example, to obtain emission reduction credits, trading firms must demonstrate that the subject reductions are surplus, enforceable, permanent, and quantifiable. EPA Trading Policy, supra note 29, at 43,831. Trades that do not meet these requirements may be subject to additional emission reductions. EPA, Emissions Trading Technical Document, supra note 102, at 43,847.

\textsuperscript{105} See U.S. GAO, supra note 94, at 40-41.
port to the view that the factors identified here have had a systematic impact on the performance of emissions trading activities.

First, there is a much higher occurrence of internal trading than external trading. For offsets and bubbles, the two activities in which firms can use either kind of trade, there have been many more internal trades than external. This is consistent with the observation that internal trading is associated with lower transaction costs and a lower probability of confiscation of property rights.

Second, there are more state bubbles than federal bubbles. The bubble program is complex and has undergone many changes, so conclusions based on the performance of this program must be viewed cautiously. Nevertheless, the fact that some state bubble programs have been much more active than the federal program is consistent with the idea that transaction costs are higher for emissions trading activities that require federal review and approval.

Finally, netting activity may be near its maximum potential volume. Virtually all the new sources in attainment areas that could use netting have done so, suggesting that little opportunity for future netting activity exists. All of the incentives identified here favor netting, since it is internal, enables sources to avoid binding stringent control requirements, and provides a favorable trading ratio.

This section has provided an overview and assessment of emissions trading activities. The analysis reveals a set of incentives that only vaguely resembles the market-based incentives embraced by economists. On the basis of this analysis, one might wonder whether all such environmental markets will exhibit such characteristics. However, as the following case study reveals, characteristics such as transaction costs and regulatory oversight can vary dramatically across programs.

B. Lead Trading

The lead trading program, formally known as “inter-refinery averaging,” was instituted by EPA as part of a regulatory program that mandated reductions in the amount of lead added to gasoline. Lead is one of several substances that can be added to gasoline to boost octane and prevent “knocking,” thus improving automobile engine performance. However, lead is acutely toxic, and its use in gasoline leads to the disper-
SION OF SIGNIFICANT AMOUNTS OF LEAD INTO THE ENVIRONMENT. INCREASING CONCERN OVER THE PUBLIC HEALTH CONSEQUENCES OF THIS DISPERSION PROMPTED EPA TO CURTAIL THE USE OF LEAD AS A GASOLINE ADDITIVE.

EPA BEGAN ITS REGULATORY PROGRAM TO REDUCE LEAD IN GASOLINE IN 1973. IN 1982, EPA INSTITUTED LEAD TRADING AT THE SAME TIME THAT IT IMPOSED NEW, LOWER LIMITS ON GASOLINE LEAD CONTENT. THE TRADING PROGRAM WAS DEVELOPED, IN PART, IN RESPONSE TO CONCERNS THAT SOME REFINERS, ESPECIALLY RELATIVELY SMALL ONES, WOULD EXPERIENCE DIFFICULTY IN MEETING THE NEW STANDARDS AND WOULD BENEFIT FROM A PROGRAM PROVIDING A DEGREE OF FLEXIBILITY FOR A PERIOD OF TIME. THE SAME CONCERNS PROMPTED EPA TO SET A SLIGHTLY LESS STRINGENT STANDARD FOR SMALL REFINERS THAN FOR LARGE REFINERS DURING THE FIRST HALF OF 1982. IT WAS ANTICIPATED THAT SOME SMALL REFINERS WOULD FIND IT PARTICULARLY DIFFICULT TO MEET THE STANDARDS. IN 1985 EPA FURTHER REDUCED THE AMOUNT OF LEAD ALLOWED IN GASOLINE AND SPECIFIED THAT THE LEAD TRADING PROGRAM WOULD BE TERMINATED AT THE BEGINNING OF 1986. LATER IN 1985, EPA INSTITUTED LEAD BANKING, WITH BANKING ALLOWED RETROACTIVELY TO THE BEGINNING OF THAT YEAR. Refiners were then allowed to trade and use banked credits until the end of 1987.

Under the program that expired in 1986, rights to add specified quantities of lead to gasoline could be traded between refineries. EPA standards specify the amount of lead that may be added to a gallon of gasoline. The quantity of rights to which a firm was entitled was determined by the firm's past lead content performance and the amount of lead allowable in gasoline. EPA regulated gasoline lead content through the control of the fuel additive lead, which is added to gasoline to improve its lubricating properties. Lead is a by-product of the production of gasoline from petroleum and is added to gasoline to improve its volatility and anti-knock properties. Lead is a toxic substance that can cause serious health problems if ingested or inhaled. EPA set limits on the amount of lead that can be added to gasoline to protect public health.

110. OFF. OF POLICY ANALYSIS, EPA, COSTS AND BENEFITS OF REDUCING LEAD IN GASOLINE, FINAL REGULATORY IMPACT ANALYSIS III-2 (1985) [hereinafter REDUCING LEAD IN GASOLINE]. For a description of health benefits from reducing lead in the environment, see id. at IV-3 to V-44.
114. Interview with Joel Schwartz, Senior Scientist, Office of Policy Analysis, EPA (July 9, 1986); Interview with Brian Mannix, Editor of REGULATION (May 27, 1987); see also EPA, Regulation of Fuel and Fuel Additives, supra note 30, at 38,078-90 (introduction to proposed rule) (setting out EPA's perspective on the unique burdens on small refiners).
115. EPA, Regulation of Fuel and Fuel Additives, supra note 30, at 49,323-26 (final rule). See generally id. at 38,078-90 (proposed rule).
116. See id. at 38,081.
120. Id. See generally EPA, Regulation of Fuel and Fuel Additives, supra note 30, at 38,078-90 (proposed rule), 49,322-24 (final rule).
121. See, e.g., 40 C.F.R. § 80.20 (1988) (controls applicable to gasoline refiners and importers).
terminated by the amount of leaded gasoline produced by the firm and the current standard. If a refiner added less lead than was allowed to a gallon of gasoline, then that refiner was entitled to trade lead rights in an amount equal to the difference between the actual and allowed quantity of lead. If a firm wanted to add more lead to a gallon of gasoline than was permitted under the standard, it had to obtain lead rights in an amount equal to the excess. Transactions were reported to EPA at the end of each calendar quarter, and each refiner was required to have a net balance of lead rights greater than or equal to zero for the quarter.

Trading of lead rights could be internal or external. In other words, under the program a firm could use lead rights itself by adding more lead to its gasoline at some point during a quarter than would otherwise be allowed, or it could sell its rights to another firm. Prior to 1985, lead rights that were not used or sold during the quarter in which they were created simply expired. Beginning in 1985, refiners could "bank" rights

122. Id. See generally EPA, Regulation of Fuel and Fuel Additives, supra note 30, at 49,326-27 (introduction to final rule).
124. For example, in 1982, the lead standard was 1.1 grams/gallon for large refiners. A firm that produced 10,000,000 gallons in the first calendar quarter containing an average lead content of 1.0 gram/gallon would have created a credit of 10,000,000 \times (1.1-1.0) = 1,000,000 grams, which it could sell to other refiners. For more details, see EPA, Regulation of Fuel and Fuel Additives, supra note 30, at 49,326-27.
125. 40 C.F.R. § 80.20(d) (1988). See generally EPA, Regulation of Fuel and Fuel Additives, supra note 30, at 38,078-90 (introduction to proposed rule); 49,322-34 (discussing leaded gasoline standards for large and small refineries). The lead credit allocation rule creates some interesting incentives. To see this, first consider a world with a fixed standard of grams of lead per gallon of gasoline in which rights are not tradable. Then, introduce trading with property rights defined on the basis of current production. The demand for gasoline is presumed to remain constant before and after trading. However, the supply curve would shift downward, due to the more efficient production that would be achieved through trading and the increased use of lead. Taken by itself, this allocation rule tends to increase both gasoline output and lead output. The degree to which these outputs would increase depends on the elasticity of demand for gasoline and the specific shift in the supply curve.

As an alternative, lead rights could have been grandfathered on the basis of past production. Although this would also have resulted in higher gasoline production, it would not have caused an increase in the aggregate amount of lead. Compared to the allocation rule that EPA adopted, see supra notes 111-18, the grandfathering rule results in lower output levels of lead and gasoline. However, for the two cases in which trading is allowed, prices will be lower and gasoline output higher than in the case of no trading.

It may seem curious that the implementers of the lead trading rule created a system that would theoretically result in the increased use of lead in the short term. One of the ostensible reasons for taking this approach is that it would induce producers to "compete away the rents" from the lead credits. Mannix interview, supra note 114. This, of course, will depend on the nature of the shift in the supply curve for gasoline. If the supply curve becomes flatter as it shifts downward, rents will be competed away. While this rule may have caused a short-term increase in lead, over the medium and longer term the ratcheting down of the standard resulted in sharp decreases in lead use.

126. 40 C.F.R. § 80.20(d)-(e) (1988). Only external trades were to be reported to EPA. The trading activity described here was also limited to external trades.
for their own future use or for sale to other refiners. The lead trading program terminated at the end of 1986, though refiners could use rights that were banked at that time through 1987.127

Figures 1 through 4 provide several indicators of the performance of lead trading from 1983 to 1987 by calendar quarters.128 In the first three figures, refiners are categorized by size, with 5,000 barrels per day of total gasoline production used to distinguish large refiners from small. The number of small refiners reporting to EPA ranged from 125 to 130, and constituted forty to fifty percent of all refiners.129 Only external lead rights trading is reflected in these figures. Although internal trading undoubtedly took place, no information on this category is available.

Figure 1 shows the lead content, in grams per gallon, of leaded gasoline produced by refiners. For comparison, the applicable EPA limit on lead in gasoline is also shown for each quarter. Small refiners consist-

### Figure 1: Lead Content of Leaded Gasoline

*Source: EPA Quarterly Reports*

- **EPA standard for lead content**
- **Actual lead content: small refiners (<5,000 bbls/day)**
- **Actual lead content: large refiners (> 5,000 bbls/day)**


128. The data used to prepare Figures 1-4 was provided in a letter from Richard D. Wilson, Director, Office of Mobile Services, EPA, to Robert Hahn (Sept. 28, 1987) (enclosing quarterly summaries of lead usage by large and small refiners 1983-1987) [hereinafter EPA Quarterly Refiner Summaries] (on file with authors).

129. See *id.*
ently added lead to gasoline at levels exceeding the EPA limit during the first six quarters of the trading program.\textsuperscript{130} They were able to do so by purchasing lead rights from larger refiners, who added lead to gasoline at levels slightly below the EPA limit.\textsuperscript{131}

In 1985, two changes to the lead program altered this pattern. First, banking of rights was allowed in all four quarters of 1985.\textsuperscript{132} Second, the limit on lead was lowered significantly for the second two quarters of the year.\textsuperscript{133} The response to these changes is evident in Figure 1. In the first and second quarters, both large and small refiners added less lead to gasoline than allowed, and thus were able to bank lead rights. In the third and fourth quarters, however, only the large refiners continued this practice; the small refiners exceeded the EPA standard. They were able to do so both by withdrawing banked rights and by purchasing additional rights from large refiners.

Beginning in 1986, rights could no longer be banked, and a lower limit on lead went into effect.\textsuperscript{134} In response, both large and small refiners exceeded the limit by withdrawing banked rights. Until 1987, small refiners continued to add more lead to their gasoline than did large refiners.

Figure 1 lends credence to the justification cited by EPA for allowing trading, namely, that some refiners, and especially small ones, would find it difficult to meet the lower limits on lead. Net transfers of lead rights tended to be from large refiners to small ones. In addition, EPA’s claim that refiners would take advantage of the banking program to delay full compliance with the stringent standard instituted in 1987\textsuperscript{135} was also confirmed.

Figure 2 shows the proportions of large and small refiners that bought and sold lead rights during the course of the program. Three things are of note here. First, the proportion of large refiners engaged in trading was greater than that of small refiners in almost all quarters.\textsuperscript{136} This indicates that more large refiners were likely to take advantage of the flexibility offered by the trading program. Second, roughly equal proportions of small refiners bought and sold lead rights. This indicates that small refiners were not uniformly hard-pressed to meet the lead stan-

\textsuperscript{130} See id.
\textsuperscript{131} See id.
\textsuperscript{133} Id.
\textsuperscript{134} Id. § 80.20(a)(1)(iii), (d).
\textsuperscript{135} See Lead Rights Banking Rule, supra note 118.
\textsuperscript{136} The total volume of trading for large refiners was also much greater than the volume for small refiners in all quarters. However, the average volume of trading, in terms of grams of lead rights per gallon of leaded gasoline produced, was greater for small refiners than for large refiners in all quarters. This indicates that those small refiners that did engage in trading were very active traders.
MARKETABLE PERMITS

Figure 2: Lead Rights trading activity by size

Source: EPA Quarterly Reports

- Small Refiners selling lead rights
- Large Refiners selling lead rights
- Small Refiners buying lead rights
- Large Refiners buying lead rights

(Small = < 5000 bbls/day) (Large = >5000 bbls/day)

In sum, Figure 2 indicates that, while there were distinct differences between the responses of large and small refiners to the lead rights banking and trading program, the market was not one-sided, with large refiners functioning primarily as sellers and small refiners as buyers. Small refiners may well have benefited particularly from the existence of the program, but participation in both the supply and demand sides of the market was widespread.

Figure 3 shows the proportions of large and small refiners banking lead rights. Lead rights could be created and deposited in 1985 only. Most large refiners deposited rights during this period, while only about one third of small refiners did so. Again, this is an indication that large refiners had more flexibility than did small refiners. After 1985, lead rights could be deposited only if they were purchased from another firm. Few refiners in either group did this. As would be expected given that more large refiners deposited rights, more large refiners withdrew rights than did small refiners in every quarter of 1985 except the

third. Beginning in the last quarter of 1985, this difference was especially large. In general, it appears that large refiners used the banking program much more than did small refiners. However, small refiners did benefit from the program, both by their ability to bank rights for their own later use and by the availability of banked rights for purchase from large refiners.\footnote{EPA reports indicate that, at the end of the second quarter of 1987, small refiners had remaining lead rights deposited averaging only 0.01 grams per gallon of leaded gas, based on average 1985 production. Large refiners had 0.25 grams per gallon deposited. EPA Quarterly Refiner Summaries, supra note 128. Thus, any use of lead rights by small refiners during the remainder of 1987 would have had to be accomplished primarily by purchasing rights from large refiners.}

Figure 4 shows the amount of lead rights traded as a percentage of all the lead added to gasoline in each quarter. This figure illustrates clearly that the market in lead rights was very active, and that this activity generally increased throughout the life of the program.\footnote{By comparison, consider the volume of trading for offsets in the Los Angeles area, where offset trading is most active. Of the five categories of air emissions that can be traded, in no case was as much as one percent traded in 1985. Hahn & Hester, supra note 43, at 121 Table 2. While this comparison is not exact because of differences in the rules of the trading programs, the magnitude of the difference gives an indication of how much more active lead trading has been.} The marked increase observed from the beginning of 1986 reflects the extensive use of banked rights. It also mirrors the reaction of refiners to the
significant reduction in the limit on lead content at this time. Throughout 1987 this limit was consistently exceeded through the use of banked rights, as seen in Figure 1.

The cost savings realized by the lead rights trading program can only be estimated. EPA has not systematically collected lead rights price data, but anecdotal evidence indicates that prices for tradable rights were consistently below one cent per gram prior to the institution of banking. Since banking was instituted, prices have fluctuated within a range of two to five cents per gram. Though EPA has not collected data on the actual cost savings realized by firms as a result of lead trading, the agency estimated that banking could lead to a savings of as much as $226 million to refiners. Absent other evidence, it is reasonable to estimate that the costs savings to refiners from lead rights trading and banking have amounted to hundreds of millions of dollars.

Lead rights trading shifted the use of lead between refiners, but it did not increase the total amount of lead that could be used. Further-

141. EPA, Lead Rights Banking Rule, supra note 118, at 13,126 (1985); EPA, Lead Phase Down, supra note 111, at 31,044 (discussing EPA’s conclusions from refiners’ lead use allocation reports).

142. EPA, Lead Rights Banking Rule, supra note 118, at 13,119; Interview with Barry Nussbaum, Field Operations and Support Division, Office of Air and Radiation, EPA (July 9, 1986); Interview with John Vallesano, Manager of Light Oils, Supply, Planning, and Optimization, Amoco Corp. (July 16, 1987).

143. REDUCING LEAD IN GASOLINE, supra note 110, at VIII-31. This report estimated that 9.1 billion grams of lead would be banked. In fact, 10.6 billion grams were banked. Memorandum from Richard Kozlowski, Director, Field Operations and Support Division, EPA, to Richard Wilson, Director, Office of Mobile Sources, EPA (Aug. 19, 1986) (regarding 1985 lead phasedown reporting summary). The accuracy of this estimate of banking activity lends credence to the accompanying estimate of cost savings.

144. REDUCING LEAD IN GASOLINE, supra note 110, at I-19.
more, because the addition of lead to gasoline is the most cost effective method of attaining necessary octane levels in gasoline, virtually the full amount of lead permitted would have been used, with or without trading.145 Therefore, the program as designed would not directly result in the use of more lead in gasoline than allowed under the regulations.146

Although the question of the actual environmental impacts of the lead trading and banking programs is important, a more important one for the purposes of evaluating the potential usefulness of marketable permit programs in general is whether such programs inevitably create enforcement problems that would not be present absent trading. One way to approach this question is to consider what additional information is required by regulators in a program involving trading. Information on transactions obviously is needed, and keeping track of and verifying this information will necessarily require some additional regulatory resources. If the gains to firms from trading exceed the cost of those resources, then a trading program can still be justified on efficiency grounds.

A trading program typically will not require information on emissions from individual sources beyond that needed for a command and control program. If accurate and complete information on emissions is available, then determining which firms are entitled to emissions rights


146. There are indications that EPA's oversight of refiners' use of lead in gasoline was inadequate during 1984, 1985, and part of 1986. Cf. Office of the Inspector General, EPA, Significant Control Weaknesses Identified in Program to Reduce Lead Emissions 3-4, 114 (1987) [hereinafter EPA, Weaknesses Identified]; Resources Community & Econ. Dev. Divs., U.S. GAO, Vehicle Emissions: EPA Program to Assist Leaded-Gasoline Producers Needs Prompt Improvement 8-9, 14-19 (1986) [hereinafter GAO, Vehicle Emissions]. The primary cause of those problems appears to have been a failure to assign sufficient staff to the task of recording and verifying data on lead usage and lead rights trading and banking submitted by refiners during the first year of the banking program. EPA, Weaknesses Identified, supra, at 2; GAO, Vehicle Emissions, supra, at 18. Assigning additional staff and hiring outside consultants enabled EPA to resolve most of the discrepancies in refiners' reports. EPA, Weaknesses Identified, supra, at 8. While these discrepancies indicate a possibility that actual lead usage exceeded applicable standards, there is no solid evidence that this actually occurred. In fact, some of the discrepancies worked against rather than in favor of the refiners. Id. at 19.

EPA obtained data for enforcing limits on the use of lead additives and trading, banking, and use of lead rights from two sources: self-reports from refiners, and reports of sales of lead additives from the two manufacturers of those additives in the United States. This second source provided an important means of confirming the accuracy of the first. EPA instituted on-site audits to verify the accuracy of refiner reports after the reports were completed. Interview with Richard Kozlowski, Director, Field Operations and Support Division, EPA (Mar. 9, 1989).

The extent to which this has resulted in the use of more lead than allowed under the regulations, if any, is unclear. It is important to note that EPA's reliance on self-reporting, rather than its encouragement of trading in lead rights, was to blame for any abuse that occurred.
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and ensuring that the use of those rights is consistent with program requirements will be relatively easy. If only poor quality information on emissions is available, then enforcement will be very difficult, whether trading is allowed or not.147

The picture of the lead rights trading and banking program that emerges from this brief performance evaluation is that of a well-designed program that gave rise to a vigorous market in lead rights. Trading in this market enabled refiners to achieve large cost savings. Moreover, the introduction of trading probably enabled some refiners to make the transition to lower lead content standards when they would otherwise have been unable to do so and remain in business. The environmental effect of the program as planned was neutral, since it did not allow any increase in the total amount of lead added to gasoline. In short, trading and banking of lead rights is an example of a successful marketable permits program.

The success of the program stems, in part, from the fact that refiners using trading and banking were subject to only three significant limitations on these activities. First, refiners in California, where gasoline lead content standards were more stringent than EPA's,148 could not use trading to exceed the state standard.149 Second, small refiners, which were then subject to a less stringent EPA standard than were large refiners, could not sell lead rights to large refiners.150 Neither of these rather minor restrictions seem to have had a significant effect on trading activity.151 After July 1, 1983 all refiners were subject to the same lead content standards, so the second restriction was eliminated.152

The third important restriction on the trading of lead rights was that the life of the rights was limited. Prior to 1985, when banking was first allowed, the rights expired at the end of the calendar quarter. After banking was instituted, rights could be used in any quarter through 1987.153 The vigorous levels of trading before and after the introduction

147. The widespread failure of metropolitan areas in the United States to meet air quality standards is a case in point. See 53 Fed. Reg. 20,722 (1988). This failure can hardly be attributed to emissions trading, since only a very small fraction of emission sources have traded. Rather, it stems from inadequate controls on emissions sources (including mobile sources, which cannot participate in emissions trading in any case), which can, in turn, largely be traced to inadequate information about quantities of emissions from those sources. Accurate information would help regulators whether or not emissions trading is used.


150. EPA, Regulation of Fuel and Fuel Additives, supra note 30, at 49,326 (small refineries subject to standards would not be allowed to trade unused allowable usage to large refinery).

151. Small refiners could sell lead rights to other small refiners, EPA Quarterly Refinery Summaries, supra note 128, so they were not shut out of participation in the supply side of the market.


of banking indicated that the restrictions on trading did not have a major effect on the viability of the market. At the same time, the increase in the price of rights with the onset of banking suggests that the increased flexibility provided by banking was a valued attribute. It is important to note that, unlike emissions trading, the lead rights trading program accorded entirely equal treatment to rights that were banked and rights that were used in the same period in which they were created.

The minimal administrative requirements for lead trading did very little to increase transaction costs for firms engaging in trading. The regulatory program for controlling the lead content in gasoline relies heavily on self-monitoring and reporting by refineries. Each quarter, refineries must submit a report to EPA on their gasoline production and lead usage. Refiners that used trading were also required to include in these quarterly reports an accounting of their lead trading, including the identity of the other refiners with which they traded and the volumes of rights traded. Refiners that used banking also had to report, on a quarterly basis, opening and closing lead right balances and transactions in banked rights. None of these requirements resulted in refiners having to report information that was not readily available to them. Thus, administrative costs for the firms participating in lead trading were quite modest when compared with the costs of other regulatory requirements.

Although the lack of restrictions and burdensome administrative requirements smoothed the way for activity in lead rights trading, these factors alone are not sufficient to explain the success of the program. The existence of well-established markets in refinery feedstocks and products, including a wide variety of gasoline additives, was a significant factor in the success of the program: personnel at different refineries who were accustomed to conducting transactions with each other facilitated the establishment of the lead trading market. By contrast, in the emissions trading program, there were no established markets that could readily be adapted to trading in rights to produce air emissions.

Even so, the significance of the minimal restrictions and lack of excessive requirements for lead rights trading should not be underestimated in assessing the success of the program. It is easy to imagine a scenario in which trading restrictions, ambiguities in the definition or distribution of rights, and demands for information about trading could severely inhibit trading activity, regardless of the existence of a network of personnel who otherwise could easily handle trading activities. For example, if refiners wishing to buy lead rights were required to demonstrate compel-

154. Id. § 80.20(a)(3).
155. Id. § 80.20(d)(2).
156. Id. §§ 80.20(e)(2)(iii), 80.20(e)(3)(iii).
157. Schwartz interview, supra note 114; Nussbaum interview, supra note 142; Vallesano interview, supra note 142.
lishing economic need to add more lead to gasoline than allowed under the EPA standard, undoubtedly much less trading would have taken place. The clarity of the regulations governing both lead trading and the conduct of firms and regulators alike certainly contributed significantly to the program's success.

C. Trading Of Water Pollution Rights: Fox River, Wisconsin

The Federal Water Pollution Control Act (Clean Water Act)\(^{158}\) provides the basis for water pollution control in the United States. The approach is similar to that used under the Clean Air Act. EPA sets standards for water quality,\(^{159}\) and the states establish permit systems for individual pollution sources.\(^{160}\) Permitted levels of discharge for sources are set by reference to technology-based standards established by EPA.\(^{161}\) Generally, only point sources are regulated through this permit system.\(^{162}\)

Since 1981, Wisconsin's permit program has allowed point sources of water pollution to trade rights to discharge into the Fox River.\(^{163}\) The primary point sources on the Fox River are paper mills and municipal wastewater plants. The Fox River trading program was developed as part of a broader effort to find ways to meet water quality standards for the river. Initially, trading of discharge rights was not a priority in this effort, but the idea was advanced by economists studying the economic impact of different approaches.\(^{164}\) Potential annual cost savings from a marketable permit approach were estimated at seven million dollars, based on industry abatement costs estimated by EPA in 1979.\(^{165}\)

Property rights that can be exchanged under the Wisconsin program are rights to discharge wastes that increase biological oxygen demand,\(^{166}\) a key measure of water quality. Because the permits establishing the initial allocation of rights set a single limit on the waste discharge of an


\(^{160}\) Id. § 402(b), 33 U.S.C. § 1342(b).

\(^{161}\) Id. § 304, 33 U.S.C. § 1314.

\(^{162}\) "Point sources" are sources of pollutants identified in the Clean Water Act that are readily identifiable and measurable, such as pipes or ditches. Id. § 502(14), 33 U.S.C. § 1362(14). They are distinct from "nonpoint sources," such as urban rainwater runoff or runoff from irrigation in agricultural operations, which are not subject to state NPDES permit programs. Id.

\(^{163}\) Wis. Admin. Code § NR 212.115 (1986). For a detailed description of the Fox River trading program, see G. Novotny, Transferable Discharge Permits for Water Pollution Control in Wisconsin (Dec. 1, 1986) (manuscript on file with authors).

\(^{164}\) Interview with Gerald Novotny, Engineer, Wisconsin Department of Natural Resources (June 16, 1987); Interview with Michael Llewelyn, Chief of Non-Point Source and Land Management Section, Wisconsin Department of Natural Resources (June 29, 1987).

\(^{165}\) G. Novotny, supra note 163, at 14.

\(^{166}\) See id. at 6, 8-10, 12, 17.
entire plant rather than a number of limits on individual waste sources within a plant. All trading of rights is external. Trading is allowed only if the plant acquiring rights is new, or is increasing production, or is unable to meet the discharge limits in its permit despite optimal operation of its treatment facilities. In addition, the firm acquiring rights must "demonstrate to the satisfaction of the [state regulatory] department that the increase is needed." Traded rights are effective only through the term of the seller's discharge permit, a maximum of five years. When permits are renewed, therefore, there is no assurance that rights that were sold will be reallocated to a permit holder.

While a mechanism for water pollution rights trading exists in Wisconsin, only one trade has taken place. This trade was between a paper mill that stopped operating its wastewater treatment plant and a municipal wastewater treatment plant that began taking the mill's wastewater and was given the wasteload allocation previously held by the mill. One pair of paper mills on the Fox River is reportedly interested in making a trade, but they have not made an application to state regulators. Although the program has been in place for only a few years, there is no indication that it will be successful in fostering a significant amount of trading.

Restrictions on trading under the Fox River program are significant. Foremost among these is the requirement that buyers of rights demonstrate need. This requirement precludes trades aimed solely at reducing operating expenses for wastewater treatment. Only changed operations, or lack of feasibility in meeting discharge limits even with optimal operation, will justify the acquisition of rights.

Limits on the duration of traded rights also restrict trading. Traded rights are limited to the term of the seller's operating permit. Since permits must be renewed every five years, the maximum life of the rights is five years. This is far less than the expected operating life of a facility

168. This is in contrast to the regulatory approach for air pollutants. Note that a single firm operating two separate waste discharging plants on the Fox River could conceivably make a trade between its own sources, but this is not internal trading as we have defined it here.
170. Wis. ADMIN. CODE § NR 212.115(2) (1986).
171. See G. Novotny, supra note 163, at 12. The minimum term for trading rights specified in the regulation is "one wasteload allocation season." Wis. ADMIN. CODE § NR 212.115(1)(c) (1986).
172. Wis. ADMIN. CODE § NR 212.115(3) (1986).
173. David interview, supra note 167.
174. Llewelyn interview, supra note 164.
175. Wis. ADMIN. CODE § NR 212.115(2) (1986); see supra text accompanying note 170.
176. Wis. ADMIN. CODE § NR 212.115(1)(c) (1986).
such as a paper mill.\textsuperscript{177} Thus, trading of rights provides a tenuous basis for firms to make decisions about operating plants that will discharge wastewater into the river. On the other hand, traded rights are required to be effective for at least one wasteload allocation season,\textsuperscript{178} which is effectively one year. This precludes trading (or leasing) of rights for shorter periods to accommodate temporary changes in operating conditions. These restrictions severely limit the usefulness of rights acquired through trading and discourage trading activity.

Administrative requirements for approving trades under the Wisconsin program also create significant transaction costs that inhibit trading. Discharge permits for both parties to a trade must be modified for a trade to be approved.\textsuperscript{179} Approval must be obtained before the trade takes place, and modification of a permit requires a minimum of 175 days.\textsuperscript{180} In addition to the cost of going through a lengthy permit process, this shortens the already limited life of the traded rights, effectively reducing their value.\textsuperscript{181}

Overall, although there may be some trading in the future under the program, the Fox River water pollution rights program is the least successful of the marketable permits programs evaluated here. It seems certain that, because the rules governing trading specifically prohibit approval of trades for which the sole justification is cost savings, the number of trades will never reach the potential indicated by economic studies.

\textbf{D. Water Pollution Rights Trading: Dillon Reservoir, Colorado}

In 1984, Colorado approved a plan that allowed trading of rights to discharge phosphorous into the waters of Dillon Reservoir, which is the source of half of Denver’s water and an economic mainstay of Summit County.\textsuperscript{182} The county relies on income from tourists who flock to the reservoir during the summer and to the four local ski areas during the winter.\textsuperscript{183} A 1984 EPA study revealed that this activity and local growth had caused the reservoir to become borderline eutrophic by 1982.\textsuperscript{184} Accommodating future growth\textsuperscript{185} while maintaining the 1982 level of water

\begin{itemize}
\item \textsuperscript{177} G. Novotny, \textit{supra} note 163, at 14.
\item \textsuperscript{178} Wis. Admin Code § NR 212.115(1)(c) (1986).
\item \textsuperscript{179} Id. § NR 212.115(1).
\item \textsuperscript{180} See G. Novotny, \textit{supra} note 163, at 12.
\item \textsuperscript{181} Id.
\item \textsuperscript{182} 5 Colo. Code Regs. § 1002-17 (1984).
\item \textsuperscript{183} Office of Policy Analysis, EPA, \textit{Case Studies on the Trading of Effluent Loads, Dillon Reservoir, Final Report} 3-2 (1984) [hereinafter EPA, Dillon Case Study]. The ski areas are substantial point source wastewater dischargers to the reservoir.
\item \textsuperscript{184} Id. at 3-4, 3-5.
\item \textsuperscript{185} During the 1970’s Summit County was the fastest growing county in the U.S. in terms of percentage population growth. Northwest Colorado Council of Govern-
quality required a reduction in discharges from existing point and nonpoint sources.\textsuperscript{186} To meet this goal, a coalition of government and private interests developed a plan to control phosphorous discharges into the reservoir.\textsuperscript{187}

Human-induced phosphorous discharges into Dillon Reservoir have a variety of point and nonpoint sources. Important point sources include four municipal treatment plants operated by subdivisions and resorts, and one industrial treatment plant.\textsuperscript{188} Nonpoint sources, primarily septic systems and urban runoff, also contribute significant amounts of phosphorous.\textsuperscript{189} The plan, approved by the state in 1984, requires the application of advanced treatment methods for all point sources and the installation of controls to minimize nonpoint discharges created after 1984.\textsuperscript{190} It also provides for a "growth margin" for point sources to accommodate development through 1990\textsuperscript{191} and allows the trading of rights to discharge phosphorous into the reservoir.\textsuperscript{192}

The plan first allocates to each discharger, on an annual basis, allowable discharges of phosphorous.\textsuperscript{193} It then provides that current and new dischargers may increase their discharges above the applicable limit in the plan only if they control nonpoint sources in the watershed.\textsuperscript{194} Rights can be acquired from nonpoint sources in existence prior to 1984 only at a 2:1 ratio.\textsuperscript{195} Thus, a point source must acquire two pounds of discharge rights from a nonpoint source to increase its phosphorous discharge by one pound.

The discrepancy in the ratio for point/nonpoint source trading is intended to provide a margin of safety required by uncertainty concerning the effectiveness of nonpoint source controls.\textsuperscript{196} Although control of nonpoint sources is less expensive than further reduction of phosphorous from point sources, it is difficult to arrange and assign responsibility for

\begin{quote}
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\textsuperscript{186} Id. at 4.
\textsuperscript{187} Id.
\textsuperscript{188} \textit{Id}. at App. A, 8.
\textsuperscript{189} \textit{Id}. at App. A, 9-10.
\textsuperscript{190} 5 COLO. CODE REGS. § 1002-17, at 4.1.6 (1984).
\textsuperscript{191} COLO. COUNCIL OF GOVERNMENTS, \textit{supra} note 185, at 6.
\textsuperscript{192} 5 COLO. CODE REGS. § 1002-17.
\textsuperscript{193} COLO. REV. STAT. § 25-8-205 (Supp. 1988).
\textsuperscript{194} 5 COLO. CODE REGS. § 1002-17, at 4.1.3, 4.1.5.
\textsuperscript{195} There is unlikely to be trading between point sources (which would be permitted in a 1:1 ratio) since all point sources are expected to discharge at least to their allocated levels. Even if phosphorous discharges from point sources could be reduced to zero, phosphorous from nonpoint sources would threaten eutrophication. Telephone interview with Bruce Baumgardner, Summit County Manager and Chairman, Colorado Water Quality Control Commission (July 1, 1987).
\textsuperscript{196} COLO. COUNCIL OF GOVERNMENTS, \textit{supra} note 185, at 6.
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all nonpoint sources. Under the new plan, the solution arrived at was to use trading that would allow point sources to install controls at existing nonpoint sources and take credit for the resulting phosphorous reductions in the form of property rights.197

Potential cost savings from the trading program are significant. The marginal cost for removal of one pound of phosphorous from a typical wastewater treatment plant in Summit County may be as much as $860;198 at a nonpoint source the average cost is $119.199 Annual savings from point/nonpoint source trading are estimated at $773,000.200 Cost savings that are realized from trading should be achieved without reducing water quality from current levels; in fact, given the 2:1 trading ratio, trading may even result in improved water quality.

The Dillon Reservoir program imposes few restrictions on trading. The primary restriction is the 2:1 trading ratio for point/nonpoint trading. Given the large disparity in costs of phosphorus removal between point and nonpoint sources, however, this does not by any means eliminate the potential for cost savings from trading. The extent of administrative regulation is as yet unclear. A Summit County Water Quality Committee has been formed to oversee the trading system.201 All transactions will be documented through changes in state discharge permits, which will specify the responsibility of point sources to maintain controls on nonpoint sources from which they acquire discharge rights.202 Exactly what transactions costs will result from these administrative requirements will necessarily remain unknown until a track record of trading is established.

No trades have yet been approved for Dillon Reservoir, though approval for some trades has been requested.203 It is highly likely that

198. EPA, DILLON CASE STUDY, supra note 183, Exhibit 3-6.
199. Id. at 3-11, Exhibit 3-8.
200. See id. Exhibit 3-16. These figures take into account the 2:1 trading ratio.
201. Intergovernmental Agreement for Summit County Water Quality 1, Apr. 4, 1984, attached as Appendix 3 to SUMMIT COUNTY PHOSPHOROUS POLICY COMMITTEE, NORTHWEST COLORADO COUNCIL OF GOVERNMENTS, RECOMMENDED WATER QUALITY MANAGEMENT PLAN FOR THE COLORADO WATER QUALITY CONTROL COMMISSION (1984) [hereinafter SUMMIT COUNTY PLAN]. The parties to this agreement are the Summit County Board of County Commissioners; the towns of Breckenridge, Blue River, Dillon, Frisco, Montezuma, and Silverthorne; the Dillon/Silverthorne Joint Sewer Authority; the Copper Mountain Water and Sanitation District; the Breckenridge Sanitation District; the Frisco Sanitation District; and the Summit County Snake River Plant. Id.
202. SUMMIT COUNTY PLAN, supra note 201, at 11.
203. Baumgardner interview, supra note 195. A decrease in the rate of population growth has delayed the time at which phosphorous allocations will be exceeded by discharges, absent additional controls. Telephone interview with Daniel Vaughn, Planner, Summit County Planning Department (Mar. 6, 1989).
there will be trading in the future, however, for two reasons. The first is the cost savings available to point sources. These are sufficiently large to induce point sources to use trading. The second reason is that the wasteload allocations for point sources are simply not sufficient to accommodate future growth (e.g., the allocations would not support the addition of new sewage hookups for municipal treatment plants). If there is to be future growth, it can only be accommodated by point sources, as a practical matter, through the acquisition of discharge rights from nonpoint sources. In this sense, the Dillon Reservoir trading program resembles the offset element of emissions trading, which requires new sources to offset their emissions with credits that represent reductions in the emission of existing sources. As noted, the wasteload allocations set in 1984 include growth margins for point sources expected to be sufficient to accommodate growth through 1990. Thus, trading activity may not begin in earnest until about that time.

III

THE POLITICAL ECONOMY OF MARKETABLE PERMIT SYSTEMS

A. Interest Groups and Policy Formulation

Applied research on marketable permit systems has typically focused on potential cost savings and issues in market structure related to the allocation of property rights. Although these certainly are necessary conditions for the success of a marketable permit program, they are not sufficient. In the preceding section, we have shown how two other factors that are rooted in administrative arrangements for marketable permit programs—namely, regulatory restrictions on trading and transaction costs resulting from administrative requirements—also have affected the performance of such programs. Until recently, the prescriptive economics literature on marketable permits assumed that these latter two factors were under the complete control of bureaucrats or politicians. In fact, regulators in charge of program design exercise only limited control over these factors. Interest groups that interact with regulators and politicians also play an important role in shaping these programs. To understand why marketable permit programs take the forms they have, it is necessary to understand these interactions and their influences. This section first examines the nature of interest group involvement in the design of market-based approaches. It then develops a series of generalizable insights related to the performance of market-based approaches.

Attention will be restricted here to three stylized interest groups: industry, environmentalists, and regulators.204 Although this is a signifi-

204. Within regulatory agencies, there are individuals who are particularly concerned
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cant simplification, a model encompassing these three groups yields important insights into the likely nature of restrictions and administrative requirements that will be incorporated into marketable permit programs.\textsuperscript{205} Interestingly, there is a distinct difference in the level of controversy resulting from interest group interactions in the cases examined here. Emissions trading and the trading of permits on the Fox River were characterized by high levels of controversy.\textsuperscript{206} In contrast, the lead trading program and the program at Dillon Reservoir were much less controversial.\textsuperscript{207} An understanding of the reasons for this variation in controversy is critical to understanding the design and performance of marketable permits as instruments for regulatory reform.

Emissions trading has been the most controversial of the four marketable permit programs. Industry has generally been supportive of the program, although that support has often been lukewarm. Given the uncertainties about emissions trading that have resulted from frequent policy changes and court challenges, many firms seem to have found meeting emission limits through conventional means preferable to supporting and using emissions trading.\textsuperscript{208} Environmentalists have opposed emissions trading vigorously.\textsuperscript{209} They argue that emissions trading has created loopholes that have allowed firms to produce greater quantities of emissions than would otherwise have been allowed. Moreover, many environmentalists believe that environmental quality is fundamentally a right to which the public is entitled, and that vesting industry with property rights to pollute deprives the public of that right.\textsuperscript{210}

\begin{footnotesize}
\begin{enumerate}
\item Either about the cost of environmental regulations for industry or about environmental quality. These concerned individuals advocate the side of either industry or environmentalists in conflicts over policies such as marketable permits. In fact, the impetus for marketable permit programs often seems to come from inside a regulatory agency rather than from industry. See generally Levin, Getting There: Implementing the “Bubble” Policy, in SOCIAL REGULATION: STRATEGIES FOR REFORM 59 (1982); Meidinger, On Explaining the Development of “Emissions Trading” in U.S. Air Pollution Regulation, 7 LAW & POL’Y 447 (1985). In the simplified model employed here, the focus is on general interest groups rather than on individual actors in policy development. Thus, regulators are treated as a group that primarily responds to pressures from the other two groups.
\item Legislators represent a fourth group that clearly influences the process. In the model presented here, legislator influence is captured by the existing laws in which regulators develop and implement policy. Hahn has argued that the role of legislators in promoting new incentive-based approaches has been minimal. R. Hahn, The Political Economy of Environmental Regulation: Towards a Unifying Framework (Carnegie-Mellon Univ. School of Urban and Public Affairs Working Paper 88-33, 1988) (forthcoming in PUB. CHOICE).
\item See, e.g., R. LIROFF, supra note 46, at 9-18 (emissions trading); G. Novotny, supra note 163; Llewelyn interview, supra note 164 (Fox River).
\item See, e.g., Schwartz interview, supra note 114 (lead trading); COLO. COUNCIL OF GOVERNMENTS, supra note 185, at 5-6 (Dillon Reservoir).
\item See Hahn & Hester, supra note 43, at 142.
\item The attitudes of environmental groups toward the use of these incentive-based approaches appears to be changing. See, e.g., Dudek & Palmirano, supra note 75; see also R. Hahn & A. McGartland, supra note 18.
\item Hahn & Hester, supra note 43, at 142.
\end{enumerate}
\end{footnotesize}
In response to these competing pressures, regulators have attempted to fashion an emissions trading program that protects environmental quality while affording industry the flexibility it needs to reduce emission control costs. These tensions have had two important effects on the structure of programs. First, they have resulted in a number of trading restrictions and administrative requirements that make trades more difficult and costly to accomplish than they otherwise would be. Second, distinctions have been made between property rights on the basis of whether they are used in internal or external trades, and whether banking is used to preserve rights. These facts alone explain much about the performance of emissions trading. Internal trading has predominated every emission program element. Netting, which by definition involves internal trades, is the element most often used. Internal trading has also dominated the bubble and offset elements. Banking, which could foster the development of markets in emission credits and lead to greater cost savings from trading, can only be characterized as a program that has fallen far short of its potential.

The regulatory systems on which emissions trading and the Fox River water rights trading program were based share common features that help to explain the strong dissonance between industry and environmentalist views on these programs. In each case, a permit system has been used to set emission limits for individual sources. However, the environmental target has been ambient environmental quality—air quality in the case of emissions trading, and water quality in the case of the Fox River. The individual limits applied to sources are supposed to result in total emissions low enough to meet ambient standards. Industry views a permit as representing a right to produce a given level of emissions. Environmentalists claim ambient environmental quality as a right vested in the public. The potential for conflict is clear.

If ambient environmental quality goals are met through the use of permit limits, there will be no conflict. However, if ambient environmental quality standards are not met, conflicts will inevitably arise over these perceptions of rights. Environmentalists will claim that all possible reductions in emissions must be made, regardless of current permit levels. Industry will assert that reducing current emission limits would be tantamount to taking away their rights. This conflict is accentuated when

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211 For more detailed descriptions of interest group involvement in emissions trading, see Hahn & Hester, supra note 43; R. Liroff, supra note 46. For treatments of this subject that concentrate more on internal interactions at EPA in the initiation of the program, see Meidinger, supra note 204; Levin, supra note 204.

212 This view gains support from the point that individual industrial sources are not the only sources of air emissions or water discharges: thus, reducing permit limits will not necessarily meet ambient standards. In the case of air quality, for example, mobile sources—cars and trucks—and unregulated minor sources produce emissions that could be reduced. In the case of water quality there are numerous nonpoint sources.
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marketable permits are involved. When permits can be traded, they have value to firms as saleable assets even when they are not being "used" to produce emissions. But environmentalists balk at the idea that "unused" rights could be sold to another firm, which could then increase its emissions and further deprive the public of its right to environmental quality. Such a struggle over property rights has led to the controversies over emissions trading and water rights trading on the Fox River.

By contrast, the lead rights trading program has not been a cause of much controversy between interest groups. In fact, the prime object of controversy over lead in gasoline has been the level of lead that should be allowed. Refiners argued for a higher limit on lead content, and environmentalists for a lower limit. Based on information suggesting that the adverse health effects from the dispersion of lead in the air were greater than previously thought, EPA gradually imposed more stringent standards from 1982 to 1985, even while initiating lead rights trading and banking.

Industry response to the lead rights trading program was complex, reflecting the fact that individual firms varied widely in production capability and ability to respond to market conditions. Also, responses of individual firms to the lead rights trading proposal were conditioned by their views on other changes in the regulation of lead in gasoline. Therefore, it is not possible to characterize any single position as being that of industry in this instance. However, most firms did favor the banking program.

The environmentalist response to the lead trading and banking programs was also dominated by their responses to other regulatory changes. Generally, they were willing to accept these programs since they were accompanied by significant cutbacks in the total amount of lead allowed in gasoline. The limited life of the programs was also viewed as favorable, because it made the impact of the programs reason-

213. See EPA, Lead Rights Banking Rule, supra note 118, at 13,118-25 (EPA's summary of and responses to public comments).
214. See EPA, Regulation of Fuels and Fuel Additives, supra note 30, at 49,322 (establishing a lead content ceiling of 1.10 grams per gallon); EPA, Regulation of Fuels & Fuel Additives, Gasoline Lead Content, supra note 117, at 9,386 (lowering the ceiling to 0.10 grams per gallon beginning in 1986). The current lead content standards are codified at 40 C.F.R. § 80.20 (1988).
215. See supra notes 132-34 and accompanying text.
217. Public comments on the lead rights banking program are summarized in EPA, Lead Rights Banking Rule, supra note 118, at 13,118-27. Complete records of the comments are contained in Regulation of Fuels and Fuel Additives, Gasoline Lead Content, EPA Docket No. EN-84-05 (1984).
ably predictable in terms of effect on lead use. As noted, this marketable permit program was evidently advocated primarily by those within EPA and the Office of Management and Budget who felt that trading and banking would provide refiners with needed flexibility to meet lead phasedown requirements.

The water pollution rights trading program at Dillon Reservoir is unique among the marketable permit programs examined here because it was initiated at the local level. Another unique aspect of the program is that the wastewater producers and environmentalists have overlapping interests. The primary point sources of phosphorus discharges to Dillon Reservoir, municipalities and resort operations, depend on the water quality of the reservoir to support the local economy by continuing to attract recreational visitors. In fact, in view of this mutual dependence it is not surprising that while the state regulates the program by issuing and enforcing permits, representatives of local governments, unincorporated developed areas, local business interests, and the Denver Water Department originally developed the trading program in conjunction with state and federal regulators and submitted it to the state for approval. All of the groups involved in the planning process had an interest in developing a workable trading plan. Thus, it is not surprising that the program that was adopted apparently has the potential to result in advantageous trading of rights.

Not all environmental markets are characterized by polarized struggles over property rights. In the case of lead rights trading, the struggle, insofar as there was one, was over the initial allocation of rights in the level of lead allowed in gasoline. Once this question was settled—and it was apparently settled in a way that satisfied most environmentalists—the only question was which refiners would be the ones to actually use the rights. From the environmentalists’ perspective, this was a matter of indifference. From industry’s perspective, trading and banking could be advantageous for some refiners, but would harm none. Similarly, in the case of Dillon Reservoir, once the rights to discharge phosphorous into

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218. The lead rights trading and banking programs are no longer in effect. See 40 C.F.R. § 80.20(d)(4) (1988) (terminating inter-refinery averaging on Jan. 1, 1986); id. § 80.20(e)(1)(i) (no banking of lead usage rights after Jan. 1, 1986); id. § 80.20(e)(2)(i) (no withdrawal of lead usage rights after Jan. 1, 1988). EPA has since considered a total ban on lead in gasoline. See Regulation of Fuels and Fuel Additives, Gasoline Lead Content, 50 Fed. Reg. 9400 (1985) (supplemental notice of proposed rulemaking requesting comment on total ban on use of lead in gasoline). Obviously, any ban that comes into effect after the suspension of the trading and programs will not affect lead rights trading.

219. Nussbaum interview, supra note 142; Mannix interview, supra note 114.

220. COLO. COUNCIL OF GOVERNMENTS, supra note 185, at 4-5.

221. There were two small groups of people who opposed the trading program. The groups have been characterized as comprised of those who opposed all environmental regulation and those who opposed further growth in Summit County. Baumgardner interview, supra note 195.
the reservoir were allocated, trading of rights was not to anyone's disadvantage. Trading between point sources is highly unlikely, since each point source was allocated an amount of rights anticipated to accommodate growth through 1990.\footnote{5 COLO. CODE REGS. § 1002-17, at 4.1.8 (1984).} The only other way to acquire rights is to reduce discharge from nonpoint sources.\footnote{Id. at 4.1.5.} This action would reduce the total discharge of phosphorous, given the required 2:1 trading ratio. Thus, both of these trading programs squarely address environmentalists' concerns that the sale of "unused" rights will result in failure to meet current standards for environmental quality.

B. The Regulatory Context of Policy Change

In addition to identifying the most important interest group concerns, it is useful to examine more carefully the broad context within which policy changes take place and within which the design and performance of a market are determined. Existing laws and regulations provide the backdrop within which new alternatives are shaped. The existing framework of laws and regulations represent an investment regulators rarely discard, but rather modify in an incremental fashion. It is through this incrementalism that existing laws and regulations may influence the design of new programs. Complementing the legal and institutional framework are the set of available technologies that can be used to implement new alternatives. Technologies, especially those used in monitoring and enforcement of regulations, have played an important role in shaping decisions on the design of new environmental approaches. The design and performance of a market are also largely determined by the background interplay of economic, political, institutional, and technological factors. It is to consideration of the structure and performance of markets that we first turn.

The traditional economic factors affecting market performance relate to the number of buyers and sellers in the market, and to their ability to exert market power. As was discussed earlier, when one or a small number of firms exerts great influence over the market, significant barriers to entry may be erected. In addition, to the extent that there are relatively few buyers or sellers, trading may be inhibited, and program performance can suffer. This phenomenon may, in part, account for the failure of the Fox River trading program to induce more than one trade. In that case, the market for trading discharge rights was composed of only a very few firms. This is in contrast to the emissions trading, lead trading, and Dillon Reservoir programs, each of which has many actual or potential market participants.

A critical political factor affecting market design is the extent to
which various interest groups agree on the underlying distribution of property rights. When there is agreement, conflict between groups is minimized, and there is an increased probability of successful trading. When there is not agreement, a struggle over property rights seems inevitable. When such a struggle occurs, the design of the existing regulatory program becomes crucial because it plays an important role in determining which groups will be more successful in having the property rights and rules for trading structured in ways that serve their purposes.

The institutional context in which reform takes place also has an important effect on the nature of the reform. Each of the four marketable permit programs described here relies heavily on existing regulatory programs. In this respect, they are all incremental in nature, even though they constitute significant innovations. The extent to which the existing regulatory framework has affected trading differs among programs. In the cases of lead rights trading and trading of water pollution rights at Dillon Reservoir, which have not been characterized by a struggle over property rights, the structure of existing regulations does not seem to have created any significant impediments to trading. In the cases of emissions trading and the Fox River program, existing regulations have been used by environmentalists and industry, respectively, to decrease or increase opportunities for trading.\(^2\)

The existing legal framework may not only be used by regulators to influence new policy decisions, but may in some instances be invoked by environmental and industry interest groups as well. The treatment of new emission sources provides the clearest example of interest groups using the existing legal framework to their advantage. Environmentalists have been largely successful in using the stringent emission limits that apply to new sources under the Clean Air Act to limit trading by those sources under the emissions trading program. As a result, new major sources of emissions must meet the stringent limits that apply to them through emission reductions rather than through the acquisition of emission credits.\(^2\) Another instance of this success is reflected in the trading ratios for offsets. By setting a ratio greater than unity, offsets become an instrument for improving, rather than worsening, the environment.\(^2\)

In general, industry has been less successful in pressing regulators for greater latitude for new sources to use trading, but has had a notable success in the case of netting. The legality of netting hinges on the tech-

\(^{224}\) The complexity of this struggle cannot be fully conveyed in the brief treatment given here. It has involved not only changes in regulations, but extensive court battles between industry and environmentalists, with EPA usually the object of the ire of both. For a more detailed description, see R. Lithoff, supra note 46, at 105-34.

\(^{225}\) See supra Table 1 and accompanying text.

technical definition of the term "source" as used in the Clean Air Act. Because EPA has allowed a "source" to be defined as an entire plant containing many individual emission points, with an aggregate emission limit applying to it, netting can be used to avoid, in large part, the permitting process even when significant additions of emissions sources are made within a plant (provided that they are accompanied by comparable emission reductions). As shown in the performance evaluation of emissions trading, netting has been used extensively by industry.

The course of this struggle between industry and environmentalists over the use of emissions trading by new sources has largely been determined by the structure of previously existing regulations and legislation. The rules governing emissions trading were not cut from whole cloth, but rather were fashioned by adding relatively few new provisions to an incredibly complex set of regulations. This incrementalism has had a major influence on the performance of the program.

Another important set of factors that shapes the selection of instruments is the set of available technologies for monitoring and enforcement. Questions about the ability to monitor emissions have played an important role in the design of emissions trading policies. Monitoring emissions of air pollutants is a difficult task for regulators. Continuous monitoring often is infeasible due to technological and economic constraints. Regulators usually are reduced to estimating emissions based on assumptions about the typical parameters of a manufacturing process, about operating hours, and about the effectiveness of pollution control equipment. Absent trading, the difficulty of monitoring emissions creates uncertainty about the permit limits necessary to attain ambient air quality standards. When trading is introduced into the regulatory system, however, the difficulty of monitoring emissions creates ambiguities about the property rights to which firms are entitled and whether those property rights are "in use" or available for trading. One response to these difficulties has been an increase in the complexity of administrative requirements intended to resolve these ambiguities. As already shown, however, these requirements increase transaction costs and reduce trading.

Technological limits on monitoring ability have affected the three non-emission marketable permit programs to varying degrees. For the Fox River program, they are not a significant constraint. Monitoring discharges from point sources of water pollution is relatively straightforward. For the Dillon Reservoir program, the problem is not in monitoring point sources, but rather the nonpoint sources that are anticipated to provide most or all of the rights which will be acquired by point sources.

228. DAMES & MOORE, supra note 83.
The 2:1 trading ratio for point/nonpoint trading is designed to counteract uncertainty about the effectiveness of nonpoint source controls.\textsuperscript{229} If nonpoint sources could be monitored more effectively, this ratio could be lowered without jeopardizing water quality. In the case of lead rights trading, monitoring was accomplished through audits of reports from refiners, comparisons of reported lead use to sales of lead additives, and tracing of transactions between refiners.\textsuperscript{230}

The analysis of the different market-based programs reveals that the performance of these programs is consistent with economic theory. Nonetheless, the factors shaping this performance are largely outside the scope of traditional economic analysis. The economic, political, institutional, and technological factors identified here all have the potential to have a major impact on both the structure and performance of markets. If effective instruments, the performance of which can be reliably anticipated, are to be chosen and designed in the future, an expanded theory of instrument choice that encompasses these factors must be developed.

IV
CONCLUSIONS AND AREAS FOR FUTURE RESEARCH

Studies of the potential for the use of marketable permit programs have tended to focus on issues related to potential efficiency gains associated with smoothly functioning markets. The implicit assumption has been that, if potential cost savings are sufficiently great and market power is not concentrated, the allocation of property rights will be sufficient to set the market in motion. The present examination of the marketable permit programs that have been introduced in the United States shows that there are several crucial factors that affect the performance of these programs. Moreover, these factors are integrally related to the politics surrounding the design of new market approaches. Two of these factors arise from the rules governing trading of permits. The first is restrictions on trading. As restrictions increase, trading activity decreases. These restrictions may apply to certain classes of rights or to particular types of sources of emissions. They may also be more subtle, such as the de facto accordance of inferior status to some rights. The treatment of banked rights under the emissions trading program is an example of this type of less obvious restriction on trading.

A second factor influencing program performance is how administrative requirements for trading affect transaction costs. When these requirements are especially complex or impose major informational burdens on firms, transaction costs increase and trading decreases. It is important to recognize that the amount of transaction costs imposed on

\textsuperscript{229} COLO. COUNCIL OF GOVERNMENTS, \textit{supra} note 185, at 6.
\textsuperscript{230} Nussbaum interview, \textit{supra} note 142; Kozlowski interview, \textit{supra} note 146.
firms is not necessarily related to the level of government that has primary responsibility for implementing the policy. For example, state programs can be cumbersome, as the Fox River program is, or relatively straightforward and effective, as some state bubble programs seem to be. The critical factor is not the level of government at which programs are administered, but rather the amount of “red tape” involved.

Technological factors that affect ease of monitoring also affect the performance of marketable permit programs in the environmental area. If monitoring is difficult, then the measurement and allocation of property rights are also likely to be difficult, controversial and expensive. Because this is likely to cause regulators to impose additional regulatory requirements on trading of rights, increased difficulty of monitoring will generally be associated with decreases in trading.

Another factor affecting performance—one that will necessarily differ for each marketable permit program—is the existing legal and institutional structure. Each of the programs examined here was an addition to an existing regulatory program. The structure and rules of the existing program had a major impact on the allocation of property rights in permits and on the complexity of the marketable permit system. Although it is difficult to make reliable generalizations from only four cases, it seems that complex regulatory systems, such as that for regulating air emissions from stationary sources, do not lend themselves well to the use of marketable permits. Simpler programs, such as that for limiting the lead content of gasoline, are better suited to a market-based approach.

The impact of these factors is determined by the preferences of various interest groups. A simple model of interactions between industry, environmentalists, and regulators helps to explain many of the important dimensions of policy formation. The degree of agreement between these groups on environmental quality targets is one crucial determinant of interest group influence. When agreement is high, conflicting pressures on regulators from industry and environmentalists will be minimized. When agreement is low, conflicting pressures are likely to lead to complex rules which incorporate significant restrictions on trading and administrative requirements which inhibit trading.

These results suggest the need for an expanded theory of instrument choice that can accommodate political and technological factors. The

231. Reducing sulfur oxides emissions from acid rain also represents a relatively simple application from the standpoint of writing new legislation. SOx emissions are relatively easy to monitor, and electric utilities account for over half of the total emissions. Utilities, however, cannot necessarily be assumed to behave as cost minimizers in trading permits to emit sulfur oxides emissions. See generally Hahn & Noll, Barriers to Implementing Tradable Air Pollution Permits: Problems of Regulatory Interaction, 1 YALE J. ON REG. 63 (1983), who argue that these issues can be resolved with the help of the public utility commissions. Of course, such help cannot be assumed, in which case some form of federal preemption may be required to encourage utilities to engage in trades that help lead to a cost-effective solution.
theory could benefit from a careful examination and comparison of different instruments which have actually been applied. In addition to drawing on environmental applications, it may be useful to draw on experience from other areas such as the use of marketable permits in fisheries, taxi medallions, and airport slots. An important question for future research is to understand the extent to which the basic interest group paradigm we have suggested generalizes to other applications. The time is ripe to construct a more complete theory of the conditions under which different policy instruments are likely to be selected. Only then will social scientists begin to have a better appreciation of the likely effectiveness of market-based instruments in real world settings.