
**Tradable Permit Approaches to Pollution Control:
Faustian Bargain or Paradise Regained?**

by

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INTRODUCTION

One of the central tenets of a property rights approach to environmental protection holds not only that people respond to incentives, but also that the structure of entitlements conveyed by property rights affects incentives. It follows that a careful study of entitlements in various environmental contexts can provide a foundation for greater understanding about why human behavior can be so environmentally destructive. Perhaps even more importantly, however, it also provides a basis for changing the environmentally destructive incentives by changing the entitlements.

One rather unique use of a property rights approach to environmental protection has been its introduction into air pollution control policy. This approach, which I shall generally refer to as emissions trading, modifies the entitlements conveyed by the permits that are used as the legal basis for controlling emissions of certain air pollutants. These permits specify the legal conditions that a facility must meet if it is to continue operating legally. One of the conditions typically involves a limit on the amount of authorized emissions.

The property rights approach simply makes these emission-control responsibilities transferable among sources. Transfers may be possible between discharge points within the same facility or even between facilities as long as they meet prespecified conditions designed to assure that the environmental impact from the transfer is negligible or beneficial. Simply introducing transferability enlists market forces in the quest for cost-effective pollution control. It offers the potential for substantially lowering costs and for encouraging technological progress.

The idea of using the market to protect the environment has become almost a fad in U. S. policy circles and it has already spread to Latin America, Africa and the Far East. (Dudek, Stewart et al. 1992; Jenkins and Lamech 1992; National Academy of Public Administration 1994; O'Ryan 1996; Hockenstein, Stavins et al. 1997; Klaassen and Nentjes 1997) Using the market to protect the environment is clearly an idea whose time has come. And the particular form of market-based approaches that shall serve as the focus in this essay, the use

of a transferable permits approach to air pollution control, is in some ways the most visible of these approaches.

Not everyone is cheering this shift in direction (Goodin 1994; Beder 1996). In less enthusiastic circles using the market to protect the environment is treated as roughly akin to showing up with the Devil for communion. Since the market is seen by deep ecologists, among others, as the source of most environmental problems, using the market to solve them seems to them to be a form of ideological suicide.

I believe it is possible to make the case that both groups are wrong. Market-based approaches are useful in some, but not all, circumstances. They should neither be universally vilified nor put on a pedestal.

Market based-approaches are in the midst of what has become known in public policy circles as the "pendulum effect". While experts in the field used to spend much of our time trying to convince reluctant policy makers that market-based approaches had merit, experts now spend much of our time convincing (in many cases the same!) legislators that these approaches are not panaceas. Market-based approaches cannot solve all environmental problems with little or no sacrifice.

In this essay my objective is to trace the evolution of this approach to air pollution control from its earliest inception to recent developments. This evolution is used to show how the programs have changed over time in response to both changing circumstances and the lessons derived from the successes and failures of earlier experiences.

DESCRIBING THE EVOLUTION

Traditional Policy

To understand the nature of the new approach it is important first to understand the policy environment that gave rise to it. Air pollution policy in the United States was, and is, designed to assure that people and ecosystems are protected from harmful levels of pollution by promulgating ambient air quality standards, which specify the permissible legal thresholds for concentrations of pollutants in the ambient air, and by establishing a process for reaching those standards.

The traditional approach for improving air quality so as to bring it into conformance with the ambient standards typically involved picking desirable control technologies, using those technologies to specify permission emission limits, and forcing emitters to live within those limits. The government authority performed all of these roles.

In the early 1970's a group of experts from the academic community suggested that it might be possible to improve upon this system by allowing firms to trade control responsibility among themselves by means of a transferable permit system. In this way firms that could control emissions relatively cheaply would voluntarily control more, selling the excess control to those that, for economic reasons, wanted to control less. The initial analysis suggested that the command-and-control policy was very cost-ineffective. (Atkinson and Lewis 1974; Tietenberg 1974) Subsequent analyses involving several different pollutants in several different regions found that the initial empirical results were robust; the control costs from command-and-control allocations were estimated to exceed least cost allocations by a substantial margin. [Seskin, 1983; Roach, Kolstad et al. 1981; Atkinson and Tietenberg 1982; Krupnick, Oates et al. 1983; Maloney and Yandle 1984; McGartland and Oates 1985)] This offered the possibility that the increased flexibility made possible by the reform would lower control costs substantially while assuring that the environmental target was met.

The Offset Policy: The Problem Becomes the Solution

The political opportunity to capitalize on the insights generated by that empirical research came in 1976. By 1976 it had become clear that a number of regions, designated "nonattainment" regions by the Clean Air Act, would fail to attain the ambient air quality standards by the deadlines mandated in the Act. The statute mandated improvements in air quality in these regions and further economic growth appeared to make the air worse, contrary to the intent of the statute. EPA was faced with the unpleasant prospect of prohibiting many new businesses (those which would emit any of the pollutants responsible for nonattainment in that region) from entering these regions until the air quality came within the standards. New sources of these pollutants would make the air quality worse not better and EPA was required to make it better.

Prohibiting economic growth as the means of resolving air quality problems was politically very unpopular among governors, mayors, and many members of Congress. EPA had a potential revolution on its hands. At this point they began to consider alternatives out of necessity. Was it possible to solve the air quality problem while allowing further economic growth?

It was possible as it turns out and the means for achieving these apparently incompatible objectives involved the creation of a transferable permit system. Sources of the pollution that were already located in the nonattainment area were encouraged to voluntarily reduce their emission levels below their current legal requirements. The EPA could then certify these excess reductions as "emission reduction credits". Once certified by the control authority these credits then become transferable to new sources that wished to enter the area.

New sources were allowed to enter nonattainment regions providing they acquired sufficient emission reduction credits (representing excess reductions) from other facilities in the region that total regional emissions would be lower (not the same!) after entry than before. (This was accomplished by requiring new sources to secure credits for 120% of the emissions they would add; the extra 20% would be retired as an improvement in air quality.) Known as the "offset policy," this approach not only allowed economic growth while improving air quality, the original objective, it made economic growth the vehicle for improving the air. It turned the problem on its head and made the problem part of the solution (Tietenberg 1985; Hahn and Hester 1989b).

Getting the Lead Out: The Lead Phaseout Program

Following the path blazed by the offset program, the government began applying the tradable permit approach more widely. One prominent use involved facilitating the regulatory process for getting lead out of gasoline. (Hahn and Hester 1989a; Nussbaum 1992; Kerr and Maré 1997)

In the mid-1980's prior to the issuance of new, more stringent regulations on lead in gasoline, EPA announced the results of a cost/benefit analysis of their expected impact. The analysis concluded that the proposed .01 grams per leaded gallon (gplg) standard would result in \$36 billion (\$1983) in benefits (from reduced adverse health effects) at an estimated cost to the refining industry of \$2.6 billion.

Although the regulation was unquestionably justified on efficiency grounds, EPA wanted to allow flexibility in how the deadlines were met without increasing the amount of lead used. While some refiners could meet early deadlines with ease, others could do so only with a significant increase in cost. Recognizing that meeting the goal did not require every refiner to meet every deadline, EPA initiated an artificial market in the rights to use lead in gasoline to provide additional flexibility in meeting the regulations.

Under this program a fixed amount of lead rights (authorizing the use of a fixed amount of lead over the transition period) were allocated to the various refiners. Refiners who did not need their full share of authorized rights (due to early compliance) could sell their rights to other refiners.

Refiners had an incentive to eliminate the lead quickly because early reductions freed up rights for sale. Acquiring these credits made it possible for other refiners to comply with the deadlines, even in the face of equipment failures or Acts of God; fighting the deadlines in court, the traditional response, was unnecessary. Designed purely as a means of facilitating the transition to this new regime, the lead banking program ended as scheduled on December 31, 1987.

Some features of this program are noteworthy. First, it resulted in a much earlier phase out of lead than would have traditionally be possible because of the inter-refinery flexibility it offered. The traditional approach, setting the deadline late enough to allow the refinery facing the most difficult compliance problems to meet it, would have resulted in a great deal more lead being injected into the air. And, as the benefit/cost analysis persuasively demonstrated, the health consequences of ambient lead were severe, particularly on children. Second, this program was designed to eliminate a pollutant, not merely place an upper limit on its annual use. That is a rather unique policy setting.

Reducing Ozone-Depleting Chemicals

Responding to the threat to the ozone shield, 24 nations signed the Montreal Protocol during September 1988. According to this agreement signatory nations were to restrict their production and consumption of the chief responsible gases to 50% of 1986 levels by June 30, 1998. Soon after the protocol was signed, new evidence suggested that it had not gone far enough; the damage was apparently increasing more rapidly than previously thought. In response, 59 nations signed a new ozone agreement at a conference in London in July 1990. This agreement called for the complete phaseout of halons and CFCs by the end of this century. Moreover two other destructive chemicals--carbon tetrachloride and methyl chloroform--were added to the protocol and are scheduled to be eliminated by 2000 and 2005, respectively.

The United States has chosen to use a transferable permit system to implement its responsibilities under the protocols. On August 12, 1988 the U.S. Environmental Protection Agency issued regulations implementing a tradable permit system to achieve the targeted reductions. According to these initial regulations all major U.S. producers and consumers of the controlled substances were allocated baseline production or consumption allowances using 1986 levels as the basis for the proration. Each producer and consumer is allowed 100% of this baseline allowance initially, with smaller allowances being granted after predefined deadlines. Following the London conference these percent-of-baseline allocations were reduced to reflect the new deadlines and limits.

These allowances were transferable within producer and consumer categories. Allowances can be transferred across international borders to producers in other signatory nations if the transaction is approved by EPA and results in the appropriate adjustments in the buyer or seller allowances in their respective countries.¹

Production allowances can be augmented by demonstrating the safe destruction of an equivalent amount of controlled substances by approved means. Some inter-pollutant trading is even possible within categories of pollutants. (The categories are defined so as to group pollutants with similar environmental effects). All information on trades is confidential (known only to the traders and regulators) so it is difficult to know how effective this

program has been. One estimate suggests that as of September 1993 the traded amount was roughly 10% of the total permits (Stavins and Hahn 1993).

Since the demand for these allowances is quite inelastic, the supply restrictions imposed by this program increased revenue. By allocating allowances to the seven major domestic producers of CFCs and halons, EPA created sizable windfall profits (estimated to be in the billions of dollars) for those producers. A revenue-starved Congress seized the opportunity by imposing a tax to soak up the rents created by the regulation-induced scarcity. The Revenue Reconciliation Act of 1989 includes an excise tax imposed on all ozone-depleting chemicals sold or used by manufacturers, producers or importers of these chemicals. The tax is imposed at the time the importer sells or uses the affected chemicals. It is computed by multiplying the chemical's weight by the base tax rate and the chemical's ozone depletion factor. In addition to soaking up some of the regulation-induced scarcity rent, this tax provides incentives to switch to less harmful (and therefore untaxed) substances.

This application was unique in two senses. It not only allowed international trading of allowances, but it involved the simultaneous application of permit and tax systems.

Tackling Acid Rain: The Sulfur Allowance Program

The most sophisticated version of a tradable permits approach to date has been incorporated into the U. S. approach for achieving further reductions in those electric utility emissions contributing to acid rain. Under this innovative approach allowances to emit sulfur oxides have been allocated to older plants; the number of allowances will be restricted in two phases to assure a reduction of 10 million tons in emissions from 1980 levels by the year 2010 (GAO 1984; Kete 1992; Rico 1995; Burtraw 1996; Conrad and Kohn 1996; Ellerman, Schmalensee et al. 1997; Klaassen and Nientjes 1997).

Perhaps the most interesting political aspect of this program is its role in the passage of the acid rain bill. Though reductions of acid rain precursors had been sought with a succession of bills over the two decades of Clean Air Act legislation, none had been able to become law. With the inclusion of a tradable permits program for sulfur in the bill, the compliance cost was reduced sufficiently to make passage politically possible.

Sulfur allowances form the heart of the tradable permit program. The total number of sulfur allowances is limited and is ultimately reduced to achieve the 10 million ton reduction. The allowances are allocated to identified utilities on the basis of an allocation formula.

Each allowance, which provides a limited authorization to emit one ton of sulfur, is defined for a specific calendar year, but unused allowances can be carried forward into the next year. They are transferable among the affected sources. Any plants reducing emissions more than required by the allowances could transfer the unused allowances to other plants. Emissions may not legally exceed the levels permitted by the allowances (allocated plus acquired). An annual year end audit balances emissions with allowances. Utilities that emit more than authorized by their holdings of allowances must pay a \$2000 a ton penalty and are required to forfeit an equivalent number of tons in the following year.

This program has several innovative features, but to conserve space I will mention only two. The first important innovation in this program was assuring the availability of allowances by instituting an auction market. These allowances can either be transferred by private sale or in the annual auction. Historically the problem with the private sale route was that prices were confidential so transactors were operating in the dark. Transactions costs were high so the market did not work very well.

EPA wanted to solve this problem by instituting an auction market run by the Chicago Board of Trade. Utilities fought the idea of an auction because they knew it would raise their costs significantly. Whereas under the traditional policy they would be given the allowances free of charge, under a traditional auction they would have to buy these allowances at the full market price.

To gain the advantages an auction offers for improving the efficiency of the market while not imposing a rather large financial burden on utilities, EPA established what has now become known as a zero revenue auction. Each year the EPA withholds somewhat less than 3% of the allocated allowances to go into the auction. Withheld permits are allocated to the highest bidders with successful buyers paying their bid price. The proceeds are refunded to the utilities from which the allowances were withheld on a proportional basis.

Private allowance holders may also offer allowances for sale at these auctions. Potential sellers specify minimum acceptable prices. Once the withheld allowances have been disbursed EPA then matches the highest remaining bids with the lowest minimum acceptable prices on the private offerings and matches buyers and sellers until all remaining bids are less than the remaining minimum acceptable prices. Although this auction design is not efficient because it provides incentives for inefficient strategic behavior (Hausker 1992; Cason 1993), the degree of inefficiency is apparently small. (Ellerman, A. D., R. Schmalensee, et al. 1997)

A second innovation in this program is that it allows anyone to purchase allowances. This means environmental groups or private citizens can buy them for the purpose of retiring them. Since retired allowances represent authorized emissions, which are never emitted, they result in cleaner air. Many of my students have purchased allowances on the internet to give to their parents for Christmas or birthdays.

RECLAIM: The States Take the Initiative

All of the previous programs were initiated by the federal government. The states were primarily involved as the enforcers of the federal programs, but that changed in 1994. Faced with the need to reduce pollutant concentrations considerably in order to come into compliance with the ambient standards, states have chosen to use trading programs as a means of facilitating rather drastic reductions in emissions.²

One of the most ambitious of these programs, and the one I will focus on in this section, is California's Regional Clean Air Incentives Market (RECLAIM) established by the South Coast Air Quality Management District, the district responsible for the greater Los Angeles area (Goldenberg 1993; Fromm and Hansjurgens 1996; Hall and Walton 1996; Johnson and Pekelney 1996).

Under RECLAIM, each of the almost 400 participating industrial polluters are allocated an annual pollution limit for nitrogen oxides and sulfur, which will decrease by 5% to 8% each year for the next decade. Polluters are allowed great flexibility in meeting these limits, including purchasing credits from other firms which have controlled more than their legal requirements.

In an important sense the RECLAIM program changes the nature of the regulatory process. The burden of identifying the appropriate control strategies has been shifted from the control authority to the polluter. In part this shift was a necessity³, and was in part motivated by a desire to make the process as flexible as possible.

As a result of the flexibility which become possible from this shift in the burden of choosing appropriate responses, many new control strategies are emerging. Instead of the traditional

focus on end-of-pipe control technologies, pollution prevention has been given an economic underpinning by this program. All possible pollution reduction strategies can, for the first time, compete on a level playing field.

Climate Change

The possibility of using emissions trading in controlling greenhouse gases was established by the Climate Change Convention, which went into force on March 21, 1994. Though that Convention did not specifically authorize emissions trading, it did express a preference for cost-effective approaches.

Specific authorization for emissions trading of greenhouse gases came from the Kyoto Protocol to the convention. The principal accomplishment of the December 1997 Conference of Parties in Kyoto, Japan was the establishment of fixed quantitative reductions in greenhouse gases⁴ for 38 nations and the European Community. The reductions, which are relative to 1990 emission levels, are to be achieved by 2012 and expected to produce a global reduction of 5.2% from 1990 levels or 30% from levels that would have been expected by 2010.

The Kyoto Protocol authorizes four rather different types of emissions trading. Article 17 (the “emissions trading” article) authorizes the trading of “assigned amounts” (AAs) among the Annex B nations and clearly offers the greatest potential to take advantage of the benefits of a trading program. Articles 6 and 12 authorize the case-by-case creation of emission reduction credits (ERCs) by Annex I (industrialized) nations and certified emission reductions (CERs) by non-Annex I (developing) countries respectively.⁵ Article 4 authorizes “bubbles”. Although originally conceived as a way of allowing the European Community to accommodate its internal burden sharing of the Kyoto commitments among its member states, the final wording of the Article is framed in general terms. It allows a group of Annex I countries to jointly fulfil their commitments under Article 3, provided that their total combined aggregate GHG emissions do not exceed their assigned amounts. A bubble must be declared when the ratification is deposited.

Exactly how those four rather different types of emissions trading programs will be implemented remains to be defined by the Parties to the convention. The process for defining the exact procedures will begin at the Buenos Aires meetings in November 1998. Much of the groundwork for that discussion has been laid by a series of reports funded by the United Nations Conference on Trade and Development (Tietenberg 1992a; Tietenberg 1992b; Tietenberg and Victor 1994; United Nations Conference on Trade and Development, 1998).

THE EVOLUTION OF DESIGN FEATURES

Defining the Tradable Commodity

An important source of controversy in the tradable permits program was the definition of the tradable right. Economists have consistently argued that these permits should be treated as secure property rights to protect the incentive to invest in pollution control equipment. Confiscation of rights could undermine the entire process.

The environmental community, on the other hand, has just as consistently argued that the air belongs to the people and it, as a matter of ethics, should not become private property. (Kelman, 1981a) According to this view the ends cannot justify the transfer of a community right into a private one; the right to a reasonable level of clean air is seen as inalienable.

The practical resolution of this matter involved providing some security to the permit holders, while making it clear that it was not a property right. According to the Clear Air Act:

An allowance under this title is a limited authorization to emit sulfur dioxide.... Such allowance does not constitute a property right.⁶

In practice this means that administrators are expected to recognize the security needed to protect control investments. However their ability to change control requirements as the need arises will not be inhibited by the need to pay compensation for withdrawing a portion of the authorization to emit. It is a somewhat uneasy compromise.

Credit Denomination

The original Emissions Trading Program was based on a system of credits which were typically denominated in terms of a pollutant flow such as tons/year. The newer programs are based on allowances defined in discrete terms (for example, “tons” rather than “tons per year”). While the former confers a continuing entitlement to a flow, the latter is a one-time entitlement to emit one ton. Once the authorized ton has been emitted, the allowance is surrendered. Authorizing additional emissions requires the issuance of new allowances. In general this is done well in advance according to specific schedules so emitters have reasonable security for pollution control investment planning. Allocating allowances in advance has also facilitated the development of futures markets.

One of the big differences between allowances and credits involves the capacity for allowances to accommodate the creation and transfer of discrete emission reductions. One of the original criteria used by EPA for approving credits was that the emission reductions supporting them should be “permanent”. Many useful strategies to reduce emissions, such as meeting a deadline early, produce temporary, rather than permanent, reductions. (As noted above the ability to set an earlier deadline in the Lead Phaseout Program was made possible by the flexibility inherent in an allowance program.) Allowance programs encourage both permanent and temporary reductions.

Baseline

Credit trading, the approach taken in the bubble and offset policies, allows emission reductions above and beyond legal requirements to be certified as tradable credits. The baseline for credits is provided by traditional technology-based standards. Credit trading presumes the preexistence of these standards and it provides a more flexible means of achieving the aggregate goals that the source-based standards were designed to achieve.

Allowance trading, used in the Acid Rain Program and RECLAIM in California, assigns a prespecified number of allowances to polluters. Typically the number of issued allowances declines over time and the initial allocations are not necessarily based on traditional technology based standards; in most cases the aggregate reductions implied by the allowance allocations exceed those achievable by standards based on currently known technologies.

Despite their apparent similarity the difference between credit and allowance-based trading systems should not be overlooked. Credit trading depends upon the existence of a previously determined set of regulatory standards. Allowance trading does not. Once the aggregate number of allowances is defined, they can, in principle, be allocated among sources in an infinite number of ways. The practical implication is that allowances can be used even in circumstances: (1) where a technology-based baseline either has not been, or cannot be, established or (2) where the reduction is short-lived (such as when a standard is met early) rather than permanent.

Caps

Allowances and credits differ in another significant way. Allowances systems set a cap on aggregate emissions that cannot be eroded by economic growth. This characteristic is not shared either by traditional technology-based, source-specific emission standards or, in the absence of other constraints, by an emission credit system that is linked to technology-based standards. Because emission standards are source-specific, they exert no control over the aggregate amount of emissions from all sources. As the number of sources increases, the aggregate level of emissions increases. As a consequence credit trading, which is based on these source-specific standards, will also allow aggregate emission increases unless some additional constraint is built into the system.

In the U. S. the additional constraint was requiring all new or expanding sources in nonattainment areas to offset all emission increases by acquiring sufficient credits from existing emitters that air quality would improve as a result of their entering the area or expanding their operations. No such constraint was mandatory in attainment areas so credit trading provided no protection from emission increases in those areas as the number of sources increased.

Allocation Method

In principle entitlements could either be auctioned off, with the sources purchasing them from their respective governments at the market-clearing price (Lyon 1989; Lyon 1990), or distributed to each source on the basis of some allocation rule (typically, but not inevitably, historical use). Only a transferable permit system that allocates permits free of charge to sources on the basis of their historic emission rate would guarantee that existing sources would be no worse off than they would under a command-and-control system imposing the same degree of control. The financial outlays associated with acquiring allowances or credits in a traditional auction market (or, a comparable emissions charge) would be sufficiently large that sources would typically have lower financial burdens with the traditional command-and-control approach than with these particular economic incentive approaches (Palmer, Mooz et al. 1980; Atkinson and Tietenberg 1982; Lyon 1982; Harrison 1983; Seskin, Anderson et al. 1983; Shapiro and Warhit 1983; Atkinson and Tietenberg 1984).

From the point of view of the source required to control its emissions, two components of financial burden are significant: (1) control costs and (2) expenditures on permits. While only the former represent real resource costs to society as a whole (the latter are merely transfers from one group in society to another), both represent a financial burden to the source. The empirical evidence suggests that when a traditional auction market is used to distribute permits (or when all uncontrolled emissions are subject to an emissions tax), the permit expenditures (tax revenue) would represent a considerable additional financial burden. Indeed the financial outlays would frequently be larger in magnitude than the control costs; the sources would spend more on permits (or pay more in taxes) than they would on the control equipment (Tietenberg 1985). This characteristic is one factor inhibiting the adoption of these approaches within the United States.

Under the traditional command-and-control system, firms make no financial outlays to the government. Control costs are necessarily higher with the command-and-control system than with a marketable permit system. However they are not automatically so high as to outweigh the additional financial outlays required in an auction market permit system (or an emissions tax system) For this reason existing sources understandably normally oppose distributing permits by a traditional auction market despite its social appeal. The one exception seems to occur when the revenue derived is used in a manner that is approved by the sources and the sources with which it competes are required to absorb similar expenses.

In the absence of either a politically popular way to use the revenue or assurances that competitors will face similar financial burdens, this political opposition could be substantially reduced by distributing the permits free-of-charge to existing sources. Though an infinite number of possible distribution rules exist, “grandfathered” rules tend to predominate. Grandfathering refers to an approach that gives some priority to existing firms. Under grandfathering, existing sources only have to purchase any additional permits they may need over and above the initial allocation (as opposed to purchasing all permits in an auction market).

Although politically the easiest path to sell, grandfathering has its disadvantages. Although reserving some permits for new firms is possible, this option is rarely exercised in practice. As a result under the free distribution scheme new firms typically have to purchase all permits, while existing firms get an initial allocation free. Thus the free distribution system imposes a bias against new sources in the sense that their financial burden is greater than that of an otherwise identical existing source, even if the two sources install exactly the same emission control devices. This new source bias has retarded the introduction of new facilities and new technologies by reducing the cost advantage of building new facilities that embody the latest innovations (Maloney and Brady 1988; Nelson, Tietenberg et al. 1993).

Shifting the Payoff

The demonstration that the traditional regulatory policy was not cost-effective had two mirror-image implications. It either implied that the same air quality goals could be achieved at lower cost or that better air quality could be achieved at the same cost. While the earlier programs were designed to exploit the first implication, later programs attempted to produce better air quality and lower cost.⁷

Trading programs were used to produce better air quality in many ways. The lower costs offered by trading were used in initial negotiations to secure somewhat more stringent pollution control targets (Acid Rain Program and RECLAIM) or earlier deadlines (Lead Phaseout Program). Offset ratios for trades in nonattainment areas were set at a ratio greater than 1.0 (implying a portion of each acquisition would go for better air quality).

Environmental groups are allowed to purchase and retire allowances (Acid Rain Program). This shift toward sharing the benefits between environmental improvement and cost reduction has had two consequences. The cost savings are lower than they would have been without this benefit sharing, but the public support, and particularly the support from environmental organizations, has been increased a great deal. Politically this means that it is now easier to implement trading programs because the potential common ground has been expanded.

Substitutes or Complements for Traditional Regulation?

The earliest use of the tradable permit concept, the Emissions Trading Program, overlaid credit trading on an existing regulatory regime and was designed to facilitate implementation of that program. Trading baselines were determined on the basis of previously established, technology-based standards and created credits could not be used to satisfy all of these standards. In some cases the requisite technology had to be installed.

More recent programs, such as the Acid Rain and RECLAIM programs, replace, rather than complement, traditional regulation. Allowance allocations for these programs were not based on preexisting technology-based standards. In the case of RECLAIM the control authority (the South Coast Air Quality Management District) could not have based allowances on predetermined standards even if they had been inclined to do so. Defining a complete set of technologies which offered the necessary environmental improvement (and yet were feasible

in both an economic and engineering sense) proved impossible. Traditional regulation was incapable of providing the degree of reduction required by the Clean Air Act.

The solution was to define a set of allowances which would meet the environmental objectives, leaving the choice of methods for living within the constraints imposed by those allowances up to the sources covered by the regulations. This approach fundamentally changes the nature of the control process. The historical approach involved making the control authority responsible not only for defining the environmental objectives and performing the monitoring and enforcement activities necessary to assure compliance with those objectives, but it was also assigned the responsibility for defining the best means for reaching those objectives. The allowance program transfers the last of these responsibilities to the private sector, while retaining for the public sector both the responsibility for defining the environmental target and performing the monitoring and enforcement function.

RESOLVING IMPLEMENTATION PROBLEMS

Certain design issues reoccur in establishing any tradable permits system. How these issues have been dealt with has depended on the particular context within which they have arisen, but it also has been shaped by experience gained in the earlier programs.

Transactions Costs

One aspect that has affected the effectiveness of tradable permit markets involves the costs of completing transactions. They include the costs of finding an appropriate trading partner, establishing the terms of the trade, and completing the arrangements.

Standard theory makes it clear that in the absence of transactions costs permit markets can reallocate control responsibility such that the control is achieved at minimum cost. (Baumol and Oates 1971; Montgomery 1972) At any point in time remaining lower cost control options create trading opportunities. The desire to lower private costs provides an incentive to exploit all of these opportunities. When all such opportunities have been exploited, the minimum cost-effective allocation has been achieved.

When transactions costs become significant, however, permit markets may not be fully cost-effective (Stavins 1995). In essence the existence of transactions costs prevents some cost-saving trades from taking place.

Transactions costs also affect the ability of governments to use permit markets to simultaneously pursue efficiency and equity goals (Stavins 1995). In the absence of transactions costs, permits can be allocated in an infinite number of ways without disturbing the ability of the system to achieve a cost-effective allocation of control. (Any initial deviations from the least cost allocation are corrected by trading). With transactions costs, the degree of cost/effectiveness becomes functionally related to the initial allocation. When transactions costs are significant, pursuing a "fair" initial allocation of permits may extract a cost-effectiveness penalty.

Despite a paucity of information most observers of the Emissions Trading Programs in the late 1980s agreed that fewer trades took place than necessary to achieve full cost-effectiveness and that high transactions costs played a role in explaining this shortcoming (Dudek and Palmisano, 1988; Hahn 1989; Hahn and Hester 1989a; Hahn and Hester 1989b; Tietenberg 1990). Confirming anecdotal evidence for the significance of transactions costs can be found in the predominance of "internal" (within firm) transfers over "external" (between firm) transfers. Further evidence is suggested by the predominance of trades involving uniformly mixed pollutants (which don't require additional air quality impact

simulations as a condition of approval) and the important role played by brokers in the process. Subsequent empirical analysis (Foster and Hahn 1995) has confirmed these initial observations.

Even the Lead Phaseout Program, which is usually advanced as an early example of a well functioning tradable permits market (Hahn and Hester 1989a), was also plagued (albeit to a much lower degree) by the existence on nonnegligible transactions costs. One econometric analysis (Kerr and Maré 1997) suggests that transactions costs produced efficiency losses due to unexploited trades and to the direct cost of transactions on the order of 10%. Smaller refineries, refineries that were not part of large companies, and refineries that did not have other refineries to trade with within the company seemed to be particularly inhibited from trading by transactions costs.

Neither the Emissions Trading Program nor the Lead Phaseout Program were consciously designed to minimize transactions costs. Later programs have attempted to incorporate design features that reduce transactions costs.

One prime example was the auction market established as part of the sulfur allowance program.⁸ This market reduced transactions costs not only by providing an easy means for buyers and sellers to transact, but also by providing (for the first time) systematic public information on prices. Better information on prices to buyers and sellers should have the effect of lowering the spread between the highest bid and the clearing price. It has. The spread has dropped considerably from \$319 (in 1993) to \$14 (in 1997) indicating the effect of public knowledge of price information.⁹

The greater availability of data on prices and the nature of trades benefits researchers as well as buyers and sellers. These data have facilitated the construction of econometric models to isolate the consequences of transactions costs. One study (Montero 1997) confirms that in the sulfur allowance program trading activity can be completely explained by conventional economic variables, hence the role of transactions costs seems to be fairly small.

Interestingly the RECLAIM system, which was also established in the 1990's, has apparently not yet been as successful in reducing transactions costs. Though it is a bit early to judge its ultimate effectiveness, a computer system set up to provide an easy means of trading has not been utilized to the expected extent (Gangadharan 1997).

An econometric study (Gangadharan 1997) on the RECLAIM NO_x market finds that both search and information cost variables explain the likelihood of being a buyer of credits in an ordered probit model. The author also finds, however, specific "learning by doing" effects in this market. In particular the results suggest that increasing the number of times a facility enters the market reduces information costs until a certain point (15 trades) is reached. After that point further increases in the number of trades seem to have no affect in reducing information costs further.

Coping With Spatial Issues

Transferable permits seem to have worked particularly well for trades involving uniformly mixed pollutants (those for which only the level of emissions matters) and for trades of nonuniformly mixed pollutants (those for which emission location also matters) involving contiguous discharge points. The plurality of consummated trades in the Emissions Trading Program have involved uniformly mixed pollutants (Tietenberg 1985). Since dispersion modeling is not required for uniformly mixed pollutants (even when the trading sources are somewhat distant from one another), trades involving these pollutants are cheaper to consummate. Additionally trades involving uniformly mixed pollutants need not be

constrained by the need to prevent local air quality deterioration since the location of the emissions is not a matter of policy consequence.

But how about when emission location matters? When emission location matters, the dominance of economic instruments over traditional command-and-control strategies is less clear cut in practice than it might appear from theory (Krumm and Wellsich 1995). Although the fully cost-effective system is relatively easy to define in this circumstance (Montgomery 1972), implementing such a system could impose a large administrative burden. In general the number of different markets necessary to produce a cost-effective allocation of control responsibility for nonuniformly mixed pollutants is equal to the number of receptors where ambient air quality is monitored to ascertain compliance with the ambient standards (Tietenberg 1985).

Spatial considerations can also give rise to environmental justice concerns. In an unprecedented complaint filed in California during June 1997, the Los Angeles-based Communities for a Better Environment contends that the SCAQMD's pollution-trading program is allowing the continued existence of toxic "hot spots" in low-income communities. Under RECLAIM rules Los Angeles-area manufacturers can buy and scrap old, high-polluting cars to create emissions-reduction credits. These credits can be used to reduce the required reductions from their own operations. Under RECLAIM most California refineries have installed equipment that eliminates 95% of the fumes, but the terminals in question reduced less because the companies scrapped more than 7,400 old cars and received mobile source emission reduction credits which they credited toward their reduction requirements. The complaint notes that whereas motor vehicle emission reductions are dispersed throughout the region, the offsetting increases at the refineries are concentrated in low income neighborhoods (Marla Cone, Los Angeles Times, as cited in GREENWIRE 7/23/97). Though this particular complaint was eventually dismissed by the court, the forces of discontent that gave rise to the suit are far from silenced.

Since the economic and environmental benefits from allowing trading both in the short run and the long run (particularly their ability to stimulate technological progress and pollution prevention) are so large, attempts to implement "second-best" designs to resolve spatial concerns may be justified. All second-best designs involve an element of compromise with the cost-effectiveness goal, but they still can represent an improvement, sometimes a substantial improvement, over more traditional approaches.

The menu of promising second-best strategies is growing (Atkinson 1994; Klaassen and Førsund 1994; Tietenberg 1995). While the most commonly discussed second-best strategies all have problems, slight modifications of those approaches as embodied in this new generation of programs appear to offer the prospect for significant reductions in compliance costs, while assuring environmental improvement.

While space does not permit an elaboration of all the possibilities here, a few approaches can be illustrated. The starting point for this approach is the assumption that it is better to implement a basic system built around standard emission permits, dealing individually with those trades which would result in hot spots or excess pollution at the most severely affected receptors, rather than establishing wholesale restrictions on trades.

One illustration of how this type of constrained trading could be implemented has surfaced in the trading rules developed by the Ozone Transport Commission. Attempting to implement a truly regional strategy that deals realistically with the spatial elements of the problem, the OTC will allow regional trading of NO_x offsets subject to some specific trading constraints.

Since the ozone plume typically moves in a particular direction and not all emissions in the region affect nonattainment status equally, in the absence of any constraints it would be possible for some specific offset trades to actually worsen the degree of nonattainment. To allow interstate trading while assuring environmental improvement in the most severely

affected areas the OTC Plan imposes two restrictions on trading to eliminate these perverse outcomes. Offsets must come from an area with equal or more severe nonattainment¹⁰ and offsetting reductions must have contributed to violations of the ambient standard in the area of the new emissions. The first rule offers protection against trades that worsen pollution in the most severely affected areas, while the second rule, in effect, creates trading zones that conform to wind flow patterns. Compared to an unrestricted trading area these rules have the effect of reducing the number of possible trades. However, since they do allow some trades across large distances, they offer the possibility of faster compliance due to lower compliance costs.

The RECLAIM program approach is similar. The entire trading area is divided into two zones--Coastal and Inland. Due to local geographic and meteorological considerations, emissions in the coastal zone can affect air quality in both zones, but emissions in the inland zone affect only air quality in that zone. As a result the SCAQMD has allowed inland sources to buy permits from either zone, but some facilities in the coastal zone can only buy RTCs from other coastal zone sources. This has created a situation in which the prices for RTCs created in the coastal zone are considerably higher than prices for RTCs created in the inland zone (Gangadharan 1997). Although these zones extract a cost-effectiveness premium, zonal permit trading still represents a considerable improvement over a system with no trading at all.

One solution to the "hot spots" problem is to allow unrestricted trading, but to exercise some control over how the permits are used. The sulfur allowance program, for example, attacks the problem with "regulatory tiering". Regulatory tiering involves applying more than one regulatory regime at a time. Sulfur allowance trading is overlaid on a traditional system of regulations, which specifies ambient air quality standards. Allowance usage is constrained by the need to meet these ambient air quality standards. Thus trading is not restricted by spatial considerations (national trades are possible), but the use of acquired allowances is subject to local regulations protecting the ambient air quality in that area. The second regulatory tier which involves the ambient standards, protects against illegal hot spots. The use of any allowances that would trigger a violation is disallowed. Notice that while this system protects citizens from trades that would trigger violations of the ambient standards, as the environmental justice suit described above suggests it does not protect them from all deterioration.

Dealing With Market Power

One of the fears that is expressed in almost any new discussion of transferable permits involves the degree to which this approach may either facilitate market power or be rendered ineffective by the existence of market power.

The first type of market power involves the ability of participants to manipulate prices strategically in the permit market either as a monopolistic seller or a monopsonistic buyer. Although only a few studies of the empirical impact of market power on emissions trading have been accomplished, their results are consistent with a finding that market power does not seem to have a large effect on regional control costs in most realistic situations (Hahn, 1984).¹¹

Within the class of grandfathered distribution rules, some rules create a larger potential for strategic price behavior than others. In general the larger the divergence between the number of permits received by the price-searching source and the cost-effective number of permits, the larger the potential for market power. When allocated an excess of permits by the control authority, price-searching firms can exercise power on the selling side of the market, and when allocated too few permits, they can exercise power on the buying side of the market.

According to the existing studies it takes a rather considerable divergence from the cost-effective allocation of permits to produce much difference in regional control costs (Tietenberg 1985). Most realistic rules used to distribute permits are estimated to affect control costs to a small degree. Hence, the deviations from the least cost allocation caused by market power pale in comparison to the much larger potential cost reductions achievable by implementing a marketable emissions permit system.

Strategic price behavior is not the only potential source of market power problems. Firms could conceivably use also permit markets as a vehicle for driving competitors out of business (Maleug 1989; Misiolek and Elder 1989; von der Fehr 1993). Both as a conceptual matter (Sartzetakis 1997) and as an empirical matter (Tietenberg 1985), however, this problem is relatively rare. In most markets, permits represent a very blunt instrument for attempting to gain a strategic advantage.

Even when the possibility of market power exists, the consequences can frequently be limited by proper program design. For example, the sulfur allowance program has two components that are designed to diminish the ability of any participant to exercise market power of either form. First, the auction market provides a continuous alternative source of permits, thereby limiting the ability of any participant or group of participants from cornering the market. In addition the program contains a set aside of allowances which the government can sell at \$1500 a ton should the need arise.

The Temporal Dimension

Standard theory suggests that a fully cost-effective tradable permit system must have full temporal fungibility, implying that allowances can be both borrowed and banked¹² (Cronshaw and Kruse 1996; Rubin 1996). Banking allows a source to store its allowances for future use. With banking, for example, a source could save unused 1998 allowances for use in 2001. When banking is not allowed, sources cannot use 1998 allowances after 1998. With borrowing a source can use allowances earlier than their stipulated date. For example, a source could choose to use 2001 allowances in 1998, but that means, of course, that they would no longer be available for use in 2001.

No existing system is fully temporally fungible. The Emissions Trading Program allowed banking, but not borrowing. The Lead Phaseout Program originally allowed neither, but part way through the program it allowed banking, at least until the program officially ended and any remaining credits became unusable. The sulfur allowance program has banking, but not borrowing, and RECLAIM has neither.

Why do so few programs have full temporal fungibility? The answers seem to lie more in the realm of politics than economics.

The first concern involves the potential for creating temporal “hot spots”. With complete freedom on their temporal use it is possible for emissions to be concentrated in time. Since concentrated emissions cause more damage typically than dispersed emissions, regulators have chosen to put *a priori* restrictions on the temporal use of permits despite the cost-effectiveness penalty that extracts.

A second concern has arisen particularly in the global warming context where imposing sanctions for noncompliance is difficult. Some observers have noted that enforcing the cumulative emissions budget on a nation that had borrowed heavily in the earlier years would become increasingly difficult over time. Given the inherent difficulties in enforcing international commitments under the best of circumstances, opponents of borrowing propose to forestall this difficulty by eliminating any possibility of borrowing. They view the resulting

loss of cost-effectiveness as a reasonable price to pay for taking the pressure off future enforcement.

In Closing

In thinking back over the two decades of experience with transferable permits I am reminded of the old Virginia Slims ad: "You've Come a Long Way Baby!" Transferable permits have come a long way from that initial abstract conception. Establishing these markets has turned out to be much harder than we originally thought. After the offset policy, and before the sulfur allowance program, trading was sporadic. Active markets did not exist. Some permits were hoarded as a reaction to the thinness and unreliability of these markets. We learned that you don't take the effectiveness of these artificial markets for granted. But we also learned that it is possible to design the systems in such a way as to promote effective markets.

In some ways we were a bit naive in our assumptions about how easy implementation would be and how completely these systems would produce cost savings and/or improvements in environmental quality. On the other hand we underestimated the impact they ultimately would have both in terms of the number of possible applications and the degree to which they would transform the regulatory system. The program is far from perfect, but the flaws should be kept in perspective. Although transferable permits lose their utopian luster upon closer inspection, they have, nonetheless, made a lasting contribution to environmental policy.

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¹ Note that this approach does not require that both trading countries have implemented a transferable permit system. It does require both countries to adjust their production and consumption quotas assigned under the protocols to assure that the overall global limits on production and consumption are not affected by the trades. The European Union has also implemented a tradable permits scheme for ozone depleting chemicals. See Council Regulation (EEC) No 594/91 of 4 March 1991 on substances that deplete the ozone layer, Official Journal of the European Communities, 14.3.91

² A listing of these state programs can be found on the web at: <http://134.67.55.16:7777/AA/Programs.nsf/>.

³ driven by the fact that traditional processes were incapable of identifying enough appropriate technologies to produce sufficiently stringent reductions,

⁴The six gases included in the Protocol were carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

⁵ The Article 12 program for developing countries is known in the Protocol as the "Clean Development Mechanism".

⁶ 104 Stat 2591

⁷ One interesting analysis examines the cost and emissions savings from implementing an emissions trading system for light-duty vehicles in California. In that study Kling (1994a) finds that although the cost savings from implementing an emission trading program (holding emissions constant) would be modest (on the order of 1% to 10%), the emissions savings possibilities (holding costs constant) would be much larger (ranging from 7% to 65%).

⁸ This auction design unfortunately provides some incentives for inefficient strategic behavior. (Cason 1993)

⁹ This information can be found at <http://www.epa.gov/acidrain/auctions/auc97tlk.html>. For a deeper analysis Schmalensee, R., P. L. Joskow, et al. (1998).

¹⁰ Nonattainment areas are further classified into one of five categories depending on current ozone concentration levels (marginal, moderate, serious, severe, and extreme). These designations affect both the deadlines for achieving the ambient ozone standards and the rules affecting offset trading.

¹¹ For an analysis of how the existence of market power could affect the incentives to cheat see (Van Egteren and Weber, 1996)

¹² Profit regulation can inhibit cost-effectiveness even with full temporal fungibility. (Cronshaw and Kruse 1996)