Tradable Permits in Principle and Practice

By

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I. INTRODUCTION

BACKGROUND

One of most prominent approaches for coping with the problem of rationing access to the commons involves the use of tradable permits. Applications of this approach have spread to many different types of resources and many different countries. A recent survey found 9 applications in air pollution control, 75 applications in fisheries, 3 applications in managing water resources, 5 applications in controlling water pollution and 5 applications in land use control. [OECD, 1999 , Appendix 1, pp. 18-19). And that survey failed to include many current applications.[1]

These approaches have been controversial.[2] The controversy arises from several sources, but the most important concerns the allocation of the wealth associated with these resources. While these approaches typically do not privatize the resources, as conventional wisdom might suggest, they do privatize at least to some degree access to (and use of) those resources. And because the access rights can be very valuable when the resource is managed efficiently, these rights may represent a substantial amount of wealth. While the ability to reclaim the previously dissipated wealth for motivating sustainable behavior is an important strength of a tradable permits system, the ethical issues raised by its distribution among completing claimants are a significant and continuing source of controversy. (Mc Cay 1999)

Another source of controversy involves a broad class of externalities. In general externalities are effects on the ecosystem or on other parties that are not adequately reflected in the decisions by those holding and transferring the access rights. These externalities may not only give rise to an inefficient use of the resource, but they can result in costs being imposed on others that are widely perceived as unjust.

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* This paper draws upon previous studies completed for the National Research Council in the United States and the OECD in Paris.

[1] Three examples of existing programs that did not make the list include the NOx Budget air pollution control program in the Northeastern US (Farrell, Carter et al. 1999), programs to control conventional air pollutants in several states in the United States (Solomon and Gorman 1998) and the carbon trading systems springing up within the European Union.. For a large on-line bibliography covering these systems see http://www.colby.edu/personal/t/thtieten/.

[2] Consider just three examples. In air pollution control a legal challenge was brought in Los Angeles during June 1997 by the Los Angeles-based Communities for a Better Environment. (Tietenberg 1995a). In fisheries a challenge was brought against the halibut/sablefish tradable permits system in Alaska.(Black 1997) and Congress imposed a moratorium on the further use of a tradable permits approach in US fisheries. (National Research Council Committee to Review Individual Fishing Quotas 1999). Though both legal cases were ultimately thrown out, as of this writing the moratorium is still in effect, despite a recommendation by the National Research Council to lift it.

A final source of controversy is ideological. It suggests that since capitalist property rights are the major source of the problem, it is inconceivable that these same rights could be part of the solution.[3] Commodifying nature in any sense, even if it proves to be an effective means of environmental improvement, is seen by some as approaching blasphemy.

OVERVIEW

In this essay I review the experience with three main applications of tradable permit systems - air pollution control, water supply and fisheries management - as well as some unique programs such as the US program to mitigate the loss of wetlands and the program in the Netherlands to control the damage to water pollution from manure spreading.[4] The purpose of this review is to exploit the large variation in implementation experience that can be gleaned from this rich variety of applications. This experience provides the basis for formulating some general lessons about the effectiveness of these systems in practice.

The essay opens with some of the methodological questions that are raised by any ex post attempt to assess how well these approaches have been working in practice, followed by a brief survey of what those evaluations have found.

The essay proceeds with a description of the common elements these programs share and the design questions posed by the approach. These include the setting of the limit on access, the initial allocation of rights, transferability rules (both among participants and across time) as well as procedures for monitoring and enforcement. It continues by examining how these design questions have been answered by the targeted applications and how the answers have evolved over time. As this essay point out, this evolution has been influenced by changing technology, increased familiarity with the system and a desire to respond to some of the controversies surrounding the use of these approaches.

The final section draws together some tentative lessons that can be drawn from this experience.

II. EX POST EVALUATION: PROBLEMS AND PROSPECTS

In principle establishing how well a program has worked in actual application seems a simple matter. In practice it is more complicated than it seems. As a result reasonable people viewing the same experience can come to different conclusions. Therefore before delving into the evidence, it seems reasonable to assess some or the difficulties of ex post evaluation.

ECONOMIC EFFICIENCY

Ex post studies that purportedly tackle the question of economic efficiency typically examine some or all of three rather different concepts: Pareto optimality, cost effectiveness or market effectiveness. Since these are in fact quite different concepts, studies relying on them could come to quite different conclusions, even if they are examining the same program.

Pareto optimality, or its typical operational formulation, maximizing net benefits, examines whether or not the policy derives all the net benefits from the resource use that are possible. Naturally this requires a comparison of the costs of the program with all the benefits achieved, including the value of reduced pollution or conserved resources. Conducting this kind of evaluation is time and information intensive

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[3] One author, for example, compares a tradable permits system to the sale of indulgences in the Middle Ages. (Goodin 1994)

[4] For a previous survey that also examines tradable permit systems across resource settings see Colby (2000).

and in our experience with tradable permit systems is rather rare.[5] An alternative form, which is somewhat less rare, is simply to compare the present value of net benefits for the program with the net benefits from some predefined alternative.

A more common evaluation approach, particularly for ex ante studies, relies on cost/effectiveness. This approach typically takes a predefined environmental target as given (such as an emissions cap or a total allowable catch) and examines whether the program minimizes the cost of reaching that target.[6] Another form is to compare the cost of reaching the target with the program to the cost of reaching the program with the next most likely alternative. This approach, of course, compares the program not to an optimal benchmark, but rather the most pragmatic benchmark.[7]

And finally a number of evaluations focus on whether the market is effective or not. In the absence of an initial allocation that happens to mimic the cost/effective allocation, transactions costs and market power can inhibit trade and prevent a market from achieving the target at minimum cost.[8] A number of the studies (Ellerman, 2003; Kerr; 2003, Wossink, 2003, Young; 2003 and Harrison, 2003) do examine market effectiveness.[9] They use both qualitative and quantitative assessments.[10]

Counterfactuals and Baselines

Many ex post evaluations compare the environmental policy to an alternative pragmatic benchmark rather than some optimum such as Pareto optimality or cost/effectiveness. Defining the appropriate benchmark raises some intriguing issues in practice.

Tradable permits of course are not usually implemented in a vacuum. They frequently complement other policies. For example the US sulfur allowance program operates within the more general framework of sulfur oxide regulation established by the National Ambient Air Quality Standards. The RECLAIM program operated within the context of a rather dramatic electric deregulation program in California. The Dutch Nutrient Quota Program operated within the framework of the European Union's Common Agricultural Policy. The interdependence of these programs makes it difficult to disentangle the unique effects of a tradable permit policy and to draw implications for how the policy might work in a rather different policy environment.

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[5] None of the studies from the recent OECD Workshop on Ex Post Evaluation of Tradable Permits: Methodological and Policy Issues attempt this type of evaluation.

[6] The demonstration that the traditional regulatory policy was not value-maximizing has two mirror-image implications. It either implies that the same environmental goals could be achieved at lower cost or that better environmental quality could be achieved at the same cost. In air pollution control while the earlier programs were designed to exploit the first implication, later programs attempted to produce better air quality <u>and</u> lower cost.

[7] On difficulty that did emerge from the workshop was that cost/effectiveness typically treats the environmental target as predetermined and exogenous. In fact several of the studies seem to indicate that the target may be affected by the choice of the policy instrument. See Ellerman, 2003 and Kerr, 2003) To the extent this is true the target become endogenous rather than exogenous and this makes the typical cost/effectiveness study more difficult. We shall elaborate on this point below.

[8] For a theoretical treatment of the role of transactions costs in permit markets see Stavins (1995).

[9] Interestingly the ex post empirical studies have rather more to say about transaction costs than they do on market power. While many ex ante studies have traditionally focussed on market power, the ex post studies cast more light on transaction costs. Our long history of modelling market power combined with the fact that suggestive data are available ex ante (i.e. number of players, market share, etc.) may bias the ex ante agenda toward the analysis of market power, while our theory about transactions cost is relatively less interesting and the evidence of it usually only emerges once the market commences operation.

[10] Both Wossink (2003) and Young (2003) reveal information of an "anecdotal" nature about transaction costs. Wossink (2003) shows how the nutrient program in the Netherlands explicitly provided support to help participants understand the nature of the market, based upon anecdotal evidence that small farmers were having trouble functioning in the market.

Shabman (2003) shows how sensitive the outcomes in the US wetlands credit program are to both the program design and more generally the Clean Water Act. As his study indicates the baseline may be particularly important for baseline-and-credit schemes since (unlike cap-and-trade schemes) it actually affects the environmental outcome and not just distributional issues.

Defining the "what would have happened otherwise" counterfactual benchmark also raises questions in a "cap and trade' framework. For example Ellerman (2003) points out that the MIT analysis of the emission reductions achieved by the sulfur allowance program is based on the assumption that the heat input observed at affected units in each year would not change from pre-Title IV rates at those units. As he also notes this counterfactual assumption has the effect of making the estimated emission reduction insensitive to changes in demand, either at individual units or in the aggregate. To the extent that other environmental regulations, or changes in relative fuel prices, would have caused the emission rate at affected units to fall during the period of evaluation, the effect of the SO2 program would be over-estimated.

Developing counterfactuals about costs are necessarily more subjective since they depend directly on the degree of inefficiency assumed in the imagined alternative regime. Since that regulatory regime doesn't exist, it is not always easy to figure out what it might have been. Young (2003) points out that the recent preliminary assessment of the costs and benefits of environmental flow enhancement for the River Murray was built upon a baseline scenario of increasing river salinity and hence declining regional income. This is a very different counterfactual than would have been produced by simply extrapolating historic trends.

It is important to note that the difficulties arise not only from specifying what policies to include in (or omit from) the counterfactual, but also in isolating the degree to which changes in observed outcomes are endogenous or exogenous to the policy change. Clearly the outcome of the allowance program has been heavily influenced by rather dramatic changes in scrubber technology and in the markedly enhanced rail availability of low sulfur coals from the western US. Would these events have occurred in the absence of the sulfur allowance program (and therefore should be in the counterfactual) or were they the result of the program (and therefore should not be in the counterfactual)? Definitive conclusions about the effectiveness of this program depend on the answers to those questions

DETERMINING ENVIRONMENTAL EFFECTIVENESS

One common belief about tradable permit programs is that their environmental effects are determined purely by the imposition of the aggregate limit, an act that is considered to lie outside the system. Hence, it is believed, the main purpose of the system is to protect the economic value of the resource, not the resource itself.

That is an oversimplification for several reasons. First whether it is politically possible to set an aggregate limit at all may be a function of the policy used to achieve it. Second, both the magnitude of that limit and its evolution over time may be related to the policy. Third the choice of policy regime may affect the level of monitoring and enforcement and noncompliance can undermine the achievement of the limit. Fourth the policy may trigger effects on resources that are not covered by the limit.

Endogeneity of The Cap

In air trading programs the lower costs offered by trading were used in initial negotiations to secure more stringent pollution control targets (acid rain program, ozone depleting gases, lead phase out and RECLAIM) or earlier deadlines (lead phase out program). The air quality effects from more stringent limits were reinforced by the use of offset ratios for trades in nonattainment areas that were set at a ratio greater than 1.0 (implying a portion of each acquisition would go for better air quality). In addition environmental groups have been allowed to purchase and retire allowances (acid rain program). Retired allowances represent authorized emissions that are not emitted.

In fisheries the institution of ITQs has sometimes, but not always, resulted in lower (more protective) TACS. In the Netherlands, for example, the plaice quota was cut in half (and prices rose to cushion the income shock). (Davidse 1999)

Endogeneity of Monitoring and Enforcement

Regardless of how well any tradable permit system is designed, noncompliance can prevent the attainment of its economic, social, and environmental objectives. Noncompliance not only makes it more difficult to reach stated goals, it sometimes makes it more difficult to know whether the goals are being met.[11]

Although it is true that any management regime raises monitoring and enforcement issues, tradable permit regimes raise some special issues. One of the most desirable aspects of tradable permits for resource users, their ability to raise income levels for participants, is a two-edged sword because it also raises incentives for noncompliance. In the absence of an effective enforcement system, higher profitability could promote illegal activity. Insufficient monitoring and enforcement could also result in failure to keep a tradable permit system within its environmental limit.[12]

Do monitoring and enforcement costs rise under tradable permit programs? The answer depends both on the level of required enforcement activity (greater levels of enforcement effort obviously cost more) and on the degree to which existing enforcement resources are used more or less efficiently. Higher enforcement costs are not, by themselves, particularly troubling because they can be financed from the enhanced profitability promoted by the tradable permit system.[13]

In general, the smooth implementation of a tradable permit program requires two different kinds of monitoring data. First, periodic data on the condition of the resource are needed to evaluate the effectiveness of the program over time. These data are used as the basis for adjusting environmental limits as conditions warrant. Second, managers need sufficient data to monitor compliance with the various limitations imposed by the regulatory system.

Monitoring compliance with a tradable permit program requires data on the identity of permit holders, amount of permits owned by each holder, permit, and permit transfers. Where programs have additional restrictions on permit use (such as type of equipment) or on quota transfers (only to "eligible" buyers) the data must be complete enough to contain this information and to identify noncomplying behavior in a timely manner.

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[11] In fisheries, for example, stock assessments sometimes depend on the size and composition of the catch. If the composition of the landed harvest is unrepresentative of the actual harvest due to illegal discards , this can bias the stock assessment and the total allowable catch that depends upon it. Not only would true mortality rates be much higher than apparent mortality rates, but the age and size distribution of landed catch would be different from the size distribution of the initial harvest (prior to discards).This is known in fisheries as "data fouling".

[12] Prior to 1988, the expected positive effects of ITQs did not materialize in the Dutch cutter fisheries due to inadequate enforcment. Fleet capacity increased further, the race for fish continued, and the quotas had to be supplemented by input controls such as a limit on days at sea. (National Research Council Committee to Review Individual Fishing Quotas 1999. p. 176)

[13] Not only has the recovery of monitoring and enforcement costs from users become standard practice in some fisheries (New Zealand, for example), but funding at least some monitoring and enforcement activity out of rents generated by the fishery has already been included as a provision in the most recent amendments to the US Magnuson-Stevens Act. In addition the sulfur allowance program mandates continuous emissions monitoring financed by the emitting sources.

One key to a smoothly implemented tradable program is ensuring that all data are input to an integrated computer system that is accessible by eligible users on a real-time basis. Such a system provides up-to-date information on permit use to both users and enforcement agencies. It would ideally also allow short-notice transfers, such as when a vessel heading for shore has a larger than expected bycatch and needs to acquire additional quota for the bycatch species before landing. Facilitating this kind of flexibility would reduce the enforcement burden considerably by giving permit holders a legal alternative to illegal discarding without jeopardizing the objectives of the program.

Technology has also played an important role in the US sulfur allowance system. (Kruger, McLean et al. 1999) Both the collection and dissemination of the information derived from the continuous emissions monitors is now handled via the web. Special software has been developed to take individual inputs and to generate information both for the public and for EPA enforcement activities. According to Kruger et al., (1999) the development of this technology has increased administrative efficiency, lowered transactions costs and provided greater environmental accountability.

A successful enforcement program requires a carefully constructed set of sanctions for noncompliance. Penalties should be commensurate with the danger posed by noncompliance. Penalties that are unrealistically high may be counterproductive if authorities are reluctant to impose them and fishermen are aware of this reluctance. Unrealistically high penalties are also likely to consume excessive enforcement resources as those served with penalties seek redress through the appeals process.

In the sulfur allowance program, for example, those found in noncompliance must not only pay a substantial financial penalty for noncompliance; they also must forfeit a sufficient number of future allowances to compensate for the overage. It is also possible to only allow those in compliance to transfer permits. Any egregious violations can lead to forfeiture of the right to participate in the program at all.

Effects on Other Resources

Evaluations of tradable permit programs must have a sufficiently large scope as to take “external” effects into account. The resource controlled by the permit program is frequently not the only resource affected. In water one significant problem has been the protection of "instream" uses of water. (Young, 2003)

In air pollution control several effects transcend the normal boundaries of the program. In the climate change program, for example, it is widely recognized (Hartridge, 2003; Ekins 1996) that the control of greenhouse gases will result in substantial reductions of other pollutants as a side effect. Other, more detrimental, effects include the clustering of emissions either in space or time.

THE MYTH OF THE HOMOGENEOUS COMMODITY

The myth perpetuated by the theory of tradable permit markets is that the commodity being traded is homogeneous. Giving a homogenous sounding name to the traded commodity such as sulfur allowances or RECLAIM credits reinforces that understanding. In practice the commodity is frequently not homogenous and the lack of homogeneity has to be taken into account in ex post evaluations.

One source of heterogeneity stems from spatial considerations, specifically the fact that the location of the emissions or resource use can matter. (Tietenberg, 1995) Thus where the permits are actually used may matter. Theory typically treats trades as if they affect only the cost, not the environment consequences. Any cost/effectiveness analysis that doesn’t account for the heterogeneity may be defining “effectiveness’ incorrectly.

Spatial issues can be dealt with within the tradable permit scheme, but those choices have implications for the homogeneity assumption. Both the RECLAIM (Harrison, 2003) and the Nutrient Quota in the Netherlands (Wossick, 2003) programs place restrictions on the spatial area within which the permits may be traded. The US Wetlands program requires regulatory approval on trades. In the sulfur allowance program (Ellerman, 2003) no regulatory restrictions are placed on permit trades, but permit users do have to assure that any permit use does not result in a violation of the National Ambient Air Quality Standards.

Heterogeneity issues can also be raised by ecological interdependence. In the Australian water case Young (2003) demonstrates a link between water consumption and the environmental damage caused by salinity. In the New Zealand fisheries case Kerr (2003) points out an interdependence between marine species for which there are ecological links, but distinct ITQ markets. Some fisheries have actually been closed despite the fact that the program did adequately protect the targeted species. The closure resulted from a sufficiently large level of bycatch discards that a nontargeted species was placed in jeopardy.

UNCERTAINTY

Even if the apparent "schedule" of targets is equivalent to that which would have been the case under direct regulation - in the face of "shocks" the cap is binding in a way that may not be the case for other policies. This has been particularly true in RECLAIM (Harrison, 2003), the Australian water case (Young, 2003) and New Zealand fisheries (Kerr, 2003).

RECLAIM participants experienced a very large unanticipated demand for power that could only be accommodated by older, more polluting plants. Permit prices soared in a way that was never anticipated.

Examples from both fisheries and water applications showed how fundamental uncertainty about the “right” level of the cap could lead to serious problems. In the New Zealand case (Kerr, 2003) a lack of understanding of the biology of the orange roughy led to a cap that permitted unsustainable harvests. In the Australian water case (Young, 2003) excessive withdrawal could trigger substantial increases in salinity.

In the context of the Dutch Nutrient Quota system, regulatory uncertainties arose for two main reasons: (1) the uncertainty of the continuance of the quota system, and (2) the uncertainty of the introduction of future constraints on quota use. A survey in 1997 showed that Dutch livestock farmers in general perceived policy uncertainty as very relevant and of the same importance as the uncertainty from production and markets (Wossink, 2003)).

Another (apparently less successful) method for dealing with uncertainty applies discounts to each trade. In the Dutch Nutrient Quota program (Wossink, 2003) each trade results in a 25 per cent retirement of the quota traded. This of courses results in fewer trades and increases the cost of compliance.

ADMINISTRATION COSTS

Ex post evaluations should examine not only compliance costs, but administrative costs as well. Although most published case studies don’t shed much light on administrative costs, some case studies do. They demonstrate how the amount and nature of public administration tasks can change with the adoption of a tradable permits approach. One general theme that emerges seems to be that the administration of tradable permit systems involves fewer administrative person-hours (McLean, 2203), but the bureaucratic functions performed are quite different (McLean, 2003; Harrison, 2003). These changing administrative functions have implications for the nature of the skills required by administrators. Those who can monitor and enforce compliance replace engineers who seek to identify the correct control strategies for sources and to negotiate permit exemptions.

Ex post evaluations have to keep in mind that administrative expenditures are a moving target. With technological change in monitoring costs such as the continuous emission monitoring and web–base reporting in the sulfur allowance program (Ellerman, 2003), these expenditures may come down even further. An interesting question for ex post evaluation is the degree to which technological progress in monitoring and enforcement is exogenous and the extent to which it is promoted by tradable permit schemes. To the extent that it is endogenous, ex post evaluation schemes that treat it as exogenous will be biased.

The studies from the OECD Workshop also point out that the type of tradable permits system seems to affect administrative costs. Credit-based programs (such as the Emissions trading System designed in the United Kingdom (Hartridge, 2003) keep a large element of the previous administrative work in place. Programs with regulatory pre-approval (i.e. wetlands credits and water trading) do so to an even greater extent. In addition, other specific design features (such as the opt-in in the sulfur allowance program (Ellerman, 2003) and the use of relative targets in the UK ETS (Hartridge, 2003)) also add considerably to administration costs. Since the design features vary so much from program type to program type, it will be difficult to generalize insights about administrative costs across programs. Despite this evaluations are likely to improve our information on how these design features influence administrative costs.

INSIDE THE BLACK BOX: ORGANIZATIONAL STRUCTURE

Although hard evidence on the point is scarce, a substantial amount of anecdotal evidence is emerging about how tradable permit programs are changing the way environmental risk is being treated within firms. (Hartridge, 2003; McLean, 2003) The story that emerges is that environmental management used to be relegated to the tail end of the process. Historically the environmental risk manager was not involved in the most fundamental decisions about product design, production processes, selection of inputs etc. Rather the risk manager was simply confronted with the decisions already made and told to keep the firm out of trouble. This prevents one major, frequently attractive avenue of risk reduction - pollution prevention.

Because tradable permits put both a cap and a price on environmental risks, it tends to get financial people involved. Furthermore as the costs of compliance rise in general, environmental costs become worthy of more general scrutiny so reducing environmental risk become an important component of the bottom line.

The evidence on the extent of organization changes that might be initiated by tradable permits that arises from these case studies should be treated more as a hypothesis to be tested than a firm result. As such it provides an interesting target for further ex post evaluations.

Economic theory treats markets as if they emerge spontaneously and universally as needed. In practice the applications examined in this review point out that participants frequently require some experience with the program before they fully understand (and behave effectively) in the market for permits. This suggests that particularly in the earlier years ex post evaluation of market effectiveness can be crucial not only in understanding the impediments to smoothly operating markets, but also to how those barriers could be reduced. (Pedersen, 2003; Hartridge, 2003; Wossink (2003) and Young (2003). Furthermore if, as these studies suggest, a private "learning by doing" effect is associated with the TP market itself, this would affect the optimal timing of ex post evaluations or the interpretations of the results of earlier versus later studies.

EFFECTS ON THE REGULATORY PROCESS

One further endogeneity that ex post evaluation must confront is the effect of the choice of policy instrument on the regulatory structure itself. Ex post evaluation also has begun to reveal how tradable permits, particularly cap-and-trade permit systems, change the fundamental nature of regulation. (Ellerman, 2003; Harrison, 2003, McLean, 2003) With tradable permits bureaucrats are no longer in charge of defining the appropriate way to meet the goal. Rather they are in charge of assuring that the user meets the goal.

One rather unexpected point that emerges from ex post evaluation or tradable permit systems is the degree to which the number of errors in pre-existing emission registries are brought to light by the need to create accurate registries for TP schemes.[14] (Wossink, 2003; Pedersen, 2003; Montero, 2002 and Hartridge, 2003). Although inadequate inventories plague all quantity-based approaches, tradable permits seem particularly effective at bringing them to light.

DYNAMIC EFFECTS

One of the major theoretical expectations about tradable permits is that they will promote more technological progress. It is important for the ex post evaluations to test this expectation, difficult though it may be. Some support for the hypothesis that tradable permits promote technological change is now emerging, though the examples all far short of a ringing endorsement of the strong theoretical expectation.

Wossick, (2003) identifies some changes in livestock feeding practices Ellerman (2003) reveals how fuel mixing technologies and newer, less expensive sulfur scrubbers have appeared in the sulfur allowance program. This work complements new insights that are emerging elsewhere in the literature (Carlson et al 2000; Popp 2001; and Kerr, 1997).

These case studies also reveal the importance of banking schemes in proving firms with temporal flexibility. Tradable permit schemes differ considerably in how they treat banking and/or the role of forward markets. And the message that emerges from these studies is that this temporal flexibility can be quite important. Ellerman (2003) discusses the considerable role that both banking and forward markets have played in the US sulfur allowance program. Harrison (2003) shows how the price spikes in the RECLAIM program (which does not have banking) were probably intensified by the absence of this flexibility. Pedersen (2003) also mention the importance of temporal flexibility for investment in the Danish case.

The introduction of an ITQ system may also encourage entry and exit with the inevitable result that the composition of resource users changes. When the New Zealand ITQ system was introduced consolidation occurred, with many "artisanal" fishers getting out of the sector altogether. While this had no appreciable effect on market concentration, it may have lead to changes in fishing technology. In particular since discards of species for which quota is not held are subject to imperfect monitoring, technological change in the fleet may trigger environmental implications that either improve or worsen the situation. By providing artisanal fishermen a secure asset that they could not previously transfer and liquidate, ITQ fisheries may have directly encouraged exit and therefore indirectly affected the fishing technologies in use.

The Dutch Nutrient Quota system also affected the composition of resource users. Wossink (2003) suggests that many of the "sales" of quotas in the "surplus" region were from farmers who got out of farming altogether or shifted to the "deficit" area. This rather large turnover in quota holders could potentially have quite large environmental consequences, not only in terms of where the quotas were being used, but also in terms of the change in practices that could result from the change in ownership.

[14] This was also true in the tradable permit scheme set up to control pollution in Chile. See Montero et al. 2002)

III. A REVIEW OF EVALUATIONS OF TRADABLE PERMIT SYSTEMS

This assessment of the outcomes of these systems focuses on three major categories of effects. The first is implementation feasibility. A proposed policy regime cannot perform its function if it cannot be implemented or if its main protective mechanisms are so weakened by the implementation process that it is rendered ineffective. What matters to policy makers is not how a policy regime works in principle, but how it works in practice. The second category seeks to answer the question "How much environmental protection did it offer not only to the targeted resource, but also other resources that might have been affected either positively or negatively by its implementation?" Finally, what were the economic effects on those who either directly or indirectly use the resource?

IMPLEMENTATION FEASIBILITY

Until recently the historic record on tradable permits, however, seemed to indicate that resorting to a tradable permits approach usually only occurred after other, more familiar, approaches had been tried and failed. In essence the costs of implementing a new system with which policy administrators have little personal experience are typically perceived as large, so incurring such large costs can only be justified when the benefits have risen sufficiently to justify the transition. (Libecap 1990)

Most fisheries that have turned to these policies have done so only after a host of alternative input and output controls have failed to stem the pressure being placed upon the fishery. A similar story can be told for air pollution control. The offset air pollution control policy, introduced in the US during the 1970s, owes its birth to an inability of any other policy to reconcile the desire to allow economic growth with the desire to improve the quality of the air.

It is also clear from the historical record that not every attempt to implement a tradable permit approach has been successful. In air pollution control attempts to establish a tradable permits approaches have failed in Poland (Zylicz 1999) and Germany (Scharer 1999). The initial attempts also failed in United Kingdom (Sorrell 1999), although recent attempts in that country have succeeded. Programs in water pollution control have generally not been very successful. (Hahn and Hester 1989)

On the other hand it does appear that the introduction of new tradable permit programs becomes easier with familiarity. In the U. S. following the very successful lead phase out program new supporters appeared and made it possible to pass the sulfur allowance program.[15]

It also seems quite clear that, to date at least, using a grandfathering approach to the initial allocation has been a necessary ingredient in building the political support necessary to implement the approach.[16] Existing users frequently have the power to block implementation while potential future users do not. This has made it politically expedient to allocate a substantial part of the economic rent that these

[15] It is frequently suggested that new programs should be of the "cap and trade" type because they reduce transaction costs. While I agree that they reduce transactions costs, it is less clear to me that "cap and trade" programs can always achieve the political will to be implemented without gaining familiarity though the more heavily controlled credit programs. My own reading of the US case suggests that we would not currently have "cap and trade" programs if we had not proceeded first to implement credit programs. These served as a training ground for the various stakeholders before moving to the more flexible programs.

[16] One exception is the ITQ program used in one Chilean fishery. Here the permits are allocated by auction. (Bernal and Aliaga 1999)

resources offer to existing users as the price of securing their support. While this strategy reduces the adjustment costs to existing users, it generally raises them for new users.[17]

One tendency that seems to arise in most new applications of this concept is placing severe restrictions on its operation as a way to quell administrative fears about undesirable, unforeseen outcomes. As Shabman (2003) points out this is precisely the state the US wetlands credit program is currently in. Although with increased familiarity (and comfort) initially imposed restrictions tend to disappear over time, they do tend to severely diminish the early accomplishments of the programs.

ENVIRONMENTAL EFFECTS

One common belief about tradable permit programs is that their environmental effects are determined purely by the imposition of the aggregate limit, an action that is considered to lie outside the system. Hence, it is believed, the main purpose of the system is to protect the economic value of the resource, not the resource itself.

As pointed out above, however, several aspects of these programs that have traditionally been treated as exogenous may in fact be endogenous.

Setting the Limit

In air trading programs the lower costs offered by trading were used in initial negotiations to secure more stringent pollution control targets (acid rain program, ozone depleting gases, lead phase out and RECLAIM) or earlier deadlines (lead phase out program). The air quality effects from more stringent limits were reinforced by the use of adjusted offset ratios for trades in nonattainment areas. Offset rations were required to be greater than 1.0 (implying a portion of each acquisition would go for improved air quality). In addition environmental groups have been allowed to purchase and retire allowances (acid rain program). Retired allowances represent emissions that are authorized, but not emitted.

In fisheries the institution of ITQs has sometimes, but not always, resulted in lower (more protective) TACS. In the Netherlands, for example, the plaice quota was cut in half over time (and prices rose to cushion the income shock). (Davidse 1999)

Meeting the Limit

In theory the flexibility offered by tradable permit programs makes it easier to reach the limit, suggesting the possibility that the limit may be met more often under tradable permits systems than under the systems that preceded it. In most fisheries this expectation seems to have been borne out. In the Alaskan Halibut and Sablefish fisheries, for example, while exceeding the TAC was common before the imposition of an ITQ system, the frequency of excedences dropped significantly after the introduction of the ITQ. (National Research Council Committee to Review Individual Fishing Quotas 1999)

A recent OECD review concludes:

> "The results of individual quota management on resource conservation have been mixed. For the most part, IQs and ITQs have been effective in limiting catch at or below the TAC determined by management authorities. Catch was maintained at or below the TAC in 24 out of 31 fisheries for which information on this outcome was available. …In most [of the other] cases, insufficient monitoring and enforcement allowed catches to exceed TACs". (OECD 1997, p. 80)

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[17] New users have to buy into the system while existing users retain their traditional entitlement.

Enforcing the Limit

Sometimes the rent involved in transferable permit programs is used to finance superior enforcement systems. In the sulfur allowance program, for example, the environmental community demanded (and received) a requirement that continuous emission monitoring be installed (and financed) by every covered utility. Coupling this with the rather stringent penalty system has meant 100% compliance. In the Danish system (Pederson, 2003), which does not rely on continuous emission monitoring, the electricity producers pay an administration fee of 0.079 DKK per ton of CO_2 allowance to the DEA to cover the administration costs (verification of CO_2 emissions, control, hearing and distribution of allowances, operating the registry, monitoring of trading, development of the scheme etc.).

The rents generated by ITQs have also provided the government with a source of revenue to cover the costs of enforcement and administration. In many of the IQ fisheries in Australia, Canada, Iceland, and New Zealand, industry pays for administration and enforcement with fees levied on quota owners.

Not all uses of tradable permits, however, offer as convincing a solution for the monitoring and enforcement problems. With respect to fisheries one comprehensive review found:

> "Higher enforcement costs and or greater enforcement problems occurred in 18 fisheries compared to five that experienced improvements. Enforcement proved particularly difficult in the high value fisheries, in multispecies fisheries, and in transnational fisheries. Support from industry for increased enforcement is common, as quota holders recognize that the illegal fishing by others damages the value of their quota rights and have an incentive to aid authorities with enforcement. ITQ management has led to increased co-operation between fishers and enforcement authorities in several cases, including the New Zealand fisheries in general, and the US wreckfish fishery….Underreporting of catch and data degradation was documented for 12 fisheries, but improvements were made in six fisheries." (OECD 1997, p. 84)

As Shabman (2003) points out reviews of the wetlands permitting program have identified failures to secure the "no net loss" objective. Some reviews have found that the ecological functions, especially for wildlife and habitat, of avoided wetlands and on-site wetlands offsets are compromised by polluted runoff and adverse changes in hydrologic regimes. In some cases ecological failure resulted from poor construction techniques. In other cases, a promised restoration project may not have been undertaken at all. In general the failure to prevent these compromises to the program could be traced back to limited agency resources available for enforcement.

Direct Effects on the Resource

In air pollution the programs have typically had a very positive effect on reducing emissions. In both the lead phase out and ozone-depleting gas programs the targeted pollutants were eliminated, not merely reduced. Both the sulfur allowance and RECLAIM programs involve substantial reductions in emissions over time.

In the fisheries what have been the effects on biomass? The evidence has been mixed. In the Chilean squat lobster fishery the exploitable biomass has rebounded from a low of about 15,500 tons (prior to ITQs) to a level in 1998 of between 80,000-100,000 tons. (Bernal and Aliaga 1999) The herring fishery in Iceland has experienced a similar rebound. (Runolfsson 1999)

On the other hand one review of 37 ITQ or IQ fisheries, found that 24 experienced at least some temporary declines in stocks after instituting the programs. These were largely attributed to a combination of inadequate information on which to set conservative TACs and illegal fishing activity resulting from ineffective enforcement. Interestingly 20 of the 24 fisheries experiencing declines had additional command-and-control regulations such as closed areas, size/selectivity regulations, trip limits, vessel restrictions, etc. (OECD 1997 p. 82) These additional regulations were apparently also ineffective in protecting the resource.

Other Effects

In water one significant problem has been the protection of "instream" uses of water. In the U. S. some states only protected private entitlements to water if water was diverted from the stream and consumed. Recent changes in policy and some legal determinations have afforded more protections to these environmental uses of water. In Australia a singular focus on water withdrawal could trigger substantial salinity problems. (Young, 2003)

In air pollution control several effects transcend the normal boundaries of the program. In the climate change program, for example, it is widely recognized (Ekins 1996) that the control of greenhouse gases will result in substantial reductions of other pollutants as a side effect. Other, more detrimental, effects include the clustering of emissions either in space or time.

In fisheries two main effects have been bycatch and highgrading. Bycatch is a problem in many fisheries, regardless of the means of control. The evidence from fisheries on how the introduction of ITQs affects bycatch and highgrading is apparently mixed. Two reviews found that bycatch and highgrading may either increase or decrease in ITQ fisheries depending on the fishery. (OECD 1997. p. 83,) (National Research Council Committee to Review Individual Fishing Quotas 1999 p. 193)

ECONOMIC EFFECTS

While the evidence on environmental consequences is mixed (especially for fisheries), it is clearer for the economic consequences. In the presence of adequate enforcement tradable permits do appear to increase the value of the resource (in the case of water and fisheries or lower the cost of compliance (in terms of emissions reduction).[18]

In air pollution control considerable savings in meeting the pollution control targets have been found. (Ellerman, 2003; Harrison, 2003; Hahn and Hester 1989; Tietenberg 1990) For the increase in value brought about by transferring the resources from lower valued to higher valued uses has typically been substantial. (Young, 2003 Easter, Dinar et al. 1998). In fisheries the increase in value not only results from the higher profitability due to more appropriately scaled capital investments (resulting from the reduction in overcapitalization), but also from the fact that ITQs frequently make it possible to sell a more valuable product at higher prices (fresh fish rather than frozen fish). (National Research Council Committee to Review Individual Fishing Quotas 1999) One review of 22 fisheries found that the introduction of ITQs increased wealth in all 22. [OECD, 1997, p. 83]

In both water and air pollution the transition was not from an open access resource to tradable permits, but rather from a less flexible control regime to a more flexible one. The transition has apparently been accomplished with few adverse employment consequences, though sufficient data to do a comprehensive evaluation on that particular question do not exist. (Berman and Bui, 2001; Goodstein 1996)

The employment consequences for fisheries have been more severe. In fisheries with reasonable enforcement the introduction of ITQs has usually been accompanied by a considerable reduction in the amount of fishing effort. Normally this means not only fewer boats, but also less employment. The evidence also suggests, however, that the workers who remain in the industry work more hours during the

[18] It was interesting to note in these case studies that it is not always possible to compare ex ante and ex post cost savings. Harrison (2003) reports, for example that when the RECLAIM program was being developed, cost savings were estimated to be about 40 percent compared to the cost of achieving the same emission levels using the traditional command-and-control approach. However, no ex post estimates of cost savings have been made.

year and earn more money. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 101)

The introduction of ITQs in fisheries has also had implications for crew, processors and communities. Traditionally in many fisheries crew have co-venturers in the fishing enterprise, sharing in both the risk and reward. In some cases the shift to ITQs has shifted the risk and ultimately shifted the compensation system from a share of profits system to a wage system. Though this has not necessarily lowered incomes, it has changed the culture of fishing. (McCay, Gatewood et al. 1989; McCay and Creed 1990)

Secondary industries can be affected by the introduction of tradable permits in a number of ways. Consider, for example, the effects on fish processors. First the processing sector is typically as overcapitalized as the harvesting sector. [19] Since the introduction of ITQs typically extends the fishing season and spreads out the processing needs of the industry, less processing capacity is needed. In addition the more leisurely pace of harvesting reduces the bargaining power of processors versus fishers. In some remote areas such as Alaska a considerable amount of this processing capital may lose value due to its immobility. (Matulich, Mittelhammer et al. 1996; Matulich and Sever 1999)

Communities can be, and in some cases have been, adversely affected when quota held by local resource users is transferred to resource users who operate out of other communities. Techniques developed to mitigate these effects, however, seem to have been at least moderately successful. (National Research Council Committee to Review Individual Fishing Quotas 1999. p. 206)

Generally market power has not been a significant issue in most permit markets despite some tendencies toward the concentration of quota. In part this is due to accumulation limits that have been placed on quota holders and the fact that these are typically not markets in which accumulation of quota yields significant monopoly-type powers.[20] In fisheries some concern has been expressed (Palsson 1998) that the introduction of ITQs will mean the demise of the smaller fishers as they are bought out by larger operations. The evidence does not seem support this concern.[21]

IV LESSONS FOR PROGRAM DESIGN

THE BASELINE ISSUE

In general tradable permit programs fit into one of two categories: a credit program or a cap-and-trade program. The credit program involves a relative baseline. As such it vests regulators with the authority and responsibility for determining whether and when a trade can occur. With a credit program an individual access baseline is established for each resource user. The user who exceeds legal requirements (say by harvesting fewer fish than allowed or emitting less pollution than allowed) can have the difference certified as a tradable credit.

The cap-and trade program involves an absolute baseline and it places responsibility for trading decisions with dischargers. The distinction between centrally directed and managed trades and truly market-based programs is fundamental to understanding the varied performance of the so-called trading programs that have been implemented to date. In this case a total resource access limit is defined and then allocated among users. Air pollution control systems and water have examples of both types. Fisheries tradable permit programs are all of the cap-and-trade variety.

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[19] In derby fishing the harvest is landed in a relatively short period of time, creating the need for more peak capacity.

[20] In many fisheries, for example, the relevant markets are global with many different sources of supply. In air pollution the number of participants is typically quite high.

[21] An OECD review concludes " There was very little evidence to support the hypothesis that small scale fishers would be eliminated." (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 84)

The other major difference is that cap-and-trade programs generally establish an upper aggregate limit on the resource use, while the credit programs establish only an upper limit for each user. In the absence of some other form of control over additional users, an increase in the number of users can lead to an increase in aggregate use and the eventual degradation of the resource.

Credit trading, the approach taken in the Emissions Trading Program (the earliest program) in the United States, allows emission reductions above and beyond legal requirements to be certified as tradable credits. (Tietenberg, 1985) The baseline for credits in that program 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.

The wetlands banking program and the Dutch Nutrient Quota program are both credit programs. (Shabman, 2003; Wossink, 2003)) They have retained a sufficiently high degree of intervention by regulators that it has stifled the market. These additional restrictions result in higher transactions costs for market participants. Wossink (2000) estimates the conventional transaction costs incurred by the markets participants for swine in the Dutch Nutrient Quota program and finds them to be significant-as high as 17 % of the average quota price.

Allowance trading, such as used in the US Acid Rain Program, assigns a prespecified number of allowances to polluters. In allowance programs initial allocations are not necessarily based on traditional technology based standards; in many cases the aggregate reductions implied by the allowance allocations exceed those achievable by standards based on currently known technologies.

Theory would lead us to believe that allowance systems would be much more likely to achieve the efficiency and environmental goals and the evidence emerging from ex post evaluations seems to support that conclusion. (Shabman, Stephenson and Shobe, forthcoming).

<u>THE LEGAL NATURE OF THE ENTITLEMENT</u>

Although the popular literature frequently refers to the tradable permit approach as "privatizing the resource" (Spulber and Sabbaghi 1993; Anderson 1995), in most cases it doesn't actually do that. One compelling reason in the United States why tradable permits do not privatize these resources is because that could be found to violate the well-established "public trust doctrine". This common law doctrine suggests that certain resources (such as water and, arguably, air) belong to the public and that the government holds them in trust for the public; they can't be given away.[22]

Economists have consistently argued that tradable permits should be treated as secure property rights to protect the incentive to invest in the resource. Confiscation of rights could undermine the entire process.

The environmental community, on the other hand, has just as consistently argued that the air, water and fish belong to the people and, as a matter of ethics, they should not become private property. (Kelman, 1981a) In this view no end could justify the transfer of a community right into a private one. (McCay 1998)

The practical resolution of this conflict in most US tradable permit settings has been to attempt to give "adequate" (as opposed to complete) security to the permit holders, while making it clear that permits are

[22] For example, Article XIV of the California Constitution of 1879 denied the ownership of water to individuals and granted them a usufructory right- the right to the *use* of the water. (Blomquist 1992). The 1981 Water Code in Chile stipulates that water is a national resource for public use, but rights to <u>use</u> water can be granted to individuals. (Hearne 1998)

not a property rights.[23] For example according to the Title of the US Clean Air Act dealing with the sulfur allowance program:

> "An allowance under this title is a limited authorization to emit sulfur dioxide....Such allowance does not constitute a property right. (104 Stat 2591)

In practice this means that administrators are expected to recognize the security needed to protect control investments by not arbitrarily confiscating rights. They do not, however, give up their ability to change control requirements as the need arises. In particular they will not be inhibited by the need to pay compensation for withdrawing a portion of the authorization to emit as they would if allowances were accorded full property right status. It is a somewhat uneasy compromise, but it seems to have worked.

ADAPTIVE MANAGEMENT

One of the initial fears about tradable permit systems is that they would be excessively rigid, particularly in the light of the need to provide adequate security to permit holders. Policy rigidity was seen as possibly preventing the system from responding either to changes in the resource base or to better information. And this rigidity could seriously undermine the resilience of biological systems. (Hollings 1978)

Existing tradable permit systems have responded to this challenge in different ways depending on the type of resource being covered. In air pollution control the need for adaptive management is typically less immediate and the allowance is typically defined in terms of tons of emissions. In biological systems, such as fisheries, the rights are typical defined as a share of the TAC. In this way the resource managers can change the TAC in response to changing biological conditions without triggering legal recourse by the right holder.[24] Some fisheries and water allocation systems actually have defined two related rights.(Young 1999; Young 2003) The first conveys the share of the cap, while the second conveys the right to withdraw a specified amount in a particular year. Separating the two rights allows a user to sell the current access right (perhaps due to an illness or malfunctioning equipment) without giving up the right of future access.[25] Though share rights have not use in air pollution controlled, they have been proposed (Muller, 1994).

Water has a different kind of adaptive management need. Considerable uncertainty among users is created by the fact that the amount of water can vary significantly from year to year.[26] Since different users have quite different capacities for responding to shortfalls, the system for allocating this water needs to be flexible enough to respond to this variability or the water could be seriously misallocated.

These needs have been met by a combination of technological solutions (principally water storage) and building some flexibility into the rights system. In American west the appropriation doctrine that originated in the mining camps created a system of priorities based upon the date of first use. The more senior rights then have a higher priority of claim on the available water in any particular year and consequently could be expected to claim the highest price.[27] (Howe and Lee 1983; Livingston 1998)

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[23] One prominent exception is the New Zealand ITQ system. It grants rights in perpetuity. (National Research Council Committee to Review Individual Fishing Quotas 1999, . p. 97)

[24] Compare this case with a case where the rights were defined in tons. If biological conditions indicated the need to lower the TAC significantly, the need to confiscate existing rights might trigger suits seeking compensation against the resource manager.

[25] Other systems achieve this result by allowing rights holders to lease the rights to others for a specific period of time.

[26] Livingston reports on an unpublished World Bank survey that found that out of 35 developing countries examined, more than half had rainfall variability of 40%. (Livingston 1998)

[27] In the western US, the number of rights expected to be fulfilled in any given year is determined by snowpack measurements and satellite monitoring of streamflows. (Livingston 1998)

In Australia under current arrangements most entitlements are issued as an irrigation license – defined in terms of the reliability that a periodic allocation of a volume of water will be made available in any one year. While some systems give all license holders the same priority, many define two or more levels of priority. (Young, 2003; Livingston 1998)

An alternative approach to flexibility with security, the "drop-through mechanism" involves a cascade of fixed term entitlements, a variation of an approach currently used in the New South Wales fishery. (Young 1999) and proposed for use in controlling climate change. (Tietenberg 1998) Under this scheme initial entitlements (call them Series A Entitlements) would be defined for a finite period, but one long enough to encourage investments (say, for the sake of illustration, 30 years). The rights and obligations covered by the Series A entitlements would be known in advance.[28] Periodically (say, for illustration, every ten years) a comprehensive review would be undertaken which would result in a new set of entitlements (Series B, Series C, etc), which would also have a 30-year duration. Emitters holding Series A Entitlements could have the option to switch to the new set of entitlements at any time earlier than the expiration of their Series A Entitlements. Once they switched they would be able to hold Series B Entitlements for their remaining life. This process would continue until such time as it appeared no more reviews were necessary.

Caps and Safety Valves

The caps in a cap-and trade system are typically defined on the basis of some notion of sustainable use. In RECLAIM the limits are defined so as to assure that the resulting concentrations will ultimately fall below the Ambient Air Quality Standards (AAQS). The primary AAQS are defined so as to protect human health.[29] In water the aggregate limit is typically based upon expected water flow. (Easter, Dinar et al. 1998). In formal tradable permit fisheries the governing body routinely estimates the size of the fish stocks to determine the amount of fish that can be harvested in a given year so that fisheries can be sustained; this amount is termed the "allowable biological catch" (ABC). The catch level that fishermen are allowed to take, the Total Allowable Catch, would in principle be equal to or less than the ABC. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 3)

In pollution, unlike fisheries, the cap is rather rigidly defined. The question that arose in the context of the RECLAIM program was how this approach could handle unexpected, and sometimes rather large, changes in circumstances that can cause the cost of achieving the cap to skyrocket. The general prescription is to allow a "safety valve" in the form of a predefined penalty that can be imposed on all emissions over the cap in lieu of meeting the cap. This penalty can be different from the normal sanction imposed for noncompliance during more normal situations. In effect this penalty would set a maximum price that would have to be incurred in pursuit of environmental goals.[30] (Harrison, 2003; Pizer, 1999)

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[28] The scheme is sufficiently flexible that entitlements could rise over time, fall over time or be constant. The main condition is that the time path be specified for the duration of that particular series. The entitlements in each series could also involve different side restrictions, such as the prohibition of the use of a certain habitat destroying gear in fisheries.

[29] Some programs have additional requirements. In the lead phaseout program the annual limits declined over time until, in the final year, they went to zero. (Nussbaum 1992). In the RECLAIM program in Los Angeles the limits decline 8% per year. (Fromm and Hansjurgens 1996; Zerlauth and Schubert 1999)

[30] The rules that set up RECLAIM specified that if permit prices went over some threshold the program would be suspended until they figured out what to do. An alternative fee per ton was imposed in the interim. (Harrison, 2003).

INITIAL ALLOCATION METHOD

The initial allocation of entitlements is perhaps the most controversial aspect of a tradable permits system. Four possible methods for allocating initial entitlements are:

- Random access (lotteries)
- First-come, first served
- Administrative rules based upon eligibility criteria
- Auctions

All four of these have been used in one context or another. Both lotteries and auctions are frequently used in allocating hunting permits for big game. Lotteries are more common in allocating permits among residents while auctions are more common for allocating permits to non-residents. First-come, first-served was common historically for water when it was less scarce. The most common method, however, for the applications discussed here is allocating access rights based upon historic use.

Two justifications for this approach are typically offered[31]. First, it enhances the likelihood of adoption.[32] Not only does allocating entitlements to historic users cause the least disruption from historic patterns, but also it involves a much smaller financial burden on users than an auction.[33] (Lyon 1982; Tietenberg 1985; Hausker 1990; Grafton and Devlin 1996) Second, it allocates permits to those who have made investments in resource extraction. In this sense it serves to recognize and to protect those investments.[34]

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

Grandfathering has its disadvantages. Recent work examining how the presence of preexisting distortions in the tax system affects the efficiency of the chosen instrument suggests that the ability to recycle the revenue (rather than give it to users) can enhance the cost-effectiveness of the system by a large amount. That work, of course, creates a bias toward taxes or auctioned permits and away from "grandfathered" permits. (Goulder, et. al., 1999) How revenues are distributed, however, also affects the attractiveness of

[31] An interesting third possibility by examination of the air pollution control experience in Chile. (Montero, 200). Apparently the use of a grandfathered system of allocation coupled with the high rents from holding those permits induced a number of previously undiscovered sources to admit their emissions in order to gain entry to the program.

[32] For example, assigning rights in this way is considered one factor in how the US was able to implement a system to control acid rain after many years of failed attempts. (Kete 1992)

[33] From the point of view of the user, two components of financial burden are significant: (1) extraction or 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), to the user both represent a financial burden. The empirical evidence suggests that when a traditional auction market is used to distribute permits (or, equivalently, when all uncontrolled emissions are subject to an emissions tax), the permit expenditures (tax revenue) 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)

[34] The downside occurs when the investments being rewarded were initiated purely for the purpose of increasing the initial allocation of tradable permits. Not only are these investments inefficient, but rewarding them undermines the ethical basis for an initial allocation based upon historic use.

alternative approaches to environmental protection from the point of view of the various stakeholders. To the extent that stakeholders can influence policy choice, “grandfathering” may have increased the feasibility of implementation. (Svendsen 1999) On the other hand the empirical evidence suggests that the amount of the revenue needed to hold users harmless during the change is only a fraction of the total revenue available from auctioning. (Bovenberg, et al., 2000) Grandfathering is apparently not inevitable, even from a political feasibility point of view.

A second consideration involves the treatment of new firms. 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 users in the sense that their financial burden is greater than that of an otherwise identical existing user. In air pollution control this “new user” 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.[35] (Maloney and Brady 1988; Nelson, Tietenberg et al. 1993)

Other initial allocation issues involve determining both the eligibility to receive permits and the governance process for deciding the proper allocation.[36] Controversies have arisen, especially in fisheries, about both elements. In fisheries the decision to allocate permits to boat owners has triggered harsh reactions among both crew and processors.

In some fisheries the allocation to boat owners has transformed the remuneration arrangements from a sharing of the risks and revenues from a catch on a predefined share basis to a wage system. Though this transformation can result in higher incomes for crew (Knapp 1997), the change in status has been difficult to accept for those used to being co-venturers, thereby sharing in both the risk and reward of fishing. (McCay, Gatewood et al. 1989; McCay and Creed 1990)

Processors have also staked their claim for quota (especially in Alaska), albeit unsuccessfully to date. (Matulich, Mittelhammer et al. 1996) The claims are based upon the immobility of the processing capital and the fact that allocating quota to boat owners changes the bargaining relationship in ways that could hurt processors. (Matulich and Sever 1999)

Finally some systems allow agents other than those included in the initial allocation to participate through an “opt-in” procedure. This is a prominent feature of the sulfur allowance program, but it can be plagued by adverse selection problems. (Montero, 1999; Montero 2000b)

Traditional theory suggests that tradable permits offer a costless trade-off between efficiency and equity, since, regardless of the initial allocation, the ability to trade assures that permits flow to their highest valued uses. This implies that the initial allocation can be used to pursue fairness goals without lowering the value of the resource.

In practice implementation considerations almost always allocate permits to historic uses whether or not that is the most equitable allocation. This failure to use the initial allocation to protect equity concerns has caused other means to be introduced to protect equity considerations (such as restrictions on transfers). The additional restrictions generally do lower the value of the resource. In practice, therefore, tradable permits systems have not avoided the trade-off between efficiency and equity so common elsewhere in policy circles.

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[35] The “new source bias” is, of course, not unique to tradable permit systems. It applies to any system of regulation that imposes more stringent requirements on new sources than exiting ones.

[36] Tradable permits systems are perfectly compatible with the principles of co-management. In this case the community would play a large role in defining the goals and procedures in the system. see the discussion of this in (National Research Council Committee to Review Individual Fishing Quotas 1999, pp. 135-138)

These case studies also reveal some tendency to over allocate quota in the initial years, presumably to enhance the political feasibility of program adoption. The evaluation of the Dutch phosphate quota program, for example, shows that initial quota was over-allocated 10 to 25 %. (Wossink, 2003) Initial allocations were also high in the RECLAIM program (Harrison, 2003)

TRANSFERABILITY RULES

While the largest source of controversy about tradable permits seems to attach to the manner in the permits are initially allocated, another significant source of controversy is attached to the rules that govern transferability. According to supporters, transferability not only serves to assure that rights flow to their highest valued use, but it also provides a user-financed form of compensation for those who voluntarily decide to no longer use the resource. Therefore restrictions on transferability only serve to reduce the efficiency of the system. According to critics, allowing the rights to be transferable produces a number of socially unacceptable outcomes including the concentration of rights, the destruction of community interests and the degrading of both the environment and traditional relationships among users.

Making the rights transferable allows the opportunity for some groups to accumulate permits. The concentration of permits in the hands of a few can either reduce the efficiency of the tradable permits system (Hahn 1984; Anderson 1991; Van Egteren and Weber 1996) or it can be used as leverage to gain economic power in other markets. (Misiolek and Elder 1989; Sartzetakis 1997) Although it has not played much of a role in air pollution control, concentration has been a factor in fisheries. (Palsson and A.Helgason 1995)

Typically the problem in fisheries is not that the concentration is so high that it triggers antitrust concerns (Adelaja, Menzo et al. 1998), but rather that it allows small fishing enterprises to be bought out by larger fishing enterprises. Smaller fishing enterprises by some observers are seen as having a special value to society that should be protected (Palsson, G. (1998).

Protections against “unreasonable” concentration of quota are now common in program design. One typical strategy involves putting a limit on the amount of quota that can be accumulated by any one holder. In New Zealand fisheries, for example, these range from 20% to 35% depending upon the species. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 90-91), while in Iceland the limits are 10% for cod and 20% for other species.(National Research Council Committee to Review Individual Fishing Quotas 1999, p. 102)

Another strategy involves trying to mitigate the potential anticompetitive effects of hoarding. The US sulfur allowance program does this in two main ways. First it sets aside a supply of allowances that could be sold at a predetermined (high) price if hoarders refused to sell to new entrants.[37] Second, it introduced a zero-revenue auction that, among its other features, requires permit holders to put approximately 3% of its allowances up for sale in a public auction once a year.[38]

Another approach involves directly restricting transfers that are perceived to violate the public interest. In the Alaskan halibut and sablefish ITQ program, for example, several size categories of vessels were defined. The initial allocation was based upon the catch record within each vessel class and transfer of quota between catcher vessel classes was prohibited (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 310). Further restrictions required that the owner of the quota had to

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[37] This set aside has not been used because sufficient allowances have been available through normal channels. That doesn't necessarily mean the set-aside was not useful, however, because it may have alleviated concerns that could have otherwise blocked the implementation of the program.
[38] The revenue is returned to the original permit holders rather than retained by the government. Hence the name "zero-revenue auction". (Svendsen and Christensen 1999)

be on board when the catch was landed. This represented an attempt to prevent the transfer of ownership of the rights to "absentee landlords".

A second concern relates to the potentially adverse economic impacts of permit transfers on some communities.[39] Those holders who transfer permits will not necessarily protect the interests of communities that have depended on their commerce in the past. For example in fisheries a transfer from one quota holder to another might well cause the fish to be landed in another community. In air pollution control owners of a factory might shut down its operation in one community and rebuild in another community, taking their permits with them.

One common response to this problem in fisheries involves allocating quota directly to communities. The 1992 Bering Sea Community Development Quota Program, which was designed to benefit remote villages containing significant native populations in Alaska, allocated 7.5% of the walleye pollock quota to these communities. (Ginter 1995) In New Zealand the Treaty of Waitangi (Fisheries Claims) Settlement Act of 1992 effectively transferred ownership of almost 40% of the New Zealand ITQ to the Maori people. (Annala 1996) For these allocations the community retains control over the transfers and this control gives it the power to protect community interests. In Iceland this kind of control is gained through a provision that if a quota is to be leased or sold to a vessel operating in a different place, the assent of the municipal government and the local fishermen's union must be acquired. (National Research Council Committee to Review Individual Fishing Quotas 1999, p. 83)

A final concern with transferability relates to possible external effects of the transfer. While in theory transfers increase net benefits by allowing permits to flow to their highest valued use, in practice that is not necessarily so if the transfers confer external benefits or costs on third parties.

Such external effects are not rare. In water, for example, transfers from one use to another can affect the quality, quantity and timing of supply for other downstream users.[40] (Livingston 1998) In air pollution control transfers can affect the spatial distribution of pollution and that can trigger environmental justice concerns.[41] (Tietenberg 1995c) In fisheries quota could be transferred to holders with more damaging gear, or a higher propensity for by catch. In all cases "leakage" provides another possible external effect. Leakage occurs when pressure on the regulated resource is diverted to an unregulated, or lesser regulated, resource as when fishermen move their boats to another fishery or polluters move their polluting factory to a country with lower environmental standards.

Western US water markets attempt to solve the externality problem by giving any affected party a chance to intervene in the transfer proceeding. (Colby 1995) In the case of a third party intervention the transferring parties bear the burden of establishing the absence of damage to third parties. While this probably is an effective way to internalize the externality, it raises transaction costs significantly and has resulted in many fewer transfers than would have otherwise been the case. (Livingston 1998) Technology

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[39] This concern does not arise in all communities because in several fisheries and in air pollution control the effect of any particular transfer or set of transfers is negligible.

[40] These effects may be less pronounced in short river systems. This may be one of the reasons tradable permit markets in water are so active in Chile. (Hearne 1998)

[41] In an unprecedented complaint filed in California during June 1997, the Los Angeles-based Communities for a Better Environment contents that RECLAIM 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. Though this particular complaint was eventually dismissed by the court, the forces of discontent that gave rise to the suit are far from silenced.

is now making an entrance in water markets (the Water Links electronic water exchange in California, for example) to lower transaction costs. (OECD 1999)

One strategy used in US air pollution control policy to resolve the spatial externality problem is regulatory tiering. Regulatory tiering implies applying more than one regulatory regime at a time. Sulfur oxide pollution in the United States is controlled both by the regulations designed to achieve local ambient air quality standards as well as by the sulfur allowance trading program. All transactions have to satisfy both programs. Thus trading is not restricted by spatial considerations (national trades are possible), but the use of acquired allowances is subject to local regulations protecting human health via the ambient standards. The second regulatory tier protects against the harmful spatial clustering of emissions (by disallowing any specific trades that would violate the standards), while the first tier allows unrestricted trading of allowances. Because the reductions in sulfur are so large and most local ambient standards are not likely to be jeopardized by trades, few trades have been affected by this provision. Yet its very existence serves to allay fears that local air quality could be in jeopardy.

In the Dutch Nutrient Quota program (Wossink, 2003) the transfer of phosphate quota was allowed within regions and from a surplus region into a deficit region, but prohibited from a deficit region into a surplus region. In addition to phosphate quota, farmers willing to expand animal production in the surplus region had to acquire ammonia rights. Trade in ammonia rights was only allowed within the same county and hence was even more spatially restricted than trading in phosphate quota.

THE TEMPORAL DIMENSION

Standard cost/effectiveness theory suggests that a cost-minimizing tradable permit system must have full temporal fungibility, implying that allowances can be both borrowed and banked. (Rubin 1996; Kling and Rubin 1997) Banking allows a user to store its permits for future use. With borrowing a permit holder can use permits earlier than their stipulated date.

No existing system that I am aware of is fully temporally fungible. Older pollution control programs have had a more limited approach. The Emissions Trading Program allowed banking, but not borrowing. The Lead Phase Out Program originally allowed neither, but part way through the program it allowed banking, at least until the program reached its scheduled termination date. The sulfur allowance program has banking, but not borrowing, and RECLAIM has very limited banking and borrowing due to the use of overlapping time frames for compliance.

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 a temporal clustering of emissions. When intertemporal trades are defined on a one-for-one basis, it is possible for emissions to be concentrated in time. Since emissions concentrated in space or time cause more degradation than dispersed emissions (due to a nonlinearity in the dose-response function), regulators have chosen to put *a priori* restrictions on the temporal use of permits despite the economic penalty that imposes.

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 envisioned by the Kyoto Protocol on a nation that had borrowed heavily in the earlier years would become increasingly difficult over time. (Tietenberg, Grubb et al. 1998) 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 increased compliance cost as a reasonable price to pay for taking the pressure off future enforcement.

The ex posts evaluations reveal, however, that temporal flexibility can be important. Harrison (2003) reports that during the tremendous pressure placed on the market by the power problems in California, even the limited temporal flexibility in RECLAIM allowed the excess emissions to be reduced by more than a factor of three—from about 19 percent to 6 percent.

V. WHAT HAVE WE LEARNED?

How well have tradable permits performed? The evidence has been mixed. In certain applications, such as the sulfur allowance program and several of the fisheries, tradable permits have lived up to the high expectations of the theory. In order areas, such as wetlands banking, they have not.

Theory creates expectations and in the case of tradable permits the expectations have been high, sometimes unreasonably high. Several assumptions behind the theory may be violated in practice.

One case in point is the assumption that the tradable commodity is homogeneous. In many applications the tradable commodity is clearly not homogenous. The location or timing of permit use may matter as might the extraction or emission methods used by the permit holder. The impact of the nonhomogeneity is intensified when the associated environmental benefits or damage are external to the permit user. In this case permit holders who use or trade permits cannot be expected to maximize society's net benefits when they maximize their own.

Another aspect of tradable permit systems that seems to have been under appreciated is endogeneity. The choice of a policy instrument can affect aspects of implementation that are frequently considered exogenous, but which in fact are not. These include the targeted degree of control, the feasibility of implementation, the likelihood of compliance, the form and intensity of monitoring and enforcement as well as the degree of technical change.

A third under appreciated aspect is the role equity plays in the design of operating tradable permit systems. Theory tells us that a cost/effective allocation will ultimately be achieved regardless of the initial allocation of permits. In principle this allows equity goals to be pursued via the initial allocation and cost/effectiveness goals to be handled by transfers. In practice initial allocations are frequently either used to improve feasibility (thereby reducing or eliminating their ability to address fairness issues) or they prove inadequate in addressing equity concerns (especially when the equity concerns arise from transfers). Responding to fairness concerns about transfers frequently involves placing restrictions on transfers, restrictions that reduce the cost/effectiveness of the system.

A fourth under appreciated aspect arises from the fact that at least historically tradable permit systems have tended to evolve considerably over time. Regulators have had to become comfortable with the flexibility these systems afford. Users have had to become comfortable with the fact that defining the means of control is now up to them. Initial tradable permit markets may bear only a remote resemblance to the goods or asset markets with which we are more familiar.

These four aspects of tradable permit systems, which emerge from an evaluation of operating systems, have implications for the way we evaluate these systems, the way we design these systems and the way we interpret the outcomes.

Failure to recognize nonhomogeneity or endogeneity in the evaluation process can lead to biased evaluations. Treating systems that have *ex ante* identical emission reductions or withdrawal as equivalent may miss important temporal or spatial impact on the targeted resources as well as external effects on nontargeted resources. Considering aspects such as the feasibility of the system, the level of the target, the likelihood of reaching the target, and the effectiveness of monitoring and enforcement as outside the scope of analysis can miss important consequences of instrument choice.

Failure to recognize the evolutionary nature of the system may result in conclusions drawn from an analysis of a transitory stage being mistakenly interpreted as reflecting what would have been found at a later stage. It may also lead to an underestimate of the importance of early evaluations in shaping the speed and form of the evolution.

And finally the evidence suggests that fairness considerations have shaped many tradable permit systems. Analysis that assumes that fairness is either handled by the initial allocation or has no analytical importance may miss a comparative aspect of policy instrument choice that seems to matter.

These aspects also raise some suggestions for when and how these systems are implemented. The evidence is very persuasive that tradable permit systems have worked extremely well in many circumstances, but it is equally clear that the success of tradable permit system seems to rest on certain preconditions.

These preconditions include:

- either the absence of significant externalities or an ability to deal with them in system design.
- a reasonable ability to monitor emissions or withdrawal.
- an acceptable capability to enforce compliance.
- a sufficient level of information to set a politically acceptable cap.
- permit holders who are sufficiently knowledgeable about the system and the menu of choices they have before them.

The degree to which each of these preconditions is met is, of course, a continuous variable. Nonetheless isolating these conditions sets the stage for thinking about defining the appropriate niche for tradable permit systems. That niche is large and growing, but it is definitely bounded by the unique circumstances of each potential application.

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