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Multi-lateral emission trading: Implications for international efforts from two U.S. examples

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Abstract: Common property regimes that privatize international common pool resources are often proposed as efficient means of managing environmental problems. One such approach is the use of marketable emission allowances to control atmospheric pollution, most common in the United States, which has been suggested for the control of greenhouse gas (GHG) emissions in order to avoid dangerous changes to the earth's climate. A significant problem for the development of such common property regimes is heterogeneity among potential participants. Another is the set of practical difficulties associated with establishing and operating an emission trading program. This problem is exacerbated for the case of international GHG emissions by the lack of examples of multi-lateral emissions trading programs from which lessons for successful implementation can be drawn. This paper looks at two such efforts to establish inter-state marketable emissions permit programs for the control of nitrogen oxides (NO_X) in the eastern United States, focusing on the implications of heterogeneity among the participants and practical aspects of emissions trading.

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1 Introduction

Marketable emissions allowance systems have been proposed as efficient means of managing emissions of carbon dioxide (CO_2) and other greenhouse gases (GHG) to mitigate global climate change.[2] The United States Acid Rain Program to control SO_2 emissions from power plants is often held up as an example for international CO_2 control efforts (Solomon 1995; Solomon 1999; Stavins 1997). However, there are serious limitations to this example, including the fact that the Acid Rain Program was developed within a national framework of domestic environmental laws, while any agreement on GHG control will need to be agreed to by several (perhaps most) nations of the world, which vary enormously in terms of wealth, political culture, and many other characteristics (Fort and Faur 1997; Victor 1991, Grubb et al. 1999 pp. 210-13). In this paper, we examine two examples of efforts to establish air pollution emissions trading programs among several states in the eastern United States, which present different, and perhaps less limited insights for international GHG emissions trading since they were not developed through a system of central government. In particular, this paper examines heterogeneity among political jurisdictions attempting to come to agreement on a joint approach to environmental protection, by looking at how variation among the states affected these two efforts.

The atmosphere and the rest of the climate system can be characterized as a common property resource (CPR), which implies that their management may be problematic since many different actors must negotiate and agree on any management scheme. A particularly difficult issue in the development of a management scheme is the heterogeneity of the actors. The literature on CPR dilemmas is fairly large (see Ostrom, Burger et al. 1999 for a review), but only recently has the issue of heterogeneity among the actors in CPR disputes been discussed in any detail (Connolly 1999; Hackett 1992; Mitchell 1999; Schlager and Blomquist 1998).

Several relevant hypotheses have been generated from this prior research. First, the position of each actor with respect to the resource itself and on other dimensions can vary significantly, so that some actors are advantaged and others disadvantaged. Schlager and Blomquist (1998) give hypothetical examples of institutionally differentiated actors and deduce the outcomes, but present no examples. Second, Mitchell (1999) shows that for a variety of reasons CPR dilemmas are likely to be more common and more difficult to manage in the international domain than in the domestic. Third, Connolly (1999) shows that an important feature of negotiations about common resources is how the perception of self-interest can change whether an actor favors developing CPR use or not. These authors provide some evidence for their hypotheses, but none for cases of multi-lateral emission trading.

Illustrative examples of how such a multi-lateral marketable emissions permit schemes may or may not emerge in the heterogeneous international setting come from the inter-state markets for the control of nitrogen oxides (NO_X) in the eastern United States. These programs, designed to combat smog in the eastern part of the country include one successful example, the OTC NO_X Budget, and one highly troubled example, the NO_X SIP Call (Farrell, Carter et al. 1999; Farrell 2000: U.S. Environmental Protection Agency 1997). Comparisons between these examples and potential international emissions trading are of course limited since they were developed within a federalist political structure, but they are do have the key desirable feature that they could only be implemented through the voluntary efforts on the parts of states (i.e. the federal government could not impose a NO_X emission trading program). As is argued below, these two examples had relatively favorable conditions for the creation of a multi-lateral emission trading system, yet only one of them succeeded. Explaining the difference in outcomes here is thus important if we are to have any hope of understanding the potential for international GHG emission trading.

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[2] The phrase 'emission trading' will be used as a shorthand for marketable emissions allowance systems due to its frequency in the literature and among practitioners.

Finally, we note that using the conceptual framework laid out by Schlager and Ostrom (1992), this paper examines what they identify as the constitutional level of action, in which the methods to devise collective choice rules are decided upon, but not the rules themselves. In particular, we are interested in how different jurisdictions can agree to create and govern a multi-lateral emissions trading system, but not what sort of jurisdictions should be participants in that system.

1.1 Emissions Trading

Several types of marketable emissions trading systems exist.3 We will focus on the "cap-and-trade" variety because the most successful examples use this type of system and because Article 17 of the Kyoto Protocol essentially envisions such a system (Farrell 2000; Klier, Mattoon et al. 1997; Stavins 1997).4 In cap-and-trade programs, regulated firms are allocated a fixed number of allowances and are required to redeem one allowance for every ton of pollution emitted. The allocations are smaller than previous emissions, so regulated firms have four basic options: 1) control emissions to exactly match their allocation, 2) "under control" and buy allowances to meet this redemption requirement, 3) "over control," and bank allowances for use in future years (when even fewer allowances may be allocated), or, 4) over control and then sell their excess. Cap-and-trade systems have gained support over traditional command-and-control regulations from various corners because they greatly improve the likelihood of meeting emission reduction goals while at the same time are more flexible and lower in cost than traditional approaches. However, several practical considerations must be accounted for. It must be possible to:

1. *Define and accurately measure the pollutant(s*) of concern, their sources (both natural and anthropogenic) and their atmospheric fate and transport (i.e. understand the science);
2. *Agree on the quantity of emissions* that will be allowed (the cap) – a value that typically declines over time;
3. *Account for differences* (if any) in environmental impact for all pollutants being traded to normalize damages across emission locations and times, and across pollutant types;
4. *Create emission allowances, a distribution mechanism, and an enforceable redemption requirement* for regulated sources such that they can obtain, but then must surrender to the government (i.e. redeem) one allowance for each unit of emission they release; and,
5. *Operate a market* with enforceable contracts and rules and which assures competitive behavior.

It is important to recognize that there are roles for both private and public actors, and for both technical and political factors in meeting the requirements set out above. For instance, measuring emissions is essentially a technical issue, while deciding on allocation allowances is essentially a political one, and accounting for differences is both. Similarly, government takes most of the steps listed above, but both government and private industry are crucial to establishing an effective market. Actors negotiating a common property regime may specify other requirements beyond those listed above. For example, to obtain agreement among the actors, it may prove necessary to demonstrate some minimum level of "burden sharing", that is, to show that all emitters are doing something to reduce their own pollution, not just buying permits from others, even if this raises overall costs somewhat.

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[3] Other types of emissions trading are called Emissions Reduction Credits (Foster and Hahn 1995; Solomon and Gorman 1998) and "Open Market Trading" (Ayres 1994; Goffman and Dudek 1995). For a review of experience with market-based instruments in general, see (Stavins 2000).

[4] This discussion assumes the principal participants are firms, which are accountable to a government body. For a discussion of how this sort of system might be implemented internationally for GHG, see Grubb, et al. 1999 pp. 194-196, 206-213.

Several outcomes of existing cap-and-trade programs are worth noting. First, all the U.S. examples have a highly coercive character – government determines (sometimes through the legislative and rulemaking processes at the federal level, occasionally by similar processes at the state level, and sometimes through inter-state negotiations) the rules for the emission trading programs and specifies what counts as a regulated source, not private industry. Of course, the views and concerns of private industry are taken into account by government, but in the end the government has the final say. Indeed, cap-and-trade programs can be construed as simply the most flexible form of command-and-control regulation, and that many of the cost savings observed in the SO_2 example are due to this new flexibility alone (Burtraw 1996).

Second, cap-and-trade programs are usually ascribed with the property of ensuring absolute emissions limits, given adequate monitoring and enforcement provisions. The lead phase out program provided an example of the types of problems that could arise along these lines (Loeb 1990; Nichols 1997).[5] The main problems were over-reliance on self-reported data to ensure compliance with the program requirements. As a result subsequent cap-and-trade programs in the U.S. have had very strict monitoring requirements and have been very successful in reducing emissions. An important deviation on this point is worth noting – due to the potential for very high costs of a CO2 cap-and-trade program price caps have been suggested (Kopp, Morgenstern et al. 1999, Victor 2001). This approach, sometimes called a "safety valve," would have the government print new allowances and sell them at a fixed price that would escalate over time. This would invalidate the cap unless the sale price rose beyond the cost of emissions control, but would retain many of the desirable flexibilities of emissions trading programs.

Third, in all of the cap-and-trade programs implemented so far in the U.S., the allowances themselves have been distributed free of charge to exiting sources (a practice called grandfathering), generally based on previous emissions. The advantage of this approach is that politicians can literally use allowances as bargaining chips to help arrange the necessary support to pass legislation enacting such systems (Joskow and Schmalensee 1998).

1.2 The Potential For An Emission Trading Program For Greenhouse Gases

The nations of the world are currently in the process of negotiating what may become an international regime for the control of GHG emissions, through Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC). The Kyoto Protocol contains several "flexibility mechanisms" which can be interpreted as authorizing various sorts of international emissions trading. The approach that is most relevant to this discussion would follow from Article 17, and primarily involve industrialized countries (Grubb, et al. 1999 pp. 89-96, 194-217). This approach involves only the industrialized nations of the world, which are those who are identified in Annex 1 of the (still ungratified) Protocol as having obligations to reduce GHG emissions.

1.2.1 Emissions trading under the Kyoto Protocol

The U.S. is one of 160 signatories to the UNFCC, which was ratified by the US Senate on October 7, 1992. While the agreement commits the nations of the world to work to stabilize atmospheric concentrations of greenhouse gasses at a level that will "prevent dangerous anthropogenic interference with the climate system", no specific quantities, timetables or strategies are specified. These have been worked out in a series of Conferences of the Parties (COP) meetings, which are analyzed in detail by Grubb et al. (1999) and monitored by various environmental organizations (see, for instance, http://www.iisd.ca/linkages). These efforts led ultimately, in December 1997 to the Kyoto Protocol, which calls for the developed, or "Annex 1," nations to collectively reduce their GHG emissions in the 2008-12 period by about 5% below 1990 emission levels, although each nation received different specific

[5] In this program, the amount of tetraethyl lead petroleum refiners were allowed to add to motor gasoline was reduced, and finally eliminated.

target. For instance, the US target is 7%; this may be less when the accounting rules for the three industrial gasses and sinks are factored into the 1990 base line. Since Kyoto additional Conference of the Parties meetings have tried to hammer out the details of how the agreement will be implemented, including the recently suspended COP-6 negotiations in The Hague in November 2000.

Several provisions were included in the Kyoto Protocol to provide flexibility in how the targets are met, including emissions trading. Also included are credit for sinks, for emissions reductions undertaken in non-Annex 1 countries, and multi-gas provisions (Reilly, Prinn et al. 1999). As we saw in Table 1, these inclusions raise fundamental difficulties for the design and implementation of trading systems.

1.2.2 Early Action in the U.S.

Even though the United States signed the Kyoto Protocol, it was never likely to ratify it, and recent actions by the Bush Administration suggest that the United States may attempt other approaches (Bush 2001). In addition, the Administration's new 170-page energy policy devotes less than one page of text to climate change, and stresses scientific and technological research with no mention of limiting emissions (National Energy Policy Development Group 2001). Nonetheless, there have been some limited actions.

Early in the Clinton Administration a voluntary program was started through the Department of Energy to attempt to meet the Kyoto targets (Clinton and Gore 1993). However, this plan had little effect, U.S. GHG emissions through 1996 have continued to increase, and projections for the near future show a similar trend (Energy Information Administration 1999; U.S. Environmental Protection Agency 1998a).

Several bills have been introduced in the U.S. Congress to grant credit in any future regulatory system to firms that undertake control actions today (Nordhaus, Fotis et al. 1998). While in principle such "credit for early action" sounds like a good idea, which might get the country moving while Congress slowly builds the political confidence to act, a look at the details leaves one far less confident. Most current proposals would create complex auditing and accounting systems, which in some cases would treat different industrial sectors differently. In the interests of giving credit to actions taken now they would impose substantial constraints on the freedom of action available in the future design of a national regulatory program. The more complexities and differentiated sectoral treatment in a domestic program (whether imposed through legislation directly or by subsequent regulatory actions), the greater the difficulties of integrating that program into any international emission trading system that is developed. In addition, depending upon how regulatory arrangements develop subsequently, such credits could constitute a very large wealth transfer to those who earn early credits.

1.2.3 Early and voluntary efforts internationally

Control of GHG on a global basis may not begin with an international agreement at all, but may instead be built up from national or sub-national efforts (Morgan 2000). A few nations have already implemented internal market-based instruments for controlling CO2 emissions, most notably Sweden. Originally, this was a tax on most energy consumption, but this has recently been changed to an emissions trading program. More importantly, a recent announcement by the European Commissions indicated that emissions trading could be an integral part of Europe's strategy to reduce greenhouse gases.

In addition, a few industrial firms have begun to experiment with emissions trading. Most notably, BP-Amoco has started an effort to control CO_2 emissions, and has decided to employ an internal (business unit-to-business unit) emission trading program to do so. Some financial services companies (generally those already involved in the U.S. pollutant emission allowance markets) have begun to facilitate emissions trades of various sorts, usually bilateral deals between a U.S.-based or transnational firm and an organization (often associated with a national government) in a less developed nation.

1.2.4 Types of heterogeneity

The applicability of a cap-and-trade system within this context is summarized in Table 1, based on the five criteria outlined at the beginning of this section. Two types of difficulties are apparent, both instances of heterogeneity, a factor that can complicate the management of CPRs and emissions trading systems generally (Ben-David, Brookshire et al. 1999; Hackett 1992; Schlager and Blomquist 1998).

The first is heterogeneity among the actors, which can be characterized as differences in capabilities (assets), in preferences, in information and beliefs, and in decision-making. (Keohane and Ostrom 1994). In this case, heterogeneity springing from differences in capabilities are possibly the most important. The nations of the world vary enormously in historical GHG emissions, population, level of development, economic output, and other parameters. Since GHG emission allowances (or, requirements to reduce emissions) are thought to be very valuable (or costly if reduction requirements), so arguments about the appropriateness of allocation arrangements based on any of these parameters are highly contentious (Baer, Harte et al. 2000). However, other sources of heterogeneity among the actors is also important, such as differences in how important different jurisdictions judge climate change is, and even how reliable they feel climate change-related information is. Since international emissions trading may bring significant savings, it is likely to be sought, highlighting the importance of heterogeneity due to differences in rules and decision-making since property rights and trade rules are not uniform globally.

The second set of difficulties arises due to heterogeneity of the components of the climate system, as well as current scientific understanding of those components. Many of these stem from complexities and uncertainties regarding GHGs themselves. For instance, greenhouse gases vary extremely widely in atmospheric lifetime and in warming potential, so comparing them is difficult, and including them in the same emission trading program that accounts for their differences is fundamentally an arbitrary choice (Reilly, Prinn et al. 1999). These problems expand if other components of the climate system are included, such as carbon dioxide sinks (e.g. growing forests) or land use.

2 Inter-State NO_X Trading

In this section of the chapter, two efforts to control NO_X emissions from large stationary sources (mostly coal-fired power plants) in the United States will be examined. One has been quite successful, and the other mostly a failure, at least in terms of achieving a negotiated solution among different political jurisdictions. Emissions of NO_X are controlled for several reasons, but for these two cases the rationale is to ease the problem of photochemical smog (usually measured in terms of ground-level ozone concentrations) in the Eastern U.S. The law, economics, and atmospheric chemistry of this issue have evolved over the last half-century, and a brief discussion of these factors is needed to understanding the successes and failures of inter-state NO_X emission trading programs in the U.S. Among other things, they describe and explain the types of heterogeneity among the actors in these cases.

Both the OTC NO_X Budget and NO_X SIP Call are designed to help regions meet clean air quality standards for tropospheric ozone (or photochemical smog), Ozone is present naturally in the lower atmosphere in low levels (~15-45 parts per billion, or ppb), but in polluted atmospheres, can rise to several times these values (80-150 ppb are not uncommon in many areas of the country) and cause significant negative health impacts. In the troposphere, ozone is conveniently thought of as a secondary pollutant formed through reactions of two classes of primary pollutants, volatile organic compounds (VOCs) and nitrogen oxides (NO_X) in the presence of sunlight. However, this simple description belies the complex chemistry that is actually involved (Seinfeld and Pandis 1998 234-336). Ozone is actually formed via the photolysis of nitrogen dioxide (NO_2). Instead of playing a direct role in the formation of ozone, the presence of VOCs only affects the speed with which NO_2 forms ozone. The photolysis reactions compete for NO_2 with other processes, including the formation of nitric acid, peroxyacetylnitrate (PAN), and other organic nitrates, and with washout by rain, which eventually remove nitrogen from the ozone formation cycle. Ozone is also eventually removed from the troposphere by further photolysis, reactions with NO_X or VOCs, or surface deposition. Thus, the formation of ozone is dependent on the fate of NO_X, which is in turn dependent on the quantity and composition of the VOCs present.

So where is the common-pool resource in all this? It is in the limitations of the removal processes for ozone and other parts of the ozone formation cycle, which are essentially fixed chemical reaction rates.[6] Ozone concentrations can rise to unheathful levels when these removal processes (which can also be called assimilative capacity, as in Connolly 1999) are overwhelmed. More generally, pollution can be defined as the point at emissions rates rise higher than assimilative capacity for long enough to cause undesirable effects (e.g. high ozone concentrations or the acidification of soils and surface waters). The most applicable term from common-pool resource theory is probably congestion.

Since it is effectively impossible to control the removal processes of the ozone formation cycle, management of this common-pool resource is transformed into an emission control problem. That is, sources are required to limit their emissions, and thereby limit the demands they place on the assimilative capacity of the environment. The primary pollutants for ozone, NO_X and VOCs are emitted from a variety of different anthropogenic and biogenic sources. Anthropogenic NO_X emissions are almost entirely due to combustion processes in which high temperatures oxidize the nitrogen in the ambient air to form NO_X. Once emitted in the atmosphere, emissions are mixed, advected, dispersed by winds, and eventually are removed by the processes described above. However, all these processes (those associated with ozone formation and pollutant removal both) may take several days to complete, during which time pollutants travel with the wind, thus photochemical smog in any given location is the result of emissions from local as well as distant sources. This phenomenon can be called ozone regionality or ozone transport.

However, ozone transport was discovered only after the basic structure of U.S. air quality policy was developed, and to which it has been slow to adapt (Farrell and Keating 2001). Under U.S. law, ozone is regulated pursuant to Title 1 of the Clean Air Act for which Congress created a governance structure called “conjoint federalism.” In this system, the federal government (specifically the Environmental Protection Agency, or EPA) is responsible for setting air quality standards (120 ppb for ozone), creating and enforcing some emissions standards for new sources, while the state environmental agencies are responsible for controlling emissions from existing sources and operational controls such as automobile inspections.[7] To carry these activities out, states are required to develop State Implementation Plans (SIPs), which detail the steps they will take (in addition to Federal control measures) to attain the ambient standard. The EPA has oversight authority over the states and must approve their SIPs as adequately demonstrating (through a series of modeling steps) that the state will attain the air quality standard, and the EPA has strong enforcement capabilities if they do not.

Over time, the preparation of SIPs and their enforcement has become the focus of state air pollution regulatory agencies and states with little need for emissions controls (due to good air quality) have not developed the same capabilities in this area that their more polluted states have had to. Most importantly, they did not monitor air pollution in much detail, and they did not develop the ability to reliably estimate emissions of pollutants for in-state sources or the ability to use complex atmospheric models developed for air pollution policy analysis during the 1980s. These were key sources of heterogeneity among the states because both air quality monitoring and the development of accurate photochemical models were crucial to the discovery and understanding of ozone transport. Thus, by the mid-1990s heterogeneity in air quality had led to heterogeneity in capabilities and information.

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[6] Reaction rates do change with variations in temperature, insolation, and pollutant concentration, but only the latter is controllable by human action. And in practice, primary pollutant concentrations are managed not to control reaction rates but to control concentrations of pollutants, so these effects can be ignored.

[7] For some pollutants, such as toxics, the EPA regulates existing sources, but these come under Title 3.

A crucial feature of Title 1 is that the EPA does *not* have the authority to regulate existing sources directly.[8] Instead the states control existing sources through a system of air quality permits. When new evidence warrants, the EPA *can* announce a “SIP Call,” which contain new requirements of states. In particular, it can define total emission reductions a state must make, but it cannot create specific requirements for any of the source categories that the states have authority over. In contrast, the EPA is given explicit authority in Title IV to create a national SO_2 trading program, and the states have had little to do with the implementation of these requirements.

Further, Title 1 was originally written (in 1970) when tropospheric ozone was considered a wholly local phenomenon, and states were made responsible for attaining ambient standards only within their own borders (Farrell and Keating 1998). Subsequent research has shown that this is an inadequate understanding of the problem, and that significant “transport” of ozone and its precursors (especially NO_X) occurs between states. However, because this idea has so much economic and political impact, it has been (and continues to be) hotly debated (Keating and Farrell 1999). Changes to the Clean Air Act in the 1977 and 1990 added provisions for states to pursue legal means to force other states to control sources from which they believe pollution is entering their airshed. These provisions, called Section 126 Petitions, have never been successfully used, being consistently rejected by the courts, although further revisions to this section in 1990 have not been tested until recently and is still before the Supreme Court.

The states are thus put into a very odd position where they are required to individually meet an externally imposed environmental standard for a pollutant that they (in many cases) have only partial control over.[9] This has helped create a sharp division among the states, which can roughly be characterized as “upwind” versus “downwind” states, depending on whether they tend to contribute to NO_X pollution in other states, or tend receive it.[10] (This distinction will be discussed further below.) Adding to this division is the variation in ozone levels among the states and the variation in the ways that the Clean Air Act treats them. Although transport is an important phenomenon in tropospheric ozone, it has a strong local characteristic as well. Urbanized areas, especially those along the mid-Atlantic coast from Washington to Boston, tend to have greater pollution levels, largely due to car and truck exhaust. These areas are subject to more stringent federal requirements than rural upwind areas, so power plants in rural areas (of which there are many) tend to have little or no state-level NO_X emission control requirements. Thus, combination of ozone policy that essentially recognizes only local characteristics and the reality of ozone transport creates the counterintuitive condition that NO_X sources (particularly sources with tall smokestacks) in relatively clean rural areas contribute to photochemical smog in relatively dirty urban areas. The political question, framed as a common-pool resources issue is, which sources should have access to the limited assimilative capacity for pollutants NO_X? This question is especially difficult because the upwind and downwind states are highly heterogeneous. More prosaically, how should the burden of cleaning up the dirty areas be shared between upwind and downwind sources?[11]

states do have some common interests in NO_X control. For one thing, they would all like to attain the ozone standard, both due to the Federal enforcement mechanisms and internal pressure from voters (although this tends to be a stronger force in states that face a pollution problem, i.e. downwind states).

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8 On the other hand *new* stationary sources are regulated by the federal New Source Performance Standard. Thus this discussion pertains only to sources that existed prior to the implementation of these standards. By the mid-1990s, a considerable portion of total NOX emissions came from these sources.

9 This situation is very similar to the one Connolly (1999) describes as a ”differentiated position with respect to the resource.”

10 In the eastern U.S., air tends to move to the east and to the north, and the States of the eastern seaboard are generally considered downwind of nearby Midwestern and southeastern States.

11 It is more convenient to discuss this problem using the traditional language of pollution control policy rather than in terms of common-pool resources, so this framework will be adopted for much of the rest of the chapter.

In addition, they would all like to minimize the apparent costs to voters, and the real costs to firms within their borders. Emissions trading systems can accomplish this since their principal virtue is greater efficiency than command-and-control regulations. Further, the more sources there are in an emissions trading program, the greater the available efficiency gains so states considering this approach have an incentive to joint a multi-state program rather than rely only on in-state ('domestic') emission trading.

Comparing this arrangement to the politics of climate change, one can see that the case of NO_X control is more like potential CO_2 control efforts will be than the SO_2 case was, but it is still an incomplete comparison. The biggest similarity between the two cases is that states are largely independent when it comes to establishing regulations for existing sources, and all the more so if they can support the claim that their emissions do not affect downwind states, much as nations will have the right to control CO_2 emissions any way they want in an international agreement. There are dissimilarities, as well. One is that all the states in the OTC have relatively strong incentives to control NO_X emissions. An even larger difference is that the U.S. states operate within an authoritative legal system and a single economic system that permits virtually unfettered capital and trade flows among them. Thus, although there is less heterogeneity among the U.S. states than among the nations of the world, even these relatively weak differences go far in explaining the formation and lack of formation of inter-state emissions trading, as we will see.

2.1 The NO_X Budget

The first example we will look at is a successful one, the NO_X Budget, that essentially applies to electrical generating units that are rated at 25 MW or larger and similar-sized industrial facilities (such as process boilers and refineries). About 90% of the NO_X emissions covered by the program come from electric power plants. It covers emissions from May through September in eight northeastern states of the U.S. (of the 11 in the OTC). There are over 470 individual sources in the program, owned by 112 distinct organizations (mostly private firms). The program has three phases; the first was essentially a re-labeling of the NO_X RACT program that the states were required to implement anyway. The second and third phases use a cap-and-trade emission allowance program to reduce total emissions by 55%-65% (compared to uncontrolled sources) for 1999-2002 and by 75%-85% starting in 2003. For electric power plants, these restrictions are most often discussed by referring to the equivalent emissions rate limit corresponding to the final, most stringent emissions reduction requirement, measured in terms of heat input to the Boiler. For the NO_X Budget, this value is 0.15 lb. NO_X/mmBtu.

As indicated by the explanation above, the Federal Government could not impose the NO_X Budget directly. Instead, it emerged from cooperative action by several northeastern states that had been grouped together into a special Ozone Transport Region by Section 184 of the Clean Air Act Amendments of 1990. At the same time, Section 176 created Transport Commissions for such regions, and the northeastern states were thus placed into the Ozone Transport Commission (OTC).[12] The OTC was charged with "developing recommendations for additional control measures to be applied within all or part of such transport region if the commission determines such measures are necessary."

The EPA supported the development of an emissions trading program and used several approaches to stimulate cooperative action by the OTC states, such as funding several studies of multi-state emissions trading, and supporting several multi-state organizations dedicated to regional air quality management (U.S. Environmental Protection Agency 1992).[13] Further, the EPA offered to operate systems to track NO_X allowances and monitor NO_X emissions for any OTC NO_X program.

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[12] It is worth noting that Congressional representatives from the downwind states most supportive of the OTC introduced this concept into the law and worked for its passage.

[13] For the OTC itself, see http://www.sso.org/otc/. The other groups are the Northeast States for Coordinated Air Use Management (NESCAUM, see http://www.nescaum.org/) and the Mid-Atlantic Regional Air Management Association (MARAMA, see http://www.marama.org/).

After the OTC had been created, it still took over 5 years for the states to develop the NO_X Budget, a process that occurred in two important steps. First, the states (with one exception, discussed below) signed a Memorandum of Understanding (MOU) on September 27, 1994 that committed them to emissions reductions as stated above. However, the states were not ready to agree to emissions trading yet, so the MOU presumed command and control regulation but did provide for the development of a "region-wide trading mechanism". The intent was for the states to negotiate the specifics of an emission trading regime and come to a mutually agreeable solution.

While it is all well and good to support emissions trading in the abstract, the members of the OTC (state environmental commissioners and their staffs) found that there are many particular features of emissions trading that were complex and poorly understood. At the most basic level, some regulators are uncomfortable giving flexibility to industry, based on long experience of misleading rhetoric, extensive and drawn-out lawsuits and duplicitous behavior; e.g. falsified reporting in the lead phase out program (Nichols 1997) and abuse of routine maintenance provisions to avoid new source requirements (Perez-Pena 2000). Another issue was the ability of the states to retain as much control as possible in the program. In particular, the states demanded that they individually be allowed to allocate allowances to sources (rather than using a uniform formula. Each state was also concerned about a first-mover *dis*advantage; what if they went ahead and implemented a tough emissions reduction program only to find that some of the other states backed out of, or weakened, their commitment?

Probably the most difficult question, however, was the potential impact of cross-border trades in emissions allowances. Due to the directionality of the ozone problem, downwind regulators were concerned that firms in their states would over control (and pass the cost on to in-state consumers), only to sell their excess allowances to upwind facilities (and presumably keep the profits). The upwind facilities thus would not have needed to control their emissions, which would then be transported into the downwind state. To the downwind state regulators, this seemed like the worst of all possible outcomes since costs to their state would be higher while the upwind sources would not be "doing their share" to reduce emissions. With this phrase, downwind regulators seem to imply that upwind sources must reduce their emissions at least somewhat. This rather misses the point of emissions trading that firms with high control costs can "do their share" by buying emissions from firms with low control costs, who cut emissions more than they would have otherwise had to. Of course, the directionality of the photochemical smog problem in the Northeastern U.S. provides some rationale for this concern. Regardless of the scientific basis (or the lack of a scientific basis) for such concerns, the view that such burden sharing is an important goal in itself, even if it comes at a cost, is widely held and obtains some resulting validity. The vision that state regulators have of in-state electricity consumers being stuck with the bill for emissions control is more an artifact of the monopoly franchise system for electric power than the economics of emissions trading. Moreover, the electric power system in the U.S now being restructured, and power generation is becoming increasingly competitive, downplaying the importance of this effect.

The issue of burden sharing also arises in discussions about controlling GHG emissions. Nations are just as likely as states to want all parties in an emissions trading program to share in the burden of cutting emissions, and they may also prefer burden-sharing take the form of similar emissions reductions among all participants rather than similar costs of control, even if this drives up the total cost. To some degree, these concerns are expressed within the framework of the Kyoto Protocol in discussions about "supplementarity" (Grubb et al. 1999 *xxxvii*, 217-220).

The OTC states and the EPA took several steps to solve the problem of burden sharing. First, the EPA funded studies of emissions trading programs that showed no major geographic effects (ICF Resources 1995). Importantly, the states participated in the design of these studies, so they knew their questions had been addressed and they had reasonable confidence in the accuracy of the research (Farrell 2001). Second, the OTC states solved the image problem of emissions trading by emphasizing the regional emissions reduction, not the effects on in-state facilities specifically. Third, the states cooperated to develop a model emission trading rule that all could adopt, but which was flexible enough to match the peculiarities of each state's legal framework and gave each state control over how to allocate emissions (Carlson 1996). The actual amount of emissions available for allocation was fixed ahead of time in the agreement to control emissions in the first place (in the MOU) and not part of the negotiations on the emissions trading rules.

These efforts took several years to complete, and they did not quite produce a uniform emissions trading program. Figure 1 shows which OTC states have joined the NO_X Budget **(**solid shade) and which have not (vertical cross hatch). The pattern is interesting; the states at the extreme upwind and downwind have tended not to participate. Vermont and Maine (two of the most downwind states) decided to operate traditional permit-based programs, because the small number of sources involved (less than three in each state) and their regulatory status did not justify the administrative burden of developing an emissions trading program. At the upwind end, Virginia did not join the NO_X Budget but it has not taken any other action to regulate the sources that would have been part of the program. In fact Virginia has been an uncooperative participant in the OTC negotiations all along, being the only state that did not sign the original MOU in 1994, and obstructing or ignoring many other OTC activities.

In general, this pattern of participation in the NO_X Budget matches the pattern of interests of the states. Those that participate fully both have cities on the eastern seaboard with severe ozone pollution problems, and are both upwind and downwind of other states in the OTC. The states that do not participate lack one of these two conditions.

2.2 OTAG and the NO_X SIP Call

Although the OTC NO_X Budget is an important step forward in the management of a large and complex CPR (the assimilative capacity of North America for photochemical smog and its precursors), by no means did it solve (or even truly address) the upwind/downwind problem described above. In this section, the two most important efforts to deal with that issue are presented, the Ozone Transport Assessment Group (OTAG) and the NO_X SIP Call. They followed, and to some degree were based on the successful process that resulted in the OTC NO_X Budget program, but had very different results.

The OTAG process preceded the NO_X SIP Call, and came about due to a very unusual set of circumstances. It was created in response to a crisis in air quality management that occurred in November 1994; just after the OTC MOU on NO_X control had been signed. This crisis consisted of a combination of a failure of states to submit new SIPs, which were due that month under a provision of the 1990 Amendments, and the election of a new Republican Congressional majority with an overt anti-regulatory, anti-federal government agenda (Gillespie and Schellhas 1994; Pagano and Bowman 1995). The downwind states failed to submit SIPs because their own air quality modeling had shown that even if they implemented expensive, unpopular emissions control programs mandated in the 1990 Amendments to the CAA (e.g. automobile emissions inspections), they would not necessarily achieve federal clean air standards due to incoming ozone (and precursors) from the upwind states. Of course, upwind states felt they had no serious air quality problems and had little reason to develop expensive SIPs, much less implement NO_X controls. This created a stalemate.

Traditional methods of addressing this type of problem, such as federal lawsuits or EPA orders, were not pursued by the upwind states or environmental groups due to the fear of reprisals by the newly elected Congress. The belief of state environmental agencies that they, not the federal government were the appropriate group to address this problem was also important. Thus, in the spring of 1995 the EPA quietly agreed with a few key states and NGOs to hold off on lawsuits and instead engage in a "consultative process" to be completed by the end of 1996. Their purpose would be "to reach consensus on the additional regional, local and national emission reductions that are needed for … the attainment [of the ozone standard]" (Nichols 1995).

The Director of the Illinois EPA and Vice-Chair of the newly formed Environmental Council of the States (ECOS), Mary Gade, became the chair of OTAG, which quickly gathered momentum and took on a character and direction of its own. By August 1995, there were over 300 participants and eventually, there would be approximately 1000 people involved at some level. This effort involved 37 states, including many of those partially visible in white on Figure 1. However, the participants disagreed about why they were there. To downwind states facing statutory deadlines, OTAG was a mechanism for delaying expensive and unpopular emission control programs and for obtaining long-sought emissions reductions in upwind states. However, to the upwind states that were not subject to statutory deadlines, OTAG was a mechanism being used by downwind states that *were* subject to these deadlines to *unnecessarily* extend these same expensive and unpopular emissions control programs to them. Their goal was to prevent any such thing from emerging out of what quickly became viewed as the highest-profile regional ozone study ever conducted. The essential point is that despite lengthy cooperative studies and negotiations in OTAG, the upwind states never came to believe that it was in their interest to cut NO_X emissions as the downwind (OTC) states had decided to do.

Instead, OTAG's recommendations were very vague, they recommended a level of control from the status quo (i.e. nothing beyond what was already in the Clean Air Act) through the tight limits of the NO_X Budget. In addition, the recommendations support emissions trading generally, but OTAG was not able to develop any specific proposals. This allowed a wide range of states who essentially did not agree to nonetheless "come to consensus" on these conclusions. In this way the OTAG recommendations look very much like a typical agreement that international environmental negotiations produce: a relatively soft statement that re-affirms the status quo (Keohane, Haas et al. 1994; Victor, Raustiala et al. 1998).

The end of the OTAG process was followed quickly (too quickly, in the opinion of some state leaders) by the NO_X SIP Call, in which the EPA attempted to create a cap-and-trade program much like the OTC NO_X Budget, but through the SIP process described above. It was formally proposed an EPA announcement in the *Federal Register* on October 10, 1997 (finalized on October 27, 1998, *FR* 5736-57538).

While the OTC NO_X Budget was created by a group of states to help them meet federal clean air requirements, which they were all challenged with, the NO_X SIP Call is designed primarily to reduce NO_X emissions from upwind states to help the downwind states (who are the OTC states, of course) meet those same requirements. In its announcement, the EPA identified 22 states, including all the OTC states (less Maine, New Hampshire, and Vermont) plus the states shown in horizontal cross-hatch in Figure 1 which would need to reduce NO_X emissions due to their "significant contribution" to ozone pollution in downwind states, and called on them to revise and resubmit their SIPs to accomplish these reductions. Thus, the NO_X SIP Call was proposed after the OTC NO_X Budget had begun to take shape, but before emissions reductions or emissions trading had started.

In practice, the NO_X SIP Call would extend the 0.15 lb./mmBtu requirement embodied in the NO_X Budget to all 22 states. The EPA may not specify such a requirement, of course, so instead it developed a "budget" for each state and required that the states develop SIPs that would meet this budget. In calculating these budgets, the EPA estimated the total emissions from each state assuming existing control programs would remain in place, and that cost-effective emissions controls would be used on all sources. Among the additional controls that EPA identified as cost-effective were those that would bring coal-fired electric power plants down to 0.15 lb./mmBtu, plus a few others. Most importantly, the EPA applied *uniform* controls across all 22 states, ignoring any spatial effects.

To encourage the formation of an emissions trading program, the EPA included in it's *Federal Register* announcement a provision that it would automatically approve SIPs that contained emissions trading provisions published simultaneously. It also volunteered to take on many of the administrative and monitoring tasks, just as it had for the OTC NO_X Budget, and sponsored studies of emissions trading over the larger geographic area as well (Dorris, Agras et al. 1999; ICF-Kaiser 1996; U.S. Environmental Protection Agency 1998b).

It also appears that the NO_X SIP Call more or less conforms to the emissions reductions that the EPA had internally decided would be need even before OTAG started, based on a previous set of studies (Milford, Gao et al. 1994; Possiel and Cox 1993; Possiel, Milich et al. 1991; Roselle and Schere 1995). It is important to note that the analysis conducted subsequently under OTAG did not contradict these previous findings; rather it tended to increase the number of people (especially those outside the EPA) who were familiar with the results (Keating and Farrell 2000). It is also worth noting that the EPA at the time was pre-disposed to support emissions trading, which is most easily implemented with a uniform reduction requirement (Nichols 1999).

The NO_X SIP Call was spectacularly unpopular and generated as large number of lawsuits by the upwind states, who claimed that the EPA did not have the authority to issue the NO_X SIP Call and that the analysis underlying it was flawed in any case (Anonymous 1996; Flannery 1997; Flannery and Spatafore 1998). Most states subject to the SIP Call are planning to require controls on power plant NO_X emissions to help maintain air quality in their own states. Non-OTC states seem willing to impose emission trading requirements equivalent to 0.25-0.20 lb./mmBtu, which may be a 50%-65% reduction on average, but refuse to go further (Arrandale 2000).

Many of the downwind states filed Section 126 petitions at about the same time the NO_X SIP Call was announced, further adding to the dispute. Some time later, the EPA decided to grant several of these petitions (the disposition of some of them is as yet undecided), which were similar to the requirements of the NO_X SIP Call (Wald 1999).

After the NO_X SIP Call and Section 126 petitions were filed, the upwind states and power companies operating there filed numerous lawsuits.[14] The U.S. Supreme Court eventually rejected these arguments, so the emission reductions will be made (Kelley 2000). However upwind the states never agreed to this approach, they were literally forced into it by an authoritative federal government. Implementation plans currently being developed by the states do not appear to be aimed at developing a multi-state emission trading program; some states may introduce in-state emission trading while others may stick to command-and-control approaches. Further, a national-level program of NO_X reductions from power plants may be implemented through legislation currently before the 107th Congress, an action that would partially fulfill a campaign promise by President Bush. None of these outcomes would be very informative examples of how a multi-lateral cap-and-trade system for atmospheric emissions could be developed.

3 Discussion

The political and economic conditions for the creation of a multi-lateral cap-and-trade system for NO_X among the states of the U.S. are more favorable than they are likely to be in most international settings. In large part, this is due to the much more limited heterogeneity among the states compared with the differences that exist among the nations of the world. Yet even these relatively smaller differences played a large role in both cases. This section discusses the main issues for multi-lateral emissions trading brought out in the comparison of the OTC NO_X Budget and the NO_X SIP Call, many of which spring from heterogeneous features among the actors.

3.1 Coordination

Coordination among different political jurisdictions is central to a multi-lateral emissions trading program, and the OTC NO_X Budget shows that such coordination is possible, a useful finding in itself. More critically, the coordination of regulatory development in that case proceeded from a prior history of

[14] Simultaneously, many of the same interests were engaged in a separate legal battle over the ozone standard itself.

cooperative technical assessment and interaction among regulators. Even more importantly, the effort needed to develop a coordinated multi-state cap-and-trade program was undertaken *after* a political agreement to control emissions has preceded agreements to use of cap-and-trade systems. The original MOU committed the states only to NO_X controls; it explicitly left the option of emission trading open, but it was not at all clear in 1994 when it was signed that efforts to develop an effective emissions trading program would be successful.

In the contrasting case, a larger number of states with very divergent interests were able to coordinate in a technical assessment, but they were not able to agree on a firm pollution control strategy. The lack of specific recommendations by OTAG on an emissions trading program may be related to a lack of any feeling of necessity on the part of the participants. Subsequently, as the final outcome of the NO_X SIP call continues to emerge from the courts, it appears that emissions trading will proceed on a piecemeal, state-by-state basis, if at all, most likely raising the costs of compliance.

3.2 Existing regulations

Several authors have claimed that the absence of prior regulations was an important feature of the success of the SO_2 program. This is not true for the NO_X Budget, nor is it true for the SO_2 program either! Power plant SO_2 had been controlled for human health reasons beginning in the 1970s, at the Federal level for new sources and the state level for existing (Ackerman and Hassler 1981). Moreover, the emissions trading provisions of the 1990 Clean Air Act Amendments clearly state that emissions trading cannot result in any violations of the Title 1 health based standards for SO_2. Of course, it is true that Federal SO_2 controls on existing power plants, and that controls designed to address acidification were new. In any case, the NO_X Budget is clearly an addition to pre-existing regulations on both the state and Federal levels, and is designed to achieve long-standing human health goals.[15] Thus it appears that cap-and-trade programs can be used to supplement or replace existing command-and-control regulations just as easily as they can be used to regulate a new pollutant. What is difficult is to combine the two sorts of regulations (Foster and Hahn 1995).

3.3 Symbolic power

Emissions trading programs are sometimes thought to have less symbolic power; politicians supposedly cannot earn the same level of admiration and support for enacting an emissions trading program as they can for “getting tough with polluters” through command-and-control approaches. While there is some truth to this hypothesis, it appears that in the U.S. at least a reasonable portion of the public understands that emission trading programs do in fact have teeth. This can be seen in the positive media stories about the NO_X Budget and the vociferous language used by states attempting to avoid the NO_X SIP Call.

It may be difficult to generalize this observation to the international community, however, since the U.S. is quite singular in its use of emissions trading. Other nations (and especially public opinion in other nations) may continue to misperceive emissions trading as an ineffective means of emissions control, particularly since most countries are less willing than the U.S. to rely on the market for things like health care or labor supply. In addition, buying emissions allowances looks to many like avoiding any responsibility for the problem (despite paying for cleanup elsewhere), and this may pose fundamental political impediments.

3.4 Flexibility and simplicity

Two of the standard prescriptions for emissions trading is for simplicity of design and flexibility for the participants, however the inter-state NO_X cases show that it is all too easy to be *too* simple and *too* flexible. The uniform standard embodied in the NO_X SIP Call is a case of an overly simple design. Had

[15] The same can be said for California’s RECLAIM program (Lents and Leyden 1996).

the EPA responded to the upwind (mostly Midwestern) states concerns about the effects of distance, some form of emissions trading might already be in place. In fairness, if it is in fact true that 85% reductions across all 22 states are necessary to achieve the ozone standard in the cities of the eastern seaboard, than the EPA's approach has considerable merit. (To some degree, of course, a debate about what is *"scientifically necessary"* is misleading and misses the point. Many combinations of local and regional emissions control plans would attain the standard; the real question is which one is most easily accomplished *politically*.)

Further, the flexibility that firms have in timing their emissions within the five-month season may prove to be excessive (Farrell 2000; Farrell, Carter et al. 1999). Although there is less of a temporal and spatial pattern in the global warming system than in the tropospheric ozone system, the basic lesson still holds: there must be a close match between the regulations to control an environmental problem and the physical and social phenomena that create it in the first place.

3.5 Expertise and Leadership

A common view of the way an international emission trading program could be developed is for the U.S. to "lead" by establishing a domestic emission trading program that other countries could copy (Solomon 1995). However, the evidence provided by the NO_X Budget and the NO_X SIP Call strongly counterindicate, the program that was centrally-sponsored (the SIP Call) failed, while the program that was cooperatively developed (the Budget) has turned into a significant success. Further, during the OTAG discussions on emissions trading, the disparities between the OTC states and EPA on one side, and the remainder of the states was very large (Keating and Farrell 1999 pp. 70-80). The OTC states were comfortable with the idea of emissions trading and understood the policy implications of various options, while the upwind states were much less familiar with the concepts and were concerned about being tricked into an agreement that was disadvantageous due to being less well informed. In addition, the same problem of uniform controls emerged. The OTC states assumed (or asserted) that uniform controls were necessary for the creation of a successful emissions trading program, while the upwind states insisted on finding a way to enable emissions trading between regions with differentiated control requirements.

The lesson is clear, expertise and experience in emissions trading does automatically not translate into a leadership position, rather it is far easier for advocacy of this approach to look like an effort to pressure other jurisdictions into an arrangement they may not understand as well and which may be disadvantageous to them. This is especially true of how the upwind states viewed the NO_X SIP Call. In the NO_X Budget case, the key to a successful program seems to have been cooperation in analysis and policy development, not advocacy disguised as "leadership." With the U.S. reputation as a dominating participant in international negotiations in addition to its position as the leading advocate of emissions trading, this problem seems particularly relevant to attempts to develop an international CO_2 trading regime.

3.6 Reading market signals

If creating cap-and-trade programs is a relatively new and uncertain endeavor for government, so, too, does industry have new roles and new challenges. These programs are vastly different from traditional environmental regulations, typically leading to the creation of new markets for emissions allowances, which bear some resemblance to financial markets. The newness of these markets, plus the changes in the electric power sector have produced a number of questionable interpretations. One is that emissions trading markets are "thin" (i.e. lightly traded) and thus inefficient or subject to high transaction costs. However, the fact that these markets are quite concentrated (a small number of firms own many allowances and many power plants) means that many firms can achieve considerable savings simply by re-allocating allowances internally, something that would not be picked up in market transaction data (Burtraw 1996). Some observers seem to think that a large volume of traded emissions is a necessary condition for success, partly because many early models of emission trading programs forecast this outcome. Second, periods of low allowance prices during an early part of the SO_2 market have been widely misinterpreted, and the advantageous conditions that produced those bargains may not occur in other markets (Schmalensee, Joskow et al. 1998; Smith, Platt et al. 1998). Third, some have suggested that transaction costs in these markets are high, yet none of the participants have made such complaints.

Several consistent and convincing signals have been observed, though, 1) consistent low allowance prices (volatile periods aside) 2) an increasing reliance on the market and an increasing sophistication in how it is used, and 3) significant emissions reductions (Ellerman 1998; Ellerman and Montero 1998; Farrell 2000; Klier, Mattoon et al. 1997; Mueller 1995). This combination suggests that despite the oddities of these markets and short-term glitches, the major cap-and-trade programs operate more or less as advertised to reduce total emissions at relatively low costs. Even more encouraging are the signs that these programs have stimulated technological change, which will help bring down costs even more in the future (Conrad and Kohn 1996; Farrell 2000).

3.7 Participation and interests

An important finding in the study of CPR is that the position of the actor relative to the resources can affect their willingness to participate in solving CPR problems (Schlager and Bloomquist 1998 pg. 102, Connolly 1999). Both of the cases examined here strongly support this contention, and suggest that it can be broadened somewhat: participation in the development of an emissions trading system varies according to the interests of potential participants, greater similarity implies greater likelihood of participation.

In the case of the NO_X Budget, the fact that Virginia has not joined is a good example of an actor that perceives itself as immune to the adverse effects of others (to use Shlager and Blomquist's phrase). But Maine and Vermont have chosen not to join for a different reason – their level of industrialization is so low that it seems like too much of an administrative burden. And even though Maryland did join the NO_X Budget, they were forced by an industry lawsuit to delay for a year. The basis of the suit was that Maryland did not have a NO_X RACT program before the NO_X Budget was to go into effect, putting regulated sources in a particularly difficult situation. Thus, because the state was a little behind the rest of the OTC states in terms of regulation, its ability to participate in the NO_X Budget was affected. On the other hand, the states facing the largest emissions control costs, such as New Jersey, were the strongest supporters of emissions trading.

Even stronger examples exist in the NO_X SIP Call case. Here, not only did state environmental agencies vary in their support for emissions trading according to their location, but so did firms. The usual monolithic "no" to more regulation shattered during the OTAG negotiations, as firms located in down-wind states came to recognize they would be advantaged by a larger emissions trading program and they became stronger supporters (Keating and Farrell 1999 pp. 93-4).

3.8 Trust

Participants in the NO_X Budget negotiations and OTAG assessment all highlight the importance of developing "trust" between the participants. In general, this came from working closely together on problems that were to some degree shared. A closer examination, however, shows that in practice, "trust," meant different things in each case. More importantly, states came to trust that the *process* they were participating in could not be manipulated against their interests. In this sense, they only trusted other states as far as they could verify their actions.

While they were developing the NO_X Budget, the OTC members came to trust that emissions trading would work to solve their problems, and to trust each other to accurately represent their own situations during group meetings. This trust developed over the course of several years as a result of repeated face-to-face interactions and through the realization that duplicitous behavior could be detected relatively easily through this process. Third parties (such as the EPA) aided in this process. Thus, when they finally agreed to control emissions, OTC members took steps to verify this was the case. This included submissions of texts of new regulations, emissions inventories, and reports of progress on control technology deployments. A key verification feature, however, was the emissions monitoring regime that was well established by Title IV of the Clean Air Act by the time the OTC NO_X Budget was being negotiated.

Similar mechanisms were at work in the OTAG process, with similar outcomes, despite the greater the distrust between the states beforehand and the shorter time available to overcome that distrust (Keating and Farrell 1999 pp. 138-9, 144-6). The fact that no permanent follow-up was created after OTAG ended and thus no verification mechanisms were available helps explain why the NO_X SIP Call has created so much opposition.

3.9 State control

It is hardly surprising that states wanted to retain as much freedom to implement the multi-lateral emissions trading program as possible. In particular, in the NO_X Budget case, states insisted on retaining control over how the allowances were allocated. As it turns out, the states have adopted very different processes for allocation (for instance, some held public meetings, others did not) but these variations have had no observable effect on the performance of the system. This suggests that there are limits in how much central control may be feasible in multi-lateral emissions trading programs, especially for one with the potentially large economic consequences of controlling CO_2 emissions.

4 Conclusions and recommendations

Despite our pessimistic view on the prospects of an emissions trading system based on the UN Framework Convention on Climate Change, we feel that it is certainly feasible for emissions trading to become part of the international response to climate change. The lessons from the study of Common Property Resources (CPRs), and from the cases above of efforts to develop inter-state emissions trading within the U.S. federal system clearly show reason for optimism. As we have stressed, understanding and managing heterogeneity among the actors is a crucial part of the process, although there are other issues as well. We now offer some closing remarks.

This paper presents evidence that multi-lateral emissions trading is possible. The key elements are a common belief among the different jurisdictions that emissions control is needed and a formal structure in which coordinated analysis and policy can be developed. Nonetheless, crafting multi-lateral emissions trading, even in a best-case scenario, is exceedingly difficult; it requires solving the institutional, resource allocation and coordination problems described above. The prospects for further progress on multi-lateral emissions trading in the United States may be limited, since it is quite rare for a large number of states to have similar enough interests to meet the first necessary condition. Even if the EPA is eventually successful in forcing a large-scale NO_X control program through the SIP process, it is not at all clear that this process will meet the second necessary condition.

Surprisingly, the prospects may be brighter internationally, as many different countries have come to see regional and global environmental issues as a common threat, and many routes for international cooperation on environmental science and policy now exist. The history of international agreements shows quite clearly that effective regimes start slowly, in areas as divergent as environmental protection and trade. International trade agreements, arguably the most successful international regime to date, grew and evolved over time, adding new countries and new goods slowly, carefully resolving conflicts between national interests (Jacoby, Prinn, and Schmalensee 1998). Developing countries often received special phase-in arrangements and even perpetual opt-outs of the most demanding requirements. It is a powerful agreement, but it took 50 years of hard work.

Once an agreement to reduce CO_2 emissions is in place between two or more states, we expect emission trading systems would arise among similar nations, where the most relevant dimension to measure similarity on is national capability to implement emissions trading.[16] This could easily happen outside of the Kyoto framework, possibly as a simple bilateral program at first, although nations that develop such a system would certainly be justified in claiming that they were *jointly* meeting their Kyoto targets thereby. Other relevant dimensions of similarity may be the presence of fossil resources, the structure and size of energy taxes, the ability of their economies to produce innovation and allow labor adaptations, the role of environmental issues in national politics. Nations that share (at least partly) energy system infrastructures (i.e. electrical generation capacity and petroleum product supply chains) and strong economic ties (e.g. the European Union or Mercosur) may be the most likely to start an international emissions trading system.

However, we would *not* necessarily expect that nations developing an emissions trading program will have similar CO_2 control costs. Indeed, emissions trading saves the most money when control costs vary most, so nations that see an opportunity to meet emissions control goals more by inducing reductions in another country than at home might well join, as well as countries that see an opportunity to improve their balance of trade and possibly stimulate energy system investments by over controlling their emissions and selling the excess. Nonetheless, there are surely limits to the amount of money nations would be willing to see leave the country in order to provide a global public good such as climate stabilization, perhaps one or two multiples of current foreign aid budgets. For these reasons (and for others stated above), we would expect that either the prices or volumes of internationally traded CO_2 emissions allowances would be relatively small. This observation suggests that balance of trade concerns might be an additional factor (besides those traditionally mentioned by economists) that could reduce the efficiency of international emissions trading systems.

Our most important conclusion, however, is that there is absolutely no need to assume comprehensive top-down international emissions trading programs that involve significant binding commitments are the only way to develop and effective, efficient GHG reduction strategy. Indeed, such approaches will almost certainly fail, since key countries such as the US, China and India will not agree to participate. The diplomats will put a good face on things and keep trying, but for at least the next decade it is unlikely that all the world's major states will simultaneously be prepared to sign up for a serious program of carbon dioxide emissions control.

Skolnikoff has argued that the US, and especially the Congress, will be slow to become an active participant in any

> "...issue in which the UN and the international community must play a central role. There is a climate of xenophobia in the Congress, reflected to some degree in the electorate that is challenging the role of the nation in world affairs and particularly in the work of the UN and its associated bodies.... [T]he current mood, often reflected in Congressional statements and votes, sees a vocal portion of the public turning away from foreign involvements...and rejecting policies that are perceived as in any way infringing American sovereignty. In this context, an agreement negotiated under the auspices of the UN that if carried out would certainly have an impact on the American economy is immediately suspect." (Skolnikoff 1999)

US domestic political concerns are not the only problem. As Jacoby et al. have noted, developing international institutions that will facilitate policies to minimize the cost of reducing GHG emissions,

> "...requires solving the monitoring and enforcement problems necessary to implement efficient international trading of rights to emit [GHGs. It also]...requires an institutional structure that can exploit the cheapest abatement opportunities, wherever they may be found...This is a tall order. The international trade regime developed under the General Agreement on Tariffs and Trade, now the World Trade Organization, hints at the difficulties involved. This regime grew and evolved over time, adding countries and goods along the way, peacefully resolving conflicts between national interests...By the standards of international affairs, the WTO has been a stunning success, but it took 50 years of hard work..." (Jacoby, Prinn et al. 1998)

[16] We can assume these nations also have a similar (high) national interest in CO_2 control, else they would not have joined the agreement to begin with.

Jacoby, his co-authors and many others, have argued that, because GHGs are global pollutants, they cannot be managed without an overarching international accord. Fortunately, as both the WTO example just cited, and many examples in the literature on the management of common pool resources, suggest (Ostrom, Burger et al. 1999), a top-down international framework may not be the only route to a global regime for managing carbon dioxide. The NO_X Budget case shows it is possible for independent jurisdictions to agree on how to implement an emissions trading system, but the limits in this example, and the outright failure (so far) of the NO_X SIP Call, warn us that it is not easy.

Indeed, a top-down approach may not even be the best route. Several countries, such as Norway and the Netherlands, have begun to take unilateral action. While these actions are dismissed by some observers as limited and self-serving, they reflect their citizens genuine political commitment. The history of international environmental protection shows quite clearly that effective regimes start slowly. The diplomatic community needs to figure out how to encourage the growth of local and regional regimes, and encourage their coordination so that ultimately they can coalesce into a set of global arrangements that encompass all major states (Morgan 2000).

An evolutionary bottom-up strategy has several benefits. Concerned states and regions can start today. As different early adopters try different strategies, the world will get an opportunity to evaluate alternative approaches and learn from mistakes. Early adopters can provide the inspiration, and proof of concept, to inspire, or shame, citizens in other countries to take action. Some will argue that a bottom-up approach can never work, because nobody will go first for fear of free riders. However, national environmental policies are often not primarily driven by economic considerations. There are growing numbers of people who believe that the world must act, and are willing to assume some extra burden, and provide an example for others.

If a bottom-up strategy is going to work, the diplomatic community needs to take concrete steps to support and encourage sub-global carbon management efforts. For example, early adopters may want to impose a domestic carbon emissions tax on power plants, process industries, and on the production or use of transportation and heating fuels. These states might be willing to have their industries face a modest competitive disadvantage in world markets. However, they will certainly not want to disadvantage domestic industries. Thus they will want to impose nondiscriminatory boarder adjustment tariffs on the carbon dioxide releases that are implicit in imports. This might be done through a set of default values that importers can replace, at their option, with real values verified by some impartial international auditing entity. Such a system would have to be made compatible with World Trade Organization rules, which today might disallow such taxes on the grounds that they are discriminatory, or inappropriately consider process. But, trade rules are always in flux and multilateral agreements are treated more favorably than unilateral initiatives. With some effort, several nations might be able allowed boarder adjustment externality taxes on global pollutants, even if not on local pollutants.

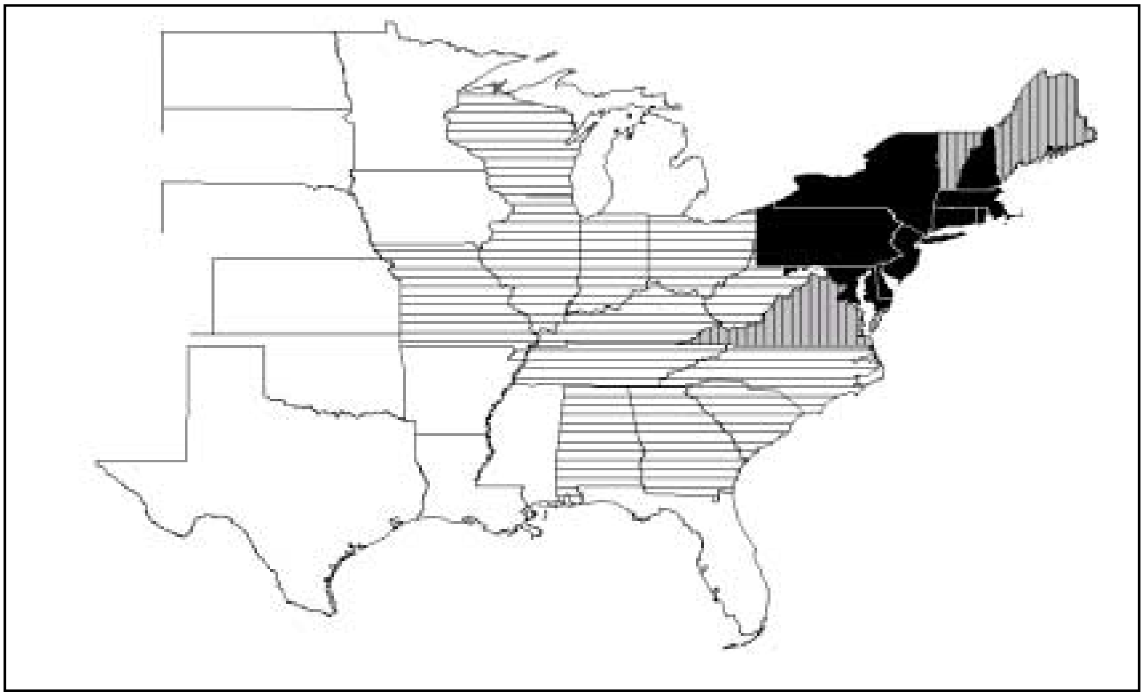
The diplomatic community could also help by opening a forum for discussions among states that want to act now. As more states begin to develop control strategies, there will be growing needs to coordinate, to reconcile tax-based approaches with cap-and-trade approaches, to figure out how to treat multinational firms, how to promote the basic technology research needed to create the intellectual capital that the market will need to develop future clean energy systems, and ultimately, to coalesce the voluntary network of controls into a more binding international system that includes all major industrialized and industrializing states.

Research into CPRs has shown societies of all sorts have managed to develop sustainable means for managing vital resources, but that many have failed to do so and perished. We need to act now to encourage initiatives by individual states and regions so that we can learn how best to move the world's economies toward a lower-impact, more sustainable future. Fortunately, it may be possible to develop such strategies from the ground up.

Table 1: Criteria for a cap-and-trade system, and two applications

Criterion	Applicability to OTC NO_X Budget	Applicability to GHGs
1 Define and accurately measure the pollutant(s), their sources, and their fate and transport.	Sources are easily identifiable and most already had Continuous Emissions Monitors (CEMs) for NO_X as part of the SO_2 Acid Rain Program monitoring requirements. Fate and transport is reasonably well understood, although varies from source to source, and with weather conditions somewhat.	Source identification and emissions measurement are relatively straightforward for CO_2 emissions due to fossil fuel combustion, but much more difficult for other gasses such as agriculturally produced CH_4. Fundamentals well understood but sinks are still a source of considerable uncertainty for many GHGs, especially CO_2.
2 Define the quantity of emissions that will be permitted and thus available for trading (the cap).	Specified by OTC NO_X MOU, which was a product of multi-state negotiations with significant input from photochemical models and engineering-economic estimates.	Internationally, this would require bilateral or multilateral international agreements that could be implemented within a framework of national laws.
3 *Account for differences* in environmental impact across emission locations and times, and across pollutant types.	Area of greatest disagreement. However, spatial variation was shown to be unimportant given the configuration of sources and deep emissions reductions. Temporal differences were largely ignored, although their effects are uncertain.	Spatial and locational differences have no effect, but GHGs vary significantly in warming functions and atmospheric lifetimes, implying important intergenerational judgments for multi-gas trading.
4 Create emission allowances, a distribution mechanism, and an enforceable redemption requirement	Accomplished by state law, although allowances created by one state are recognized by all. Allocation methods vary significantly. Enforcement mechanisms simple, strong, transparent, and certain.	Same as 2 above, but complicated by the existence of multi-national firms that operate in a number of national jurisdictions.
5 Operate a market with enforceable contracts and rules to ensure competitive behavior.	Well-defined law and practice for inter-state trade based on state contract law, federal Commerce Clause and other business law.	Could be easily established within any nation. Existing international trade law could support (or be developed to support) GHG emissions trading; new bilateral or multilateral agreements could further facilitate this development.

Figure 1: NO_X Budget and NO_X SIP Call States



Notes: Solid – States in OTC NO_X Budget, Vertical – OTC states not in NO_X Budget, Horizontal – Non-OTC states subject to NO_X SIP Call. All states shown participated in OTAG.

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