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# THE LAW. AGENCY, AND GLOBAL CLIMATE CHANGE

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If the predictions of climatologists are to be believed, we face fundamental policy choices regarding the emissions of so-called greenhouse gases. These policy choices will challenge the ingenuity of a number of national governments in both the industrialized nations and in the agrarian tropics. There will be calls for international cooperation, for a new global climate regime, and for mandated changes in behaviors so as to reduce emissions of--and/or to enhance the processing capacity for--such gases. Throughout, there will doubtless arise concerns for national sovereignty in the face of demands that individual governments enforce new behavioral norms on their citizens. The literature on international resource regimes is impressive and will not be explored here.[1]

Instead, I wish here to introduce into the discussion of international resource regimes the concept of agency. The theory of agency has arisen within economics to capture the incentive problems that exist when an individual seeks to encourage some particular performance on the part of another; the classic agency problem is the employment contract between the owner of a firm and an employee. The owner--the principal--seeks certain behaviors on the part of the employee (the agent). Notice that the performance of the agent can be differentially motivated through the nature of the contract between principal and agent--hourly wages, piece rates, or an annual salary. I hope to illustrate here that new international legal regimes

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[1] See the excellent account by Young [1989], and a nice economic discussion by Maler [1990].

**for** mitigating serious climate change can, to good effect, be treated as international agency problems.

## I. The Nature of the Problem

> The Dutch electricity industry will plant thousands of trees around the world to compensate for carbon dioxide emissions from a new power station, the association Dutch electricity producers says. The 600-megawatt coal-fired power station in the Maasvlakte area of Rotterdam is due to come on-stream in the middle of the decade. "The plant will be in operation for about 25 years and during that time it will emit 75 million tons of carbon dioxide," says a spokeswoman for the group. Carbon dioxide is the main contributor to the greenhouse effect that many scientists believe causes global warming. Trees absorb carbon dioxide through photosynthesis. "With our plan we will fully compensate" for the new plant's emissions, says the spokeswoman. The industry will spend $12 million a year from 1991 to 2015 on the plantings, with the first likely to be in Peru, Bolivia, Columbia or Indonesia [The Wall Street Journal, European Edition, November 7, 1990].

The parsimonious Dutch spending $12 million annually for 25 years in the far-away tropics? How can this be? The answer, it would seem, lies in their recognition of the interrelations between the emissions of carbon dioxide from Dutch generating stations and global atmospheric chemistry. More significantly, however, this program is a manifestation of the Dutch having taken responsibility for their role in the imposition of costs on others. Global climate problems pose important policy challenges precisely because of this interdependence of individual actions at different locations throughout the world.

With rising public concern for actions that threaten global atmospheric chemistry, certain individuals and governments face pressure to modify their

200 years for $N_2O$. All these compounds are important greenhouse gases. Although $C0_2$ is the single most important among them, the combined greenhouse forcing of $CH_4$, $CFCl_3$, $CF_2Cl_2$, $N_2O$, and a few additional gases together is about equal to that of $C0_2$. In addition, and in contrast to $C0_2$, which is chemically very stable, $CH_4$, $N_2O$, $CFCl_3$, and $CF_2Cl_2$ are of critical importance for stratospheric and tropospheric chemistry. The observed increases in the above mentioned gases have caused great concern for a rapid climate warming by several degrees in the next century, especially because of the rapid growth of $CFCl_3$ and $CF_2Cl_2$, major depletions in stratospheric ozone have already occurred [1GBP, 1990, pp. 2.1-3 - 2.1-4.].

The task is several fold. I first assume that human activities are the cause of a non-trivial proportion of the total annual production of greenhouse gases. Second, I assume that potentially effective mechanisms exist--under the right institutional circumstances--that could modify those activities in a sustainable fashion. Third, I assume the presence of some action-forcing event that brings the annual net production of greenhouse gases to the forefront of the public policy arena. Finally, I assume that, as with any policy change, there are potential winners and potential losers. The potential winners from a policy change will comprise the action-forcing dimension of our policy problem, and the potential losers will comprise the opposing force.

## II. Conflicting Interests in Global Climate Policy

One view of the policy problem is to determine if it is possible to design a resource management regime--a new institutional setup--that would give those currently unhappy with the status quo a new and more satisfactory institutional setup, yet at the same time leave those whose behavior must change (the "losers") no worse off than they are at present. This situation would qualify as a "Pareto improvement." As we begin to assess possible

winners and loser from a new international policy regime we come immediately to the very core of the problem. That is, the winners are most probably situated in different regions than the losers. Recall that by "winners" I mean those individuals who perceive (or who will reap) benefits from a change in the status quo policy regime. By "losers" I mean those individuals who perceive (or who will bear) costs from a change in the status quo policy regime. By the status QUO policy regime I mean the production of greenhouse gases under a legal regime of privilege for those responsible for such emissions, and no right for those whose interests are adversely affected by such emissions.[4]

While these terms will be elaborated below, for now it is sufficient to note that those seeking reductions in the total annual production of greenhouse gases do not have a legal right to bring that change about, and those who are well served by the status quo policy regime have the legal capacity to continue as they have been without regard to the wishes of those who seek a new policy regime. Those favoring the status quo have, in legal parlance, privilege; they are free to continue as they have without regard for the wishes of those who seek a policy change.

As suggested above, a change in the resource management regime pertinent to greenhouse gases is much complicated by the spatial distribution of their production. Industrial activity and automobile exhaust are major contributors of greenhouse gases, and these activities are more prevalent in the industrialized nations than they are in the agrarian tropics. In the tropics, greenhouse gases result from the rapid rates of land-use changes and the

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* For those familiar with the writings of Hohfeld, these are his terms. See, also, Bromley [1989a] or Munzer (1990].

associated burning of large quantities of biomass. Additionally, atmospheric nitrogen may be increased significantly from the application of nitrogen fertilizers and deforestation. As the agrarian nations become industrialized it is to be expected that they will contribute even more greenhouse gases. The disturbance of the chemistry of the tropical atmosphere is particularly significant since emissions can be rapidly transported by convective cloud systems and thence carried to other regions of the world.

So, human activities in the industrialized world result in the generation of large quantities of greenhouse gases, while the tropical forests serve an important function of processing much of that production. Those in the industrialized north have an interest in protecting tropical forests as a means to process the large and increasing production of greenhouse gases, while those in the agrarian south have an interest in promoting economic development--perhaps at the expense of the tropical forests.

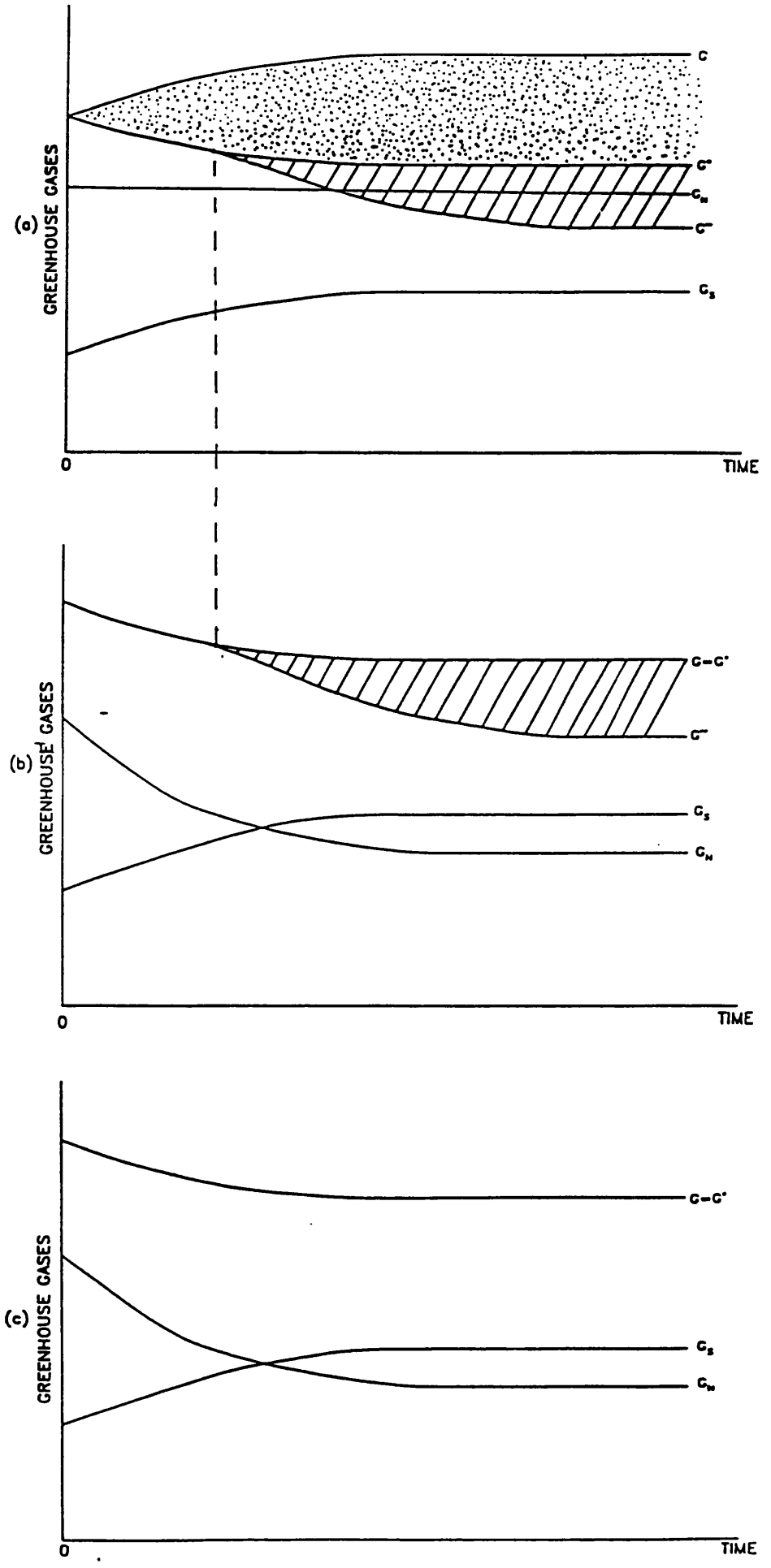
For ease of analysis therefore, I assume that there are two distinct regions of importance to the management of greenhouse gases. In the agrarian south we have essential processing services (the tropical forests) and we have certain land-use activities that contribute to the production of greenhouse gases. If a subset of tropical land-use activities results in the cutting and burning of the forests to clear land for agriculture then the problem is twice serious; burning the forests and other biomass releases massive amounts of carbon to the atmosphere. Moreover, the disappearance of plant life deprives the biosphere of an important part of its capacity to convert carbon dioxide into oxygen.

In the industrialized north we have widespread fossil-fuel based manufacturing and transportation activities that contribute a large share of

annual greenhouse gas production. The global atmosphere inextricably links these two regions of the world and makes them interdependent. If tropical forests thrive, the earth's assimilative capacity for greenhouse gases is enhanced and the large production by the industrial north is less ominous for net annual loadings of such potential threat to atmospheric chemistry. To the contrary, if the tropical forests are diminished, or if total production of greenhouse gases in the agrarian south increases, then net annual loadings of such gases will increase.

Those in the north have one primary interest with two implications. Their primary interest is to maintain their life style and their fossil-based energy system. This, in turn, requires that a way be found to: (1) maintain tropical forests to process greenhouse gases; and (2) discourage increased production of greenhouse gases by those living in the tropics. Those in the south have a primary interest in achieving economic development. This interest would seem to imply: (1) cutting down tropical forests to earn foreign exchange, or to clear land for agriculture; and (2) building factories and acquiring automobiles for the newly prosperous masses. The conflict of interests between the two regions could not be more pronounced.

The policy problem of global climate change, in simplified terms, can be seen in Figure 1. In panel (a), $G_S$ represent total production of greenhouse gases from the agrarian south, while $G_N$ represents total production of greenhouse gases from the industrialized north. G* represents the level of total production of greenhouse gases that will not change the chemistry of the atmosphere; call G* the "sustainable" level of greenhouse gases. The figure depicts the production of gases from the industrial nations holding constant over the relevant time horizon. The figure also depicts the production of


(a)
GREENHOUSE GASES
C
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C**
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(b)
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C=C*
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C_S
C_N
0
TIME
(c)
GREENHOUSE GASES
C=C*
C_S
C_N
0
TIME

FIGURE 1.

Atmospheric loadings of greenhouse gases of potential significance for global climate change.

In panel (b) I illustrate a policy setting in which excess production is eliminated by a program in which the industrialized north reduces total production of greenhouse gases at the same rate as the newly industrializing agrarian south increases its total production. In this setting the total production of greenhouse gases from the two regions matches the predicted assimilative capacity for greenhouse gases (G - G*). But notice that as the agrarian south industrializes, there is a reduction in forest cover such that actual processing capacity is less than predicted processing capacity--and the actual production of greenhouse gases ($G\sim < G^* - G$); a processing deficit still exists. Also notice that, as drawn, the industrialized north, because of stricter environmental policies, has brought its total production of greenhouse gases below that in the newly industrialized south.

In panel (c) I drop the assumption of massive forest clearing in the industrializing tropics so that G* remains the assimilative capacity for greenhouse gases, and total global production is brought in line with that capacity. The hard part, of course remains. And that concerns how to restructure the international resource management regime such that the happy results of panel (c) are realized. There are two aspects of this challenge. First, there is the problem in obtaining agreement between these two stylized regions--"North" and "South." That is difficult enough. The second problem will concern changing behaviors of individuals within the two regions. I will avoid here a discussion of divergent interests among countries in the two regions and so will regard the "North" as one nation-state, and the "South" as another. This simplification does not change the nature of the basic

greenhouse gases in the agrarian south increasing as those nations undertake economic advance, as factories become more prevalent, and as automobiles become more ubiquitous. The line labeled G shows the total production of greenhouse gases over time (where $G - G_N + G_S$). The dotted region in panel (a) shows the excess production of gases with respect to the earth's assimilative capacity ($G > G^*$).

Here one sees the threat to both the industrialized north and to the agrarian south. Efforts by an international body to impose a global production limit at G* would meet opposition from the citizens of the industrialized nations because it would threaten their lifestyle. Residents of the north would argue that it is the increased production from the newly industrialized nations of the agrarian south that has "created the problem." Similarly, a limit on total production is of considerable concern to those in the agrarian south because it would mean that the allocation of the total production would give the more favorable situation to the industrialized north. Citizens in the agrarian tropics would argue that the rich wish to impose a limit on their (the southerner's) industrial ambitions.

There is something even more ominous in panel (a). The line $\tilde{G}$ traces out the earth's assimilative capacity for greenhouse gases under the assumption that tropical forests are cleared and burned as part of the industrialization of the agrarian south. That is, G* is no longer the long-run sustainable capacity to process greenhouse gases; the assimilative capacity is now driven down to $\tilde{G}$ by the widespread clearing of Amazonian forests. The cross-hatched region in panel (a) shows the processing deficit to result from changes in land use in the agrarian nations of the tropics. The two areas in the figure--that between G and $\tilde{G}$--indicate the excess

bargaining problem, but it certainly simplifies it by reducing the number of units in the policy hierarchy.

A. The Policy Hierarchy

By the "policy hierarchy" I mean the various actors whose agreement or compliance is required for an institutional change--a new policy regime--to be established. There are two levels in each of the two or regions--there are the individuals, and there is the state. Individuals do not negotiate international agreements, governments do. This requires that we imagine a negotiated agreement between our two states--North and South--that obligates the respective governments to undertake certain policies that will affect the choice domain of individuals within those two states. As an example, the North may impose a tax on fossil fuels, and it may also require more effective processing of combustion gases from factories and automobiles. Similarly the government of the South may restrict clearing of forests by farmers and ranchers, and it may legislate pollution standards for factories and automobiles.

Negotiations by states are always in terms of the behaviors it thinks it can deliver on the part of its individual citizens. Negotiations between the governments of "North" and "South" with respect to greenhouse gases come down, ultimately, to a problem of altering the atomistic choices of millions of citizens in North and South--for it is individuals, not governments, who drive polluting cars, who consume electricity, who clear the Amazon forests, and so on. Government policies define the choice sets from within which individuals choose particular courses of action [Bromley, 1989a]. But it is individual behaviors that become the essence of policy. In economics, the field of

agency theory is concerned precisely with this policy problem. Let us now turn to a discussion of the problem in the context of greenhouse gases.

B. Agency Theory, Bilateral Negotiations, and Global Climate Change

To simplify somewhat, the policy problem is to find a set of incentives that will perfectly align the interests of individuals in the two regions under consideration here--North and South. That alignment of interests will, in fact, manifest itself in terms of a convergence of individual choices that will reduce two tendencies.[3]

The first tendency is the one that threatens the earth's capacity to process greenhouse gases. 1 will regard the forests of the Amazon as essential to that global assimilative capacity. The second tendency is the one that threatens to increase the total production of greenhouse gases in both regions of the world. Notice that individuals in both regions are inextricably linked by the physical aspects of atmospheric chemistry--more production of greenhouse gases by individuals in the North (or in the South

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[5] The usual examples in agency theory concern the problems of team production where monitoring costs of individual effort are high. Also, the employment contract--whether or not there is a team--is the essence of a principal-agent problem. In what follows I will apply agency theory to the relationship between individuals and the state. The logic for this approach is straightforward. That is, the essence of the state is to define a choice domain for atomistic decision makers such that the aggregate of millions of independent choices is seen to be in the "public interest"--whatever that is defined to be. All of the celebration of Smithian laissez faire is a fraud on logic and clear thought about social organization. Markets cannot function without a clear and precise articulation of who owns what (property rights), who may do what to whom (civil and criminal law), and who must pay whom Co have their interest protected (again, property rights and the law of contract). So called "free markets" are clearly not free of collective definition of the range of choice open to market participants, and it distorts analysis of public policy to imagine otherwise [Bromley, 1989a).

for that matter) places an ever-increasing economic value on the role of the Amazonian forests.

Put somewhat differently, with a higher total production of greenhouse gases in both hemispheres, a reduced assimilative capacity will impose greater costs on the world in terms of accelerated climate change. Or, to avert that climate change the two nations will be forced to undertake expensive alternatives to the processing capacity of the forests. This is the "backstop technology" alluded to earlier. That is, continued reduction of the Amazonian forest with total production of greenhouse gases held constant would carry non-trivial costs as well. For here the earth's capacity to process that increased production would be diminished and so again the long-run costs would be significant.

Notice that the tropical forests provide a resource service at a cost significantly less than the service could be provided through alternative technology. The only "cost" of using the forests is that they must be preserved intact. The cost then becomes the alternative uses of the forested area rendered impossible because of the presence of the forest. We will return to this "cost" momentarily.[6]

Recall that resolution of the policy problem requires the introduction of some action-forcing event; in the absence of this event there is no reason why the status quo resource management regime could not continue, despite increasing evidence of higher concentrations of greenhouse gases. One can imagine the United Nations attempting to persuade (or force) international cooperation on total production of greenhouse gases. The international Law of

[6] I am abstracting from the role of tropical forests as important assets in their own right, quite apart from their role as processors of greenhouse gases.

the Sea procedures provide a possible model as well. While the analysis we are about to consider would not be changed, it would add yet another layer of complication to the story. Hence, this particular decision problem will begin with the assumption that one of the governments (either N or S) determines that it is desirable to stabilize the production of greenhouse gases such that total production is brought into balance with the earth's processing capacity. This is shown in panel (c) of Figure 1 where G - G*. This decision could be arrived at autonomously by the government of one of the countries (N or S), or it could be "forced" upon that government by political activism of individuals within the country. At this point it does not really matter.[7]

Assume that it is the government of N which seeks a new resource management regime -that will achieve long-run sustainable production of greenhouse gases as in Figure 1 (panel (c)). In agency theory we talk of the principal and of the agent. It is the problem for the principal to establish an incentive regime that will align the interests of the agent with those of the principal. Agency theory is concerned with precisely this problem whether applied to the owners of large firms, or national governments. Consider the government of N which, in fact, faces two "agency" problems. The first is to induce its own citizens to alter their behavior with respect to activities pertinent to the production of greenhouse gases. Call this the domestic policy problem for N.

The second agency problem concerns the government of S. That is, how can the government of N induce the government of S to alter the choice environment for the individual citizens (individual decision makers) in S? Call this the

[7] In November 1990 in Geneva a number of governments of the industrialized world—not including the United States—agreed to stabilize total production of greenhouse gases.

international policy problem. Notice that, In fact, this is a hierarchical agency problem in which there are two "agents"--the government of S, and the citizens in S. That is, the government of N is the principal with respect to its own citizens as well as with respect to the government of S. But the government of S, in addition to being an agent with respect to the government of N, is itself a principal with respect to its own citizens (who are, in turn, agents to the government of S).

So the action-forcing event is the declaration by the government of N that it seeks to change the status quo resource management regime in which greenhouse gases are produced in abundance. Such production of greenhouse gases is assumed here to be of scant significance to many of the citizens of both N and S--and possibly without concern to the government of S. Indeed, the government of S may be committed to a policy of increased economic development at the expense of the tropical forests (and their processing services); such policy also increasing the production of greenhouse gases in S by accelerated industrialization.

The government of N has two challenges. First, to modify atomistic choices within N so that less greenhouse gases are produced within N. Second to modify atomistic choices in S for two reasons: (1) to produce fewer greenhouse gases; and (2) to preserve the processing services of the forests located in S. But since the government of N has no capacity to modify the choice sets of individuals in S it must work through the government of S. That is, the government of N can modify choice sets for the individuals in N but not in S.

Agency theory enters at a simple level within N, and in a hierarchical fashion with respect to S. The government of N, if it wishes to modify the

resource management regime and so individual behaviors with respect to greenhouse gases, must bring the costs of the status quo ante into clear relief for its own citizens, as well as for those citizens in S (through the government of S).[8] One way to do that is to alter the incentives for current behaviors of citizens in both countries. In blunt terms, the principal (N) could undertake several kinds of schemes to change the interests and hence behaviors of its own citizens. I will address this issue first, and then turn to the international policy problem.

C. The Domestic Policy Problem

At the moment, individual actors in N are free to behave in a way that is in total disregard for the interest of those who care about the total production of greenhouse gases. Those who care, in this first case, are a number of citizens in N. In more formal language, we would say that those who are concerned about high production of greenhouse gases have no rights, while those well served by the status quo resource management regime have privilege [Bromley, 1989a]. Recall that by privilege I mean individuals are able to act without regard for the interest of others. Should those alarmed about greenhouse gases go to the courts to prevent continued emissions the court would say, in effect, "sorry, there is no law against the production of greenhouse gases. You have no right to seek relief."

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[8] Of course if the government of N were an authoritarian one it would not need to convince its citizens of anything other than the overwhelming wisdom of doing what the government desired. I assume that neither N nor S is an authoritarian regime. I also dismiss the analytically uninteresting case in which the government of N forces the government of S to do what it (N) wishes.

Another way to put the status quo ante resource management regime is to note that the air is an open access resource in which anyone who wishes to partake of its services may do so freely and without restraint.[9] The costs that arise from the emission of greenhouse gases are of scant concern to those responsible for such emissions. Of course, as seen, some of the citizens in N are concerned about such emissions and have undertaken to pressure their government to change the status quo ante resource regime. But, as noted, the court sent them away with the assertion that they had no right to prevent such emissions. The domestic policy problem is to change the resource regime over air such that those now in a situation of no right acquire a right and those now with privilege are given, instead, duty.

Once this happens the way is open to undertake a different incentive structure such that greenhouse gas emissions are no longer the thoughtless and incidental by-product of daily life. To return to the agency problem, the problem for the principal is to restructure incentives so that individual behaviors are in line with the new regime. That is, once the rights regime is altered to one of duty for emitters there are several ways that new behaviors might be forthcoming. Note that a simple change in the law--in this case in the resource management regime--is necessary but far from sufficient to change behavior of atomistic actors. As long as it is not in my interest to comply with a new law, and as long as monitoring costs are very high--and hence there is a small chance of my being detected--I will not change my behavior if my

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[9] There is unfortunate confusion in much of the literature that fails to understand the difference between open access resources (res nullius) and common property resources (res communes). That distinction will be elaborated below.

interests will be adversely affected.[10] There are three general approaches that we might consider to the alteration of individual behaviors.

1. Facilitative Policies. By facilitative policies I have in mind an incentive regime that allows individual decision makers to undertake changes consistent with the long-run interests of the principal and of the agent, but not in the short-run interest of the agent. We have seen a recent example of facilitative policies in the Los Angeles air basin. Specifically Unocal, an oil refiner, offered $700 to buy all automobiles older than a certain model year (1972, 1 believe) in order to reduce total exhaust emissions in the basin. Unocal's expansion plans were constrained by a basin-wide limit on total emissions of certain gases, and old automobiles represented a significant source-of total emissions. By removing these polluting automobiles from the highways in the basin, Unocal was able to undertake its desired expansion.

This is a facilitative policy because it is in the long-run interest of both Unocal and automobile owners; Unocal gains some slack in total basin-vide emissions levels, and the automobile owners were able to purchase a newer model automobile that would deliver higher gas mileage—and lower emissions. The difficulty in getting this change implemented, and the rationale for the offer of $700 per automobile by Unocal, is that most individuals driving cars older than 1972 vintage were not particularly well situated to purchase newer models. And the market value of their current automobile was most certainly

[10] Catalytic converters on automobiles are an example. Not only is frequent inspection of exhaust part of the new regime, but it is a criminal offense to disconnect (or to tamper with) one's own catalytic converter. Your "ownership" of an automobile does not include the right to modify certain parts of it. In our terminology, you have a duty to leave the catalytic converter as it is.

less than $700. The Unocal offer facilitated a trade to a new model automobile that was in its long-run interest as well as in the long-run interest of the owners of older vehicles.

Another example of a facilitative policy occurred during the oil crisis of the early 1970's. As fossil fuel prices soared it became of interest to conserve on usage--particularly in home heating. Many older homes, lacking sufficient insulation, were very wasteful of energy. Energy utilities offered homeowners subsidized loans to undertake energy-saving actions such as increased insulation. It was in the long-run interest of homeowners to reduce their total energy consumption, and it was in the long-run interest of energy utilities to discourage the continued profligacy. But in the absence of the low-interest loans to homeowners few would have been able to undertake such investments.

With, respect to greenhouse gases, facilitative policies would comprise those which attempt to align the long-run interest of both the principal (the government of N) and individual decision makers. To the extent that older automobiles contribute more greenhouse gases per mile driven than do newer cars--either because older cars get fewer miles per gallon or because they burn different fuels than do the newer models--then a facilitative policy might look very much like the Unocal program in Los Angeles. In the industrial sector, facilitative policies would include investment tax credits for new technology that promises to be more parsimonious in the use of fossil fuels.

2. Inducing Policies. By inducing policies I mean those institutional changes that will realign incentives where the long-run interests of the principal and the agent fail to converge. Note that unlike facilitative

**policies, where the long-run interests of the principal and the agent are coincidental, here one needs policies to address the fact that the interests of the principal and the agent do not converge. Inducing policies however, as with the facilitative policies, work through economic incentives; they are what some call "price-based" policies.**

The classic example of inducing policies are emissions taxes on certain polluting industries. In the case of greenhouse gases we can imagine certain situations in which it would never be in the interest of some individuals to reduce greenhouse gases. For instance, there are some individuals who do not regard it as in their interest to drive automobiles which conserve on fuel; indeed, as conspicuous consumption, some individuals may get the very greatest pleasure from driving automobiles that get quite low gas mileage. For such individuals facilitative policies will not work at all.

Similarly, it is reasonably clear that American automobile manufacturers have a greater interest in producing automobiles that get low gas mileage than they do in producing automobiles that get high mileage; the profit margin is greater on the former models. Hence, when long-run interests diverge between the principal and the agent, different incentive structures are required. In essence, unlike facilitative policies where *encouragement* is sufficient, here coercion is called for.

That coercion manifests itself in the form of new administered prices for a variety of actions. An increase in the federal gasoline tax is an example of an inducing policy--it will, in the short run, induce individuals to make different choices regarding forms of transportation (mass transit as opposed to automobiles); and it will, in the long run, induce individuals to make different choices regarding the kind of automobile they will drive (fuel-

efficient as opposed to inefficient). True enough some drivers will welcome more fuel efficiency and do not need to be induced by such a tax (as seen earlier), but a policy of this sort does not leave that change in consumer choice to mere chance.

With respect to greenhouse gases, inducing policies might consist of a sulfur tax on soft (high-sulfur) coal. Such a change in price would render low-sulfur coal more attractive and would thus induce consumers of coal (such as electric utilities and many heating plants) to switch to low-sulfur coal. This would have a salutary effect on the total production of greenhouse gases.

3. Injunctive Policies. By injunctive policies I mean those that require or mandate a particular target on the part of individual decision makers. An example of injunctive policies is the fuel-efficiency requirements for American automobile companies. The CAFE, or corporate average fuel efficiency, is an injunctive policy that requires each automobile manufacturer to produce a fleet of automobiles that on average, and for a particular model year, will deliver some specified fuel efficiency to the owners. Yet another example of injunctive policies is found in prohibitions on the use of certain highly toxic chemicals. With respect to greenhouse gases, injunctive policies would, for example, prohibit the burning of high-sulfur coal.

The domestic policy problem for the government of N is, therefore, to devise an incentive scheme that will realign the incentives of all those whose decisions hold implications for the production of greenhouse gases. This will entail, in all probability, a mix of facilitative policies, inducing policies, and injunctive policies. But the problem does not stop at the domestic level. The reality of global resource management regimes implies that the government

of N cannot, in isolation, **devise** a **new** management regime to remedy problems of atmospheric chemistry.

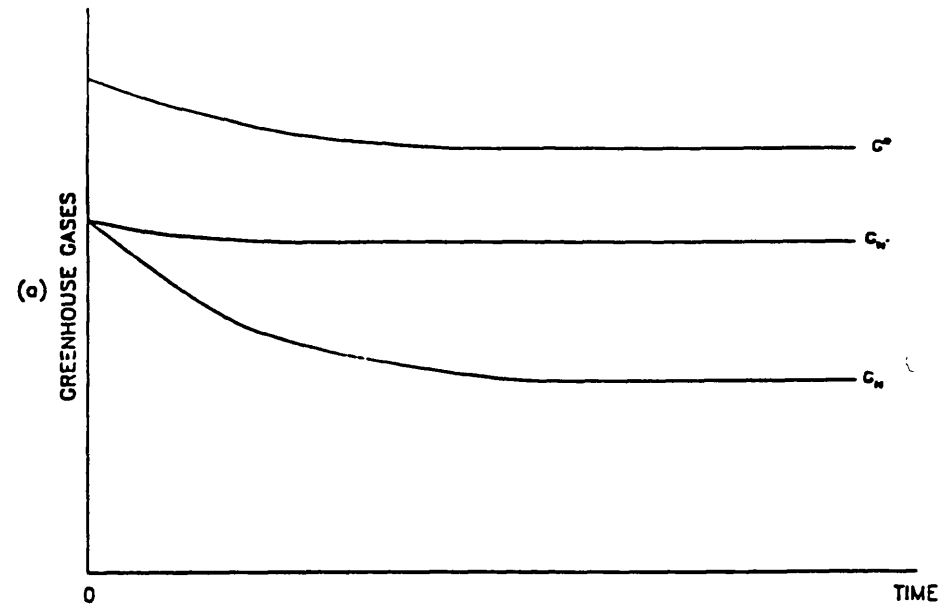
Recall from Figure 1 that individuals in S also contribute to total production of greenhouse gases, and they also, of perhaps greater importance, hold the key to the long-run sustainability of the assimilative capacity for such gases; if the tropical forests are destroyed than the problem becomes more severe, and the government of N must take even more extreme steps in the domestic arena. It is for these reasons that the government of N must enlist the government of S in policy formulation regarding greenhouse gases.

D. The International Policy Problem

The policy problem at the international level has two dimensions. The first is one of allocating the earth's assimilative capacity for greenhouse gases between the two regions (N and S). The second aspect of the problem, and one that is bound up in the problem of allocation, is to create a new institutional structure--a new resource management regime--which will sustain that allocation over the long run with a minimum of transaction costs.[11] This problem, by the way, brings us close to the matter of how to create and sustain effective and sustainable common property regimes. This will be taken up in a subsequent section.

For now, consider panel (a) of Figure 2. Here I show, as in Figure 1, the earth's sustainable assimilative capacity for greenhouse gases--G*. 1 also show a hypothetical production path of greenhouse gases from N given the creation of a new resource management regime in N for the production of

[11] By transaction costs we mean the costs of: (1) obtaining information about a situation; (2) reaching an agreement about how to alter the status quo ante; and (3) enforcing the new agreement that has been reached.


(a)
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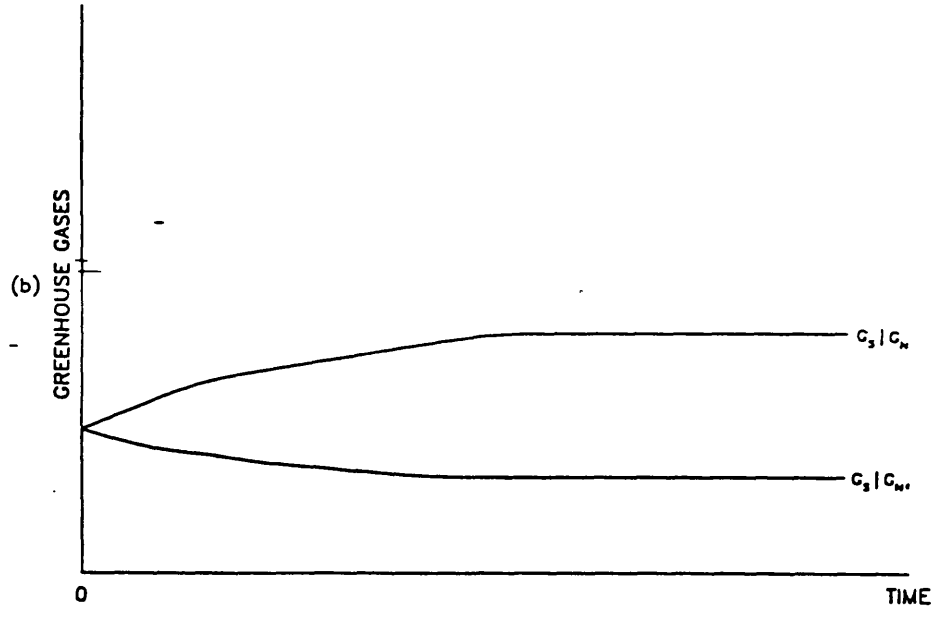
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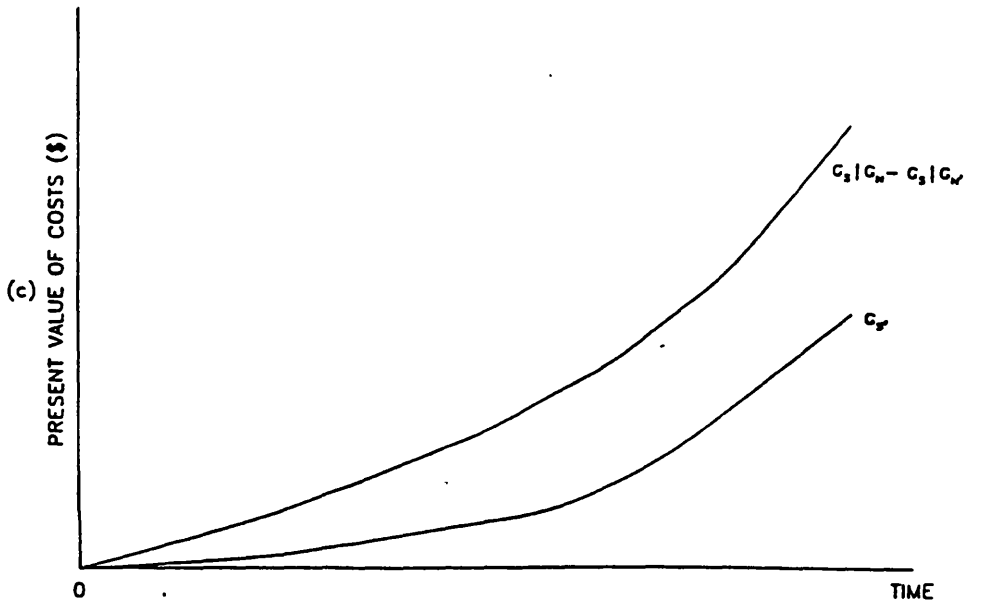
(c)
PRESENT VALUE OF COSTS ($)
0
TIME

FIGURE 2.

greenhouse gases. That is, $G_N$ shows the new emissions trajectory assuming that a mixture of facilitative, inducing, and injunctive policies are instituted in N. Notice that the policy path in N is a function of the policy path in S, and vice versa. That is, if the total production of greenhouse gases (G*) has been identified as the policy target, then it follows, by definition, that $G_S - f(G_N|T)$, where $G_S$ is the policy target level of greenhouse gas production in S, and where the area of tropical forests (T) remains constant at its current level.

The distance ($G^* - G_N$) between the two curves represents the assimilative capacity for greenhouse gases that is available for use by individuals in S. Notice that should the government of N undertake a rather more lax policy with respect to greenhouse gases, then the production path $G_{N'}$ becomes relevant. The obvious implication is that total production of greenhouse gases from S must be significantly less than would be possible were $G_N$ followed in N. That is, total "allowable" production of greenhouse gases from S is now given by:

$$G_S - f(G_{N'}|T)$$

where $C_{N'} > G_N$

These two situations are plotted in panel (b) of Figure 2 as $G_S|G_N$ and as $G_S|G_{N'}$. These two functions show the required policy domain for the government of S. If we think of the function $G_N$. as depicting the most lax policy outcome in N, and the function $G_N$ as depicting the most severe (yet feasible) policy outcome in N, then they represent, in essence, the range of

bargaining open to the government of N in its discussions with the government of S. By similar logic, the government of S will regard the two functions $G_S|G_M$ and $G_S|G_N$, as defining its bargaining domain, subject to the constraint that the total area of tropical forest (T) remains at its current level.

Another way to regard this bargaining domain between $G_S|G_N$ and $G_S|G_N$. is to consider it as the **extra** cost to fall on individuals in S should the governments of both N and S attempt to establish a resource management regime in S as a function of $G_N$. rather than as a function of $G_N$. Put somewhat differently, the costs to fall on individuals in S, ignoring for the moment the opportunity cost to S of maintaining T at its current size, will be higher if N adopts a domestic policy resulting in $G_N$. rather than a domestic policy resulting in $G_N$.

I show that extra cost in panel (c) of Figure 2. We may expect that this magnitude represents the minimum willingness to accept compensation on the part of the government of S for adopting a sustainable resource management regime with respect to greenhouse gases. That is, if the government of S is to preserve the area of tropical forests (T), and also to facilitate, or induce, or require its citizens to reduce the production of greenhouse gases, then it will insist that the government of N recognize the magnitude of its costs from pursuing a more stringent policy functionally related to the domestic policy that N Itself pursues.

Notice in panel (c) of Figure 2 that $G_s$. represents the baseline costs within S of maintaining the tropical forests in their existing state to provide resource services for processing greenhouse gases. The incremental costs between ($G_S|G_N$ - $G_S|G_N$.) and $G_s$. reflect the additional burden on individuals in S as a function of the policy environment adopted in N, under

the assumption that the government of S wishes to abide by the policy objective of a sustainable assimilative capacity for greenhouse gases (G*).

E. The Quest For Agreement

The bargaining domain for the governments of both N and S can be depicted with the aid of Figure 3. In panel (a) I show the present-valued costs of various levels of reduction in the total loadings (production) of greenhouse gases from N. Notice that as total loadings are reduced, the present-valued costs increase dramatically. In panel (b) I show the same thing for S. These two figures take the policy scenarios of Figure 2 and place them in the context of the costs to each nation of reducing its own production of greenhouse gases quite apart from what the other nation does. In other words here there is no set limit (G*) on total loadings from the two nations, there is only & consideration of what it will cost each in terms of pollution control costs--and foregone economic development benefits--to reduce the domestic production of greenhouse gases.

The relationship between Figures 2 and 3 is, however, critical for policy formulation between N and S. This can be seen by placing panels (a) and (b) together (with panel (b) inverted) to create panel (c) in Figure 3. Here we see the same cost curves from panels (a) and (b). The dimensions of the space in panel (c) are given by the total sustainable production of greenhouse gases with all of it being allocated to country N, or all of it being allocated to country S. Along the lower abscissa (NG*) the far right point (G*) shows the situation if N were able to use all of the assimilative capacity for greenhouse gases without the individuals in S having any access to that assimilative capacity. Similarly, along the upper abscissa (SG*) we see the

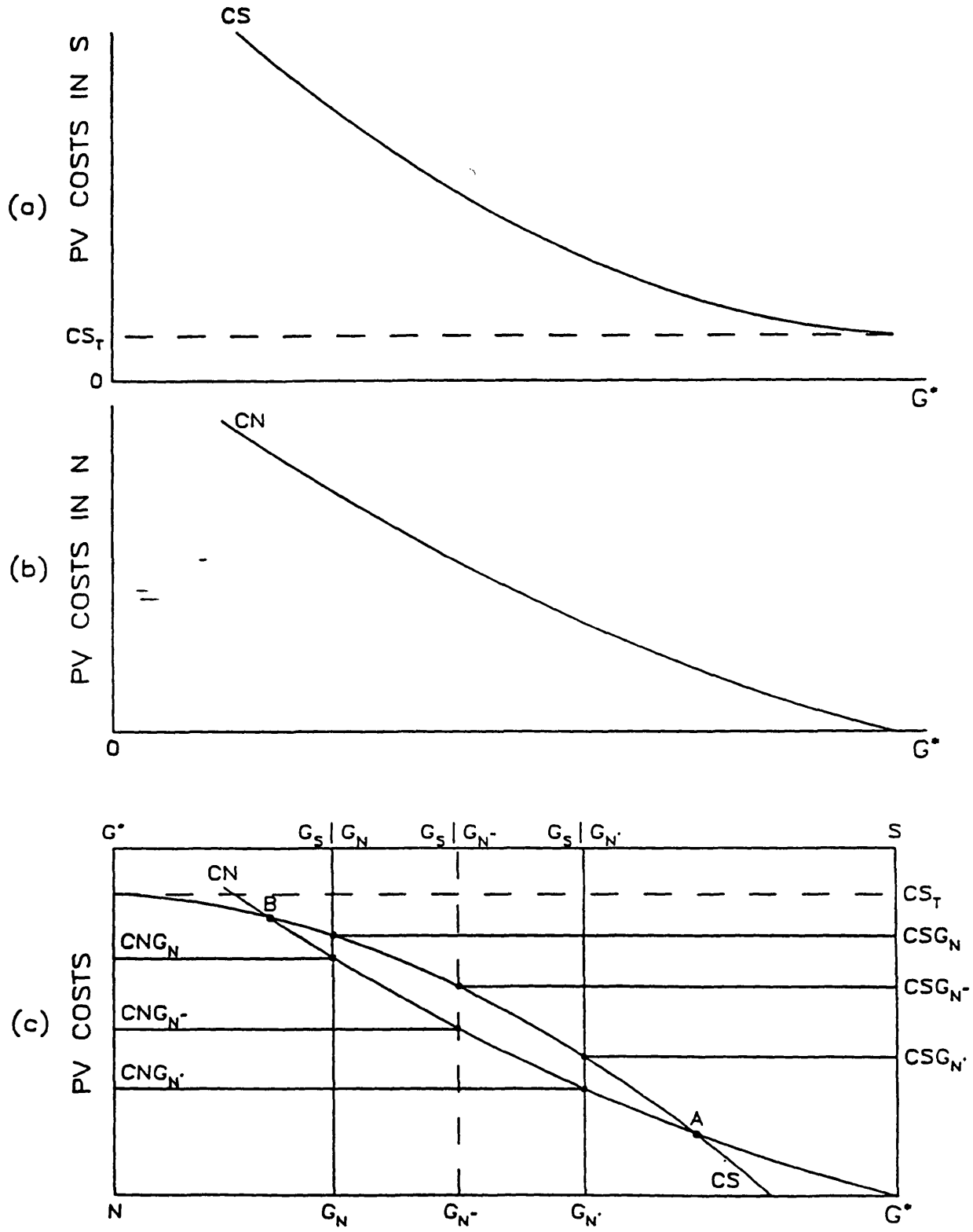
(a)
PV COSTS IN S
CS
$CS_T$
0
G*
(b)
PV COSTS IN N
CN
0
G*
(c)
PV COSTS
G*
$G_S \mid G_N$
$G_S \mid G_{N^-}$
$G_S \mid G_{N'}$
S
CN
B
$CS_T$
$CNG_N$
$CSG_N$
$CSG_{N^-}$
$CNG_{N^-}$
$CSG_{N'}$
$CNG_{N'}$
A
CS
N
$G_N$
$G_{N^-}$
$G_{N'}$
G*

FIGURE 3.

situation if S **were** able to use the entire assimilative capacity of the atmosphere without any loadings from N.

The left and right ordinates show, respectively, the present-valued costs of N and S from reductions in their citizens' production of greenhouse gases. These costs are seen to increase because a reduction in greenhouse gases requires expensive processing equipment, and it may be thought to impede economic "development." Additionally, for S, it requires the maintenance of the tropical forests whose presence--and presumed present capacity to process greenhouse gases--defines the size and shape of the box in panel (c). This fixed cost to S is shown along the right ordinate as $CS_T$.

We can next consider the two levels of production of greenhouse gases within N. Should N pursue a rather lax greenhouse gas policy, earlier referred to as $\bar{G}_N$., it will require S to pursue a very restrictive policy of $G_S|G_N$, with implied costs for S of $CSG_N$,. This domestic policy regime is very expensive for S, but cheap for N, since its costs will be only $CNG_N$. Alternatively, should N pursue a more restrictive domestic policy regime, one earlier referred to as $G_N$,, then its costs are much higher ($CNG_N$) but those that must be incurred by S are considerably less (now $CSG_N$) than under the lax policy regime in N.

The efficient policy to pursue is the one in which the marginal (not total) costs of reduction in loadings are the same between the two countries. Since the curves CN and CS are the total costs of abatement of loadings we know that their slope is the marginal cost of abatement of greenhouse gases. We also know that there is a unique point somewhere points A and B in panel (c) of the figure at which the slopes of CN and CS are identical. That point yields the efficient level of reduced production of greenhouse gases for the

global climate change, one comes face to face with the realization that some individuals (or nation-states) who are party to an agreement trill have incentives to defect from that agreement. All of the high-sounding rhetoric about the wonders of cooperation are nothing against the pull of defection. In the world of international relations one has only two means whereby agreements might be sustained--good will, and force.

Force is unlikely to play much of a role in addressing the problems of greenhouse gases. Though of course there are several dimensions of "force." For instance, it is unlikely that the government of N would consider invading S in order to coerce its government to abide by some agreement on greenhouse gases. But it is not unreasonable to imagine a situation in which the terms of trade between the two nations might be modified by N should the government of S prove to lack proper resolve. Such negative sanctions are less interesting to contemplate than are positive sanctions. That is, what mechanisms exist whereby the governments of N and S might bind themselves to a particular global resource management regime? Since N is here assumed to be relatively wealthy, while S is assumed to be poor, it is possible to imagine a range of development assistance forthcoming from N *as* part of an effort to induce certain behaviors on the part of S and its citizens. Additionally, imports to N from S could receive favorable treatment.

## III. On Resource Management Regimes

As indicated earlier, the problem of global climate change is that individuals in both nations are free to engage in activities that produce greenhouse gases without regard for the interests of their fellow citizens. Additionally, individuals are able to behave without regard for the interests

two countries, and the associated total costs. For N the efficient level of loadings (or, conversely, of abatement) is at $G_N$, and hence the efficient level for reductions in loadings in S is at $G_S|G_{N''}$. Here the costs for N are given by $CNG_{N''}$, while the costs to S are given by $CSG_{N''}$. There is no other possible allocation of loadings and abatement between the two countries that will produce a lower total cost between the two nations.

Of course "efficiency" as reckoned here is silent regarding the capacity of each of the two nations to incur these costs of reduced loadings. We assume here that N is a far richer nation than is *S,* and therefore one may not worry excessively about the fact that the present-valued costs for the richer of the two (N) exceed the present valued costs for the poorer of the two (S).

This consideration brings us back to the hierarchical principal-agent problem. For we assume that N is the principal in seeking a new resource management regime more to its (its citizens') liking, and that the government of S is the agent with respect to N. But, of course, the government of S is also the principal vis-a-vis its citizens. The nascent resource management regime, in which N must induce the citizens and government of S to incur costs of $CSG_{N''}$, then requires some sustainable agreement whereby N can count on S making sure that its new environmental policies both sustain the tropical forests, and also facilitate, induce, or require its citizens to reduce their aggregate production of greenhouse gases.

## F. Sustaining Compliance

The essence of our problem is seen to be the establishment of a resource management regime in which the governments of both N and S willingly agree to cooperate in this new institutional endeavor. In addressing problems of

of individuals in other locations, or of those living in the future. Public policy with respect to global climate change is essentially concerned with modifying the institutional arrangements that situate individual economic agents in both N and S. Notice that all individual actions take place within an institutional context that defines domains of choice for citizens of each domestic regime (N or S).

If electric utilities are free to emit large quantities of carbon dioxide into the air then other economic agents will have--in part--their choice domain defined by this fact. Those individuals concerned with atmospheric chemistry and global climate change will find a modified physical condition for the future of the earth. Those veil served by the status quo ante will claim that they have a "right" to those emissions. Those concerned about global climate change will object that the mere fact of traditional use of the air shed-for waste disposal does not constitute a "right" for the electric utilities. Rather, it will be said that the electric utilities have had the advantage of being able to ignore the implications of their actions on others. Indeed, those who care about greenhouse gases will likely suggest that they have a "right" to be free of the harmful emissions of electric utilities and other industrial polluters.

The example here is fundamental to the issue at hand, which is the actual and presumed rights structure that defines the positions of the protagonists. If one is to understand public policy in environmental matters it is essential that we start with an exposition of the property arrangements that give rise to existing behaviors, and hence to confrontation with those who believe that their 'rights' have been contravened.

A. The Concept of Rights and Correlated Duties

A right is the capacity to call upon the collective to protect one's claim to a benefit stream. Notice that rights only have meaning when there is some authority system that agrees to defend a right-holder's interest in a particular outcome. If I have a right in some particular situation then it means that I can turn to the state to see that my claim is protected. The effective protection I gain from this authority is nothing other than a correlated duty for all others interested in my claim. A right is a triadic relationship that encompasses the object of my interest (whether a physical object or a stream of benefits arising from fortuitous circumstances), plus all others in the polity who have a duty to respect my right. Rights are not relationships between me and an object, but are rather relationships between me and others with respect to that object. Rights can only exist when there is a social mechanism that gives duties and binds individuals to those duties.

When one has a right in something it means that the benefit stream arising from that situation is consciously protected by the state. The state gives and takes away rights by its willingness--or unwillingness--to agree to protect one's claims in something. Returning to the problem of greenhouse gases, the ability of an electric utility to discharge carbon dioxide means that a benefit stream exists (in the form of cost savings) which the utilities now control. This benefit stream is manifest in the form of operating costs lower than if the plant were unable to discharge large quantities of carbon dioxide.

Environmental policy is about rights and duties, and about benefit streams to various interests. This perspective tends to focus attention on the struggle over rights and duties as correlated ideas. This correlative

Table 1. THE FOUR FUNDAMENTAL LEGAL RELATIONS

| | ALPHA | BETA |
|---|---|---|
| Static Correlates | right | duty |
| | privilege | no right |
| | * * * * * * * * * | |
| Dynamic Correlates | power | liability |
| | immunity | no power |

(After Hohfeld 1917)

The above scheme is symmetrical with respect to the position of Alpha and Beta. The legal relation is identical regardless of the position from which the relation is viewed (Alpha or Beta). The difference lies "...not in the relation which is always two sided, but in the positions and outlook of...[Alpha and Beta]...which together make up the two converses entering into the relation [Hoebel, 1942, p. 955)."

Note that the four fundamental legal relations are reducible into two further categories that are either active (positive) or passive (negative). The right/duty and the power/liability relations are active in that they represent imperative relations subject to the authority of the state. On the other hand, the privilege/no right and immunity/no power relations are passive in that they are not themselves subject to direct legal enforcement. Instead, they set the limit of the state's activities in that they define the types of behavior-that are beyond the interest of the state. As seen in the privilege instance, the state declares that it is none of its direct concern if Alpha imposes costs on Beta.[12] In a sense, we have here legal relations that are statements of no lav. Every right that Alpha has upon Beta is reinforced by accompanying pressure on courts to compel Beta to perform his/her duty.

B. Possible Resource Management Regimes

Natural resource management regimes evolve over time to mediate conflicting interests among users of natural resources. The regime, the human creation, defines a structure of legal correlates. The above concepts of right, duty, privilege, and no right operate within, indeed define, what I

[12] Recall the earlier discussion in which we saw that a situation of no right meant that there was no law that one could invoke to prevent these costs.

It is useful to note that much of the confusion in environmental policy stems from a fundamental misunderstanding of possible resource regimes. The "tragedy of the commons" allegory arising from the writings of Garrett Hardin has done much to confuse scholars and others, and hence to stifle meaningful progress in understanding resource management regimes. Among these possible resource management regimes, common property carries the false and misplaced blame for "inevitable" resource degradation that properly lies with open access regimes. Hardin's allegory of the "tragedy" has been remarkably durable. By confusing an open access regime (a free-for-all) with a common property regime (in which behavioral rules are specified), Hardin's model has undermined the concept of common property in which resource users act together and institute checks and balances--rules and sanctions--for their own interaction within a given environment.

The Hardin analysis is not only socially and culturally naive, it is historically false.[13] In practice, to emphasize the "tragedy of the commons" is to deflect analytical attention away from one class of social arrangements with a potential to overcome resource degradation. Those with incomplete knowledge of tenurial differences and systems of customary rights, encouraged by those confused about the differences between open access regimes and common property regimes, may well attribute resource degradation to an assumed (but non-existent) regime of "common property."

They will then often be led to suggest that if only private property rights could be established to replace the common property regime, the problem would be solved. Yet the prospects of establishing private property rights in the global airshed are not promising. More importantly, when resource

[13] See Ciriacy-Wantrup and Bishop [1975] and Dahlman [1980].

Bean by a resource management regime. The essence of a resource management regime is that it defines--or fails to define--a structure of rights to benefit streams. At the same time, a resource management regime defines an exposure--or the absence of exposure--to a stream of future costs. We call a set of rights to a benefit stream property rights. Let me now become more specific by exploring the scope and nature of property rights inherent in four possible resource management regimes. The emphasis here is on regimes as human creations whose purpose is to manage people in their use of environmental resources.

Recall that a resource management regime is a structure of legal relations characterizing the standing of individuals to one another with respect to that particular environmental resource--be it fish, an oil pool, or the assimilative capacity of the atmosphere. Institutional arrangements are continually established (and redefined) in order to determine (and to modify) the scope and nature of the property regime over natural resources. Recall that property relations between two or more individuals (or groups) have been defined by stating that one party has an interest that is protected by a right only when all others have a duty.

It is essential to understand that property is not an object such as land, but is rather a right to a benefit stream that is only as secure as the duty of all others to respect the conditions that protect that stream. When one has a right one has the expectation in both the law and in practice that their claims will be respected by those with duty. And it is the essential function of the state to stand ready to refrain those with duty; if the state is unwilling, or unable, to ensure that compliance to duty, then rights are meaningless.

1. Open Access Regimes. Open access (res nullius) regimes are situations in which each user has privilege with respect to the use of the resource. It follows, therefore, that each user also has no rights. An open access regime is one in which there is an absence of an authority system whose purpose is to enforce a set of norms of behavior among participants with respect to that particular natural resource. When valuable natural resources are available to the first party to effect capture, it is either because those natural resources have never before been incorporated into a regulated social system, or because they have become open access resources through institutional failures that have undermined former collective or individual management regimes.

Those responsible for the vast literature on the so-called "tragedy of the commons",[-] and on the problems of alleged "common property", failed to understand the essence of property. They believed that "property" is a physical object such as a school of fish, trees, a piece of land, or the atmosphere. By confusing the social dimension and the concept of property[14] with a physical object, it is then easy to see how they could conclude that open access constitutes "common property." For if fish are mistakenly thought of as "property", and if fishing is available to all who might be interested, then the "property" is thought to be "commonly available." It is this conceptual confusion that allowed them to allege that "everybody's property (fish) is nobody's property (fish)." Since no-one owns the fish, it is said to be common to all. But property is not a physical object but is instead a social relation.

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[14] What Kant called "intelligible possession."

degradation is observed on private lands--soil erosion, water pollution--the cause is assumed not to lie with the property structure at all, but is attributed, instead, to unduly high rates of time preference on the part of the owner, or some incentive problem that can be rectified with taxes or bribes. This asymmetry of logic--blaming the absence of private property in one instance, and slipping to alternative causal explanations when private property is present--obscures rather than clarifies the real issues involved.

The egregious erosion that accompanied the Dust Bowl years of the depression has never, to my knowledge, been blamed on the private ownership of land. Rather, the problem arose from "drought". But if private ownership of land is socially optimal, that is, if private owners always take the socially correct decisions--as many claim--how did this disaster happen? Why was land suited only for pasture plowed up to be put in wheat and other annual crops? Private landowners are alleged to be rational maximizers and yet the existence of degraded lands under private ownership does little to reassure us of the thoroughgoing wisdom of private control of certain natural resources. Let similar land abuse occur under an institutional regime other than that of private property and the blame will immediately be said to lie with "common property." So it should be obvious that a more careful analytical of property regimes is called for.

1 prefer to consider four possible resource management regimes: (1) non-property regimes (open access); (2) private property regimes; (3) state property regimes; and (4) common property regimes. Each will be considered in turn. While these four categories may appear to be overly discrete, the intent is simply to provide organizing concepts to help us think about the issues inherent in devising regimes for addressing global climate change.

2. Private Property Regimes. While most think of private property as individual property, it is useful to note that all corporate property is private property. There is also a tendency to consider private property as bestowing full and absolute control on the owner. However, it is well to keep in mind that an owner is faced with a number of strictures and obligations in the use of so-called "private" land and its related natural resources; few owners are entirely free to do as they wish with such assets.

The fortuitous results emanating from the private control of land and related natural resources arise from the simple fact that the individual (or group) owner can make management decisions--and investments--in the full knowledge that good stewardship will return private rewards. There can be no mystery about this-, and its appeal is practically as old as recorded history. There are only a few assumptions that render this particular property regime socially-preferred under most circumstances. First we must assume that the owner chooses to manage well and to produce those things that are valued by society. As long as landowners produce wheat, tomatoes, trees, and cotton all is well. When landowners begin to produce marijuana, opium, and cocaine then the rather automatic beneficence of private property rights disappears. So, the compelling nature of private property regimes is moderated by the ends to which assets controlled under that particular property regime are put.

Secondly, private property is socially compelling as long as the general interests of the owner are rather in accord with the interests of non-owners. That is, if we assume that there are no untoward external effects emanating from the use of land and natural resources then complete autonomy properly rests with the owner. If soil erosion, polluting smoke, clangorous sounds, or insufferable odors emanate from a private property regime then, once again the

sanctity of that particular institutional set-up will come under close scrutiny.

The case for private property regimes, as with all property regimes, ultimately rests on judgments concerning its social utility.[15] Private property is the legally and socially sanctioned ability to exclude others--it allows the fortunate owner to force others to go elsewhere. The appeal of a private property regime for dealing with problems of global climate change is, as suggested earlier, restricted by the physical impossibility of defining individual property rights in the atmosphere. One must, therefore, search for an alternative resource management regime.

3. State Property Regimes. In a state property regime, ownership and control over use rests in the hands of the state. Individuals and groups may be able to make use of the natural resources, but only at the forbearance of the state. National (or state) forests and parks, and military reservations are examples of state property regimes. The state may either directly manage and control the use of state-owned natural resources through government agencies, or it may lease the natural resource to groups or individuals who are thus given usufruct rights for a specified period of time.

With respect to global atmospheric issues, the analogue of a state property regime would entail some supra-national body with authority over sovereign nation-states. That is, we would add one more "layer" on to the structure so that we create--in essence--a super state. Various international

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[15] See Beeker [1977] for a discussion of the philosophical foundations of private property. His work is also summarized in Bromley [1989a]. See Sax [1983] for a discussion of recent changes in perceptions regarding the social utility, in certain situations, of private property rights.

regimes that have as their purpose the subordination of national interests to transnational interests are of this nature [Young, 1989]. At the opposite pole of state (or suprastate property regimes) we find individual property rights regimes--most commonly referred to as private property.

4. Common Property Regimes. The final resource management regime is the common property regime (res communes). First, common property represents private property for the group of co-owners (since all others are excluded from use and decision making). Second, individuals have rights (and duties) in a common property regime [Ciriacy-Wantrup and Bishop, 1975]. In one important sense then, common property has something very similar to private property--exclusion of non-owners. In that sense we may think of common property as corporate group property. The property-owning groups vary in nature, size, and internal structure across a broad spectrum, but they are social units with definite membership and boundaries, with certain common interests, with at least some interaction among members, with some common cultural norms, and often their own endogenous authority systems. Tribal groups or sub-groups, or sub-villages, neighborhoods, small transhumant groups, kin systems or extended families are all possible examples. These groupings hold customary ownership of certain natural resources such as farm land, grazing land, and water sources [Netting, 1976; McKean, 1986; Stevenson, 1991; Wade, 1986].

Corporate group property regimes are not incompatible with distinct individual use of one or another segment of the resources held under common property. For instance, in customary tenure systems over much of Africa the ownership of certain farmland may be vested in a group, and the group's leaders then allocate use rights on portions of the land to various

individuals or families. As long as those individuals cultivate their plot, no other person has the right to use it or to benefit from its produce. But note that the cultivator holds use rights only (usufruct) and is unable to alienate or transfer either the ownership or the use of that land to another individual. Once the current user ceases to put the land to good use it reverts to the Jurisdiction of the corporate ownership of the group.

Common property regimes in the developing world are often characterized by group "ownership" with management authority vested in the respective group or its leaders. In many developing countries, some of the resources in the public domain (that is, non-private land) are managed as common property, some are managed by the public sector as state property, and some are not managed at all but are, instead, open access.

Essential for any property regime is an authority system able to ensure that the expectations of rights holders are met. Compliance, protected and reinforced by an authority system, is a necessary condition for the viability of any property regime. Private property would be nothing without the requisite authority system that makes certain the rights and duties are adhered to. The same requirements exists for common property. When the authority system breaks down then management of the natural resource fails and, common property (res communes) degenerates into open access (res nullius).

The common property regime as a system is broader than the set of possession entitlements that is its core; it includes also use rights, exchange rights, distribution entitlements, a management subsystem, and authority instruments as means of management. When any part of this system is undermined, the entire system ceases to be what it was. It is indeed the

management subsystem, with its authority mechanisms and capacity to force compliance, that insures that the particular property regime is adhered to, and that its integrity is well protected. This, in principle, is not different from the ways in which the other property regimes operate as systems. For instance, in private property regimes the owner also relies on the authority of the state and its coercive power to assure compliance and to prevent intrusion by non-owners. If this (or other) authority would not be exercised, the private property regime too would collapse and would become an open access regime.

C. Global Climate Change and Resource Management Regimes

In an open access regime such as the status quo, each individual is free to produce greenhouse gases without regard for the interest of those adversely affected-by those actions. We say that each individual has, at the same time, both privilege and no right. The individual has privilege in that he/she may disregard the interests of others with respect to the discharge of greenhouse gases. At the same time, any one individual has no right in that it is impossible to force others not to discharge greenhouse gases. The policy problem with respect to greenhouse gases is to find a new resource management regime other than the status quo ante of open access. If there were a meaningful supra-state then it would be possible to imagine a state property regime over the global air shed. This regime adds, in effect, one more layer of authority over the state property regime. It is the regime one finds with respect to a variety of natural resources [Young, 1989]. For instance, the International Whaling Commission provides, in essence, a supra-state management regime where the interests and choices of each nation-state are

proscribed. This in turn compels each nation-state to redefine the range of choice open to its individual whaling operations [Young, 1989].

Lacking the creation of a supra-state property regime, the next possible regime is one of common property. Under this regime there would be no external source of compulsion, but rather the two nations (N and S) would structure an institutional regime that would modify choice sets for their individual citizens. Let us now turn to a consideration of that problem.

## IV. Agency Theory and International Policy

The problem in reforming the international resource management regime can be thought of as redefining the property relations in the atmosphere. The status quo ante is one in which individuals in both N and S are free to do as they wish with respect to the production of greenhouse gases. In terms of Table 1 we would say that they have privilege in that they are free to disregard the interests of others in their production of greenhouse gases. The principal-agent problem has three dimensions: (1) the government of N with respect to its citizens (noted as $n_i$); (2) the government of S with respect to its citizens (noted as $s_i$); and (3) the government of N with respect to the government of S.

The assumption here is that the government of N takes the lead on solving problems of atmospheric chemistry--by definition N becomes the principal vis-a-vis S. The government of S is both an agent with respect to the government of N, and a principal with respect to its own citizens. The other assumption is that G* represents the target level of total emissions over the long-run. The agency problem is for N to succeed in realigning the interests of $n_i$, of S, and indirectly through S, the interests of $s_i$. Note that the government of

N cannot undertake actions **vis-a-vis** $s_i$ without the intermediation of the government of S. Let us consider in more detail these three components of the agency problem.

A. Domestic Policy in N

The agency problem in N is for the government of N to formulate a set of new institutional arrangements (new policies) that will alter the interests and so the behavior of individuals in N responsible for the production of greenhouse gases. There are certain activities of the $n_i$ which lead to high levels of greenhouse gases and it is these actions that must capture the attention of N. There will be a class of actions for which the interests of N and of the $n_i$ will-be in perfect accord. The consumption of fossil fuel is a clear example?" It is in the interest of the government of N and of the individuals in N to reduce consumption of fossil fuel. Hence *facilitative policies* should prove sufficient here. Examples would be certain incentives to assist consumers to use less fuel--for instance a major government research initiative on more fuel-efficient engines. The program, discussed earlier, Co rid Los Angeles of antiquated automobiles is another example that might be implemented at the national level.

But such policies will not work on everyone, or the impact may not be sufficient and so some *Inducing policies* might be required as well. An example here is found in the recently instituted "gas guzzler tax" in which certain low-mileage automobiles carry a surcharge at the time of purchase. Another inducing policy would be a use-tax on the consumption of coal.

Finally, the government of N may realize that these measures, though helpful, will not accomplish all that is needed. So some *injunctive policies*

will be required. As mentioned previously, it may be necessary to force yet higher CAFE (Corporate Average Fuel Efficiency) standards on American automobile manufacturers. Likewise, import restrictions could be imposed on luxury imported cars whose gas mileage is Judged too low.

These are simply illustrative of possible institutional changes that the government of N might consider with respect to its own citizens. But what can the government of N accomplish with respect to the government of S?

B. International Policy for N and S

Much the more interesting challenge arises at the international level. Unlike domestic policy for N (or for S), in international policy there is no authority system that can force the government of S to abide by the interests of the government of N. But of course the two governments have mutual interests and the problem here is to explore the nature and extent of those interests.

Facilitative policies are those employed where the two governments (or the two parties) have compatible interests. The government of S might be assumed to desire certain technology that would make large industry more fuel efficient in its consumption of fossil fuels. For instance, it is not unreasonable to suppose that the government of S seeks nuclear power generating facilities in order to reduce its dependence on imported petroleum. This alternative technology would reduce loadings of greenhouse gases and hence the government of N is pleased. Moreover, it is reasonable to suppose that the government of N is interested in exporting certain technologies to other nations'. A mutual trade and technical assistance pact might just accomplish much to alter the production regime of greenhouse gases in S.

Inducing policies are relevant when the interests of the government of N and of S are incompatible. When dealing with domestic policy the authority of the government is sufficient to enforce new policies that are not in the interest of the individuals in the polity. For instance pollution taxes can be imposed on an industry over the most strenuous objections of that industry. In the international domain there is no similar capacity to coerce unwilling participants. However, all is not lost. For in the international domain it is only necessary to redefine the interests of the two governments in such a way that inducing policies become self-enforcing on the part of the reluctant government (in this case the government of S).

We might think of this as international "cooperation" and put in those terms it is not so- surprising that domains of willing bargaining exist among nations that may have very different interests in particular behaviors. The mechanism for cooperation is one which will reformulate--or redefine--the disparate interests as being mutually compatible. Here I mean that the interests do not have to match exactly, but one must be able to map the interest of one into the interests of the other. Consider the preservation of tropical biomass to process greenhouse gases. We assume from before that the government of N has a deep and abiding interest in the preservation of as much tropical biomass as is possible. Recall that the more tropical biomass there is to process greenhouse gases the less strict the government of N must be with its own citizens in a new environmental policy regarding greenhouse gases.

Let us assume that the government of S has scant interest in the preservation of tropical biomass. To preserve such expanses of forest may deprive the government the chance to earn large amounts of foreign exchange.

It may also force the government to undertake other economic development policies to address the problems of the landless peasants clamoring for new land. Indeed, to preserve the tropical forests may require the government of S to expropriate the large estates of wealthy ranchers and then to redistribute such lands to the landless. The tropical frontier provides, as it were, a "safety valve" allowing the government of S to offer land to the poor without having to confront the landed gentry.

However, these two seemingly incompatible interests have a common element in that the desire of the government of N to protect the tropical forests suggest that N has a willingness to pay the government of S some amount to induce it to preserve its tropical biomass. Unlike domestic policy where coercion of the government is possible, international policy requires a quid pro quo between the principal (N) and the agent (S). It is not unreasonable to suppose that the government of S might seek a substantial increase in economic assistance so as to promote economic opportunities for its landless poor. That is, foreign assistance may be useful in breaking the seemingly difficult choice between expropriating haciendas and savaging the forest. Similarly, if preserving the forests implies confronting the powerful timber concessionaires then it is quite possible that payments from N could be used to redirect these contractors into other lines of work.

It may appear that these payments flowing from N to S constitute "bribes." This would be an unfortunate connotation since it tends to overlook the fact that such negotiations represent the only policy instruments available to the two parties. Would we feel better if the government of N threatened to send in the Marines unless the government of S began to protect its tropical forests? In public policy one must use the policy instruments

available and there is certainly nothing Immoral or illegal about searching for arenas of mutual interest between two or more protagonists.

Moreover, the very idea of a "bribe" has no meaning outside of a legal structure that indicates the boundary between legal and illegal actions. In the domain of international relations, where there is no law with respect to many actions, the idea of something being "illegal" is a contradiction in terms. Obviously certain actions may not be regarded as "ethical" but this is very different from labeling them as illegal.

It may happen, of course, that the domain of mutual interests is too restricted to accomplish what the principal (N) seeks; perhaps the political pressure on the government of S to continue its timber concessions is simply too overwhelming to be overcome by payments (or policy concessions) from N. In this case, and depending upon the resolve of N, we begin to approach the domain of *injunctive policies.* If the exported timber from such practices is being imported into N the solution is straightforward. The government of N could simply decide to ban exports from S. If, however, the timber is exported to a third country (T) then the government will need to involve that nation in the negotiations. The problem multiplies since the government of N could undertake a range of policy options--from facilitative, to inducing, to injunctive--in order to persuade the government of T to change its timber-importing policies.

Injunctive policies are, as a matter of course, the last resort for the simple reason that they tend to create "winners" and "losers." The essence of long-run international policy is to seek outcomes which allows both governments to interpret their new position as that of a "winner." With facilitative and inducing policies there is a potential for both parties to

consider themselves winners in that they both got something they desired. But with injunctive policies one party will always feel coerced.

In addition to the obvious psychic problem of having created winners and losers--at least for the **loser--injunctive** policies have the very great disadvantage that they are not self enforcing. International policy is, to a large extent, dealing with parties in a "state of nature." By a state of nature we mean a situation in which there is no state to enforce bargains that have been struck. There is an emerging literature on how to enforce agreements in a state of nature [Kronman, 1985].[16] But the essential problem is that self-enforcement is unlikely when one or more parties (nations) believe that they have been forced into a situation at odds with their long-run interests. The tendency for defection from the agreement is strong, and likely to grow over time.

Hence, facilitative and inducing policies have the very great advantage that both parties stand to gain something from the agreement. This has the practical advantage of holding the agreement together when, in the course of normal events, the parties may begin to harbor doubt. But, when a nation knows that defection will deny access to something of very great value, facilitating and inducing policies--when optimally structured--make defection too costly. That is, an optimal international policy regime is one in which the costs of defection exceed the costs of remaining in the agreement.

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[16] The literature on international regimes tends to refer to a state of nature as one of anarchy--a term that may conjure up notions of total chaos. However, by anarchy this literature simply means the absence of an overarching authority system to enforce agreements [Young, 1989].

C. Domestic Policy In S

In a sense the domestic policy problem for S is not very different from the domestic policy problem for N. One difference, however, is that N initiated the new policy regime (as a principal), while S entered the regime as an agent to the interests of N. This will mean that the government of S is an intermediary between the government of N and its own citizens ($S_i$). The government of S will be able to undertake facilitating, inducing, and injunctive policies as does the government of N, with several constraints added.

The government of S will define its bargaining arena for negotiations with the government of N in terms of what it thinks it will encounter in the way of opposition to the new operating domain for its citizens. As suggested earlier, if elimination of timber concessionaires is thought to be a politically risky endeavor then the government of S will require major assistance from the government of N. This, in turn, will provide the government of S with the "wherewithal" to undertake a very aggressive policy against the timber contractors. Similar arguments apply to the problem of providing economic opportunity for the landless poor. Hence it is the domestic policy arena in S that defines the nature and scope of the international bargaining arena between N and S.

D. Summary

Agency theory provides a set of organizing concepts that allow us to formulate the essence of the policy problem in global atmospheric chemistry. We see the important difference between domestic policy in the two nations, and we see how the international sphere is informed by--indeed defined by--the

domestic component of the two nation-states. The interests of the principals drive the bargaining process, and yet we see that the domain for new institutional arrangements is, in reality, entirely dependent upon the interests and importance of the individual decision makers in the two polities--$n_i$ and $s_i$. It is a mistake to imagine that governments simply order their citizens around; indeed the recent failures of the economy in the USSR suggest that unless governments get the incentives right atomistic behavior can be positively counterproductive.

The policy problem is to realign interests through the redesign of domestic and international institutional arrangements such that new behaviors occur autonomously. It is not a problem of directing individual decision makers, for such a, regime requires enormous monitoring costs. These monitoring COSTS are made necessary by the very powerful incentives for defection from the newly imposed regime. A dirigiste approach will certainly fail.

Rather, the ideal policy is one that mixes facilitative policies, inducing policies, and injunctive policies in order to modify, at the margin, atomistic behaviors among millions of individuals. When such behaviors of relevance for the production and processing of greenhouse gases are correctly modified then the problem of atmospheric chemistry will be solved. There is no magic wand that will produce a new international regime, nor is there some all-powerful supra-state to impose a new institutional regime that will reach down into the daily lives of millions of individuals in the jungles--or in the cities of the industrialized north. There is only the difficult process of changing incentives in order to alter atomistic choices.

In the authoritative work on international regimes, Young talks of three possible origins of regime formation: (1) spontaneous; (2) negotiated; and (3) imposed [Young, 1989]. The discussion here has focused on the second and third of these. It is entirely possible that the governments of N and S would come to the same realization regarding the seriousness of greenhouse gases and commence to reformulate domestic policies accordingly. This would represent the spontaneous case. It is not very interesting for the problems of atmospheric chemistry because it suggests that the problem of greenhouse gases would be rather immediately recognized by governments and solved autonomously. While this would be a wonderful situation, it is also not very realistic. What makes it unlikely is that independent nation-states have very different interests in how their citizens behave with respect to the natural environment. So the second two sources--negotiation and imposition--are the much more likely. These two classes of the origins of international regimes have comprised the essence of the approach followed here.

Young also points to the obvious result that negotiated and imposed regimes will ordinarily stand up better to the temptations offered by changing circumstances. After all, spontaneous regimes are only as durable as the separate calculations of the interests of the respective parties. In that sense then, the approach taken here, based on agency theory, seems to offer a conceptual guide to the problems of global climate change.

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