Sharing the Burden of Global Warming

When representatives from governments around the world sit down to negotiate a global-warming treaty, debate will center on how the burden of adjustment can be shared fairly. By "burden" we mean a combination of costs and risks. Since a decision to limit greenhouse-gas emissions would mean reducing reliance on fossil fuels and investing in alternative technologies, the costs could be substantial. On the other hand, the longer emissions go uncontrolled, the greater the risk of economic and ecological dislocations from flooding, changing weather patterns, and the loss of species.

The burden of costs and risks must plainly be distributed in some manner, and any realistic policy will probably combine elements of both. What, then, do we mean by a *fair* distribution of the burden?

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This highly sensitive questions cuts along a political fault line that separates nations in many other respects: North versus South, industrial versus agricultural, rich versus poor. The developing world naturally blames the greenhouse-gas buildup on developed countries, which have been spewing industrial effluents into the atmosphere gratis for well over a century now. The industrialized countries, in turn, blame some of the poorer nations for pursuing development policies that accelerate a dangerous trend. An international agreement on global warming would have to find some way to balance the disparate claims of these two groups.

In this article we shall use the theory of fair allocation to explore various solutions to the burden-sharing problem. In the process, we must leave aside other important issues, such as the magnitude of the economic dislocations that might occur, how they would be distributed geographically, and how much it would cost to avert or mitigate them. Great uncertainty surrounds such projections, mainly because scientists still know very little about the long-run effect of greenhouse-gas emissions on the biosphere. This very uncertainty leads some to conclude that no action should be taken. We, however, maintain the contrary: the level of uncertainty serves to increase, rather than reduce, the degree of concern.

The risk of catastrophic dislocations, improbable though they may be, creates a powerful incentive for taking action to reduce risk. It may be improbable, for example, that methane released from the melting permafrost would cause a significant rise in ocean levels by the middle of the next century. Nevertheless, the costs of such a catastrophe would be so immense that it would make sense to try to forestall it. Even if we can't be sure that the benefits of such a policy outweigh the costs (measured in strictly economic terms), the policy might still be advisable. Stabilizing global climate is a form of insurance. And just as we buy life insurance policies out of concern for our children, so we pursue environmental policies at least partly out of concern for future generations.

What Counts as Fair?

Though standards of fairness vary from one situation to another, they play a critical role in coordinating people's expections and legitimating the solution they reach. Suppose, for example, that two municipalities contribute different amounts to build a road connecting them. If the project costs more than expected, the two parties will almost certainly split the additional costs in proportion to their original contributions; for this is how cost overruns have usually been allocated in similar cases.

It doesn't matter if a standard is peculiar to a specific negotiating environment, just so long as everyone involved understands and abides by it. Even if there are no exactly parallel precedents, negotiators may reason by analogy from related cases. The precedents that have been established in analogous cases therefore become crucial in determining what the bargainers regard as a fair and appropriate outcome in the present case. Unfortunately, this means that negotiators find it harder to agree when they come from different cultures and are discussing an issue with few precedents. These are features of international negotiations in general and of global-warming negotiations in particular.

In asserting that there is no universally accepted rule for sharing a burden, we do not mean to suggest that

there is no moral obligation to share the burden in some manner. It seems clear that people who cause the global environment to deteriorate do have an obligation to those who are harmed. The fact that the atmosphere is currently treated as a global commons, whose use is largely unregulated, does not imply that nations, firms, or individuals have the right to continued free access to it. As with other types of commons—e.g., fishing grounds, grazing lands, and communications bandwidths—when unregulated use begins to crowd out some members of the community or deplete the resource, the community has every right to enforce limitations. These usually take the form of carefully defined entitlements to use the resource. Precisely how these entitlements should be defined, and how distributed, are key issues in negotiating a global-warming treaty.

Components of the Distributive Problem

Like every distributive problem, global warming raises three questions: What is to be distributed? Among whom? According to what principle? Simple as this structure may appear, it is often far from simple to pin down the three components in a concrete case.

To begin with, what would a global-warming treaty allocate? The most widely discussed option is to limit the quantity of greenhouse gases—carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons (CFCs)—that each nation can release into the atmosphere. In this case, the ''thing'' being allocated is a reduction in the total flow of gas—a cutback, say, of so many tons per year of carbon dioxide. The problem is therefore framed as one of sacrifice, of giving up something relative to the status quo.

Alternatively, one could focus on how much is permitted, rather than on how much is cut back. According to this second way of thinking, the thing being allocated is an entitlement to release a certain amount of gas annually into the atmosphere. If the total number of permits distributed is less than the emissions rate, this second approach will involve cutbacks, just as the first does. Nevertheless, the two approaches differ: one is framed negatively, as a sacrifice; the other is framed positively, as a right. One focuses on the loss, the other on the gain.

Both approaches have recent precedents. For example, the Montreal Protocol—an agreement signed by fifty-seven countries in 1987—requires that production of CFCs and other ozone-damaging chemicals be reduced by certain fixed percentages. By contrast, the U.S. Clean Air Act proposes to reduce sulfur dioxide emissions by granting emissions permits to electric utilities, who may trade the permits among themselves. Both of these solutions conceive of the atmosphere as a common-property resource that must be rationed by creating entitlements to its use.

Suppose the distributive problem is indeed framed in terms of emissions entitlements or permits. We still need to consider who the claimants are, how many permits should be distributed, and how many permits each claimant should receive.

First, who are the claimants? Most discussions of greenhouse-gas reductions assume that nations are the claimants: the United States would be entitled to x permits, China to y permits, and Uganda to z permits, depending on the theory under discussion. Of course, it is true that national governments will negotiate a treaty, just as they will be responsible for carrying out its terms. So it's natural to think of nations as the *repositories* of emissions permits. But this does not mean that nations must also be the primary *claimants*. It is individuals who would suffer the dislocations that global warming threatens, and it is individuals who stand to benefit from a reduction in that risk. Furthermore, it is individuals who benefit from the activities



Drawing by Scott Willis, *San Jose Mercury News*

and products that currently increase global warming. Thus it makes sense to regard individuals as the primary claimants to emissions entitlements.

But even if we agree that individuals are the natural claimants, we must still decide how many permits each person should receive. Is everyone entitled to the same number of them? If not, according to what principle should they be distributed? And what about those yet unborn, who will bear the consequences of greenhouse gases released now?

Three Ways of Determining a Fair Share

Let's consider three competing theories, each of which provides an answer to the questions just raised. The *egalitarian doctrine* holds that everyone is entitled to exactly the same number of rights. Thus, if n is the number of people alive on the day the treaty is signed, and $q(t)$ is the total quantity of emissions allowed in each year t, then every individual would be allocated $q(t)/n$ emission permits in year t.

The *cumulative liability doctrine* holds that individuals and their forebears are responsible for their total contribution to the greenhouse-gas buildup. In theory, one would estimate each nation's cumulative past emissions of (say) carbon dioxide, and then amortize them by the appropriate biotic absorption rate. These past emissions would be treated as an accumulated debt. The total debt would then be divided by the current population to obtain an average per capita rate, and the net debtors (those who exceeded the average rate) would have to pay off the net creditors according to some repayment schedule.

However fair this solution might seem, it carries with it the enormous practical problem of estimating past contributions with any degree of accuracy. There's a theoretical difficulty as well: not only did producers benefit from unregulated past emissions, so did consumers and investors—including consumers and investors in the nonindustrialized world. For example, the rents to oil-producing countries over the past half-century would surely have been less if CO_2 emissions had been taxed or restricted during the period. Indeed, the entire economic order has been based on a regime of free CO_2 disposal. The accumulated benefits and blame are both so widely diffused that past emissions are not a reliable measure of cumulative liability. In fact, the true extent of each country's liability is probably impossible to estimate.

The *status quo doctrine* represents an altogether different approach to distributing entitlements. This theory not only denies that past emitters should be held liable, it also asserts that their current rate of emissions constitutes a sort of property right established by long usage and custom. In other words, industrial countries are entitled to their higher emissions rates according to the common law doctrine of adverse possession.

A strict interpretation of the status quo doctrine treats current emissions as sacrosanct and allows only for limitations on their expansion. A more moderate interpretation holds that, if cuts must be made, then all parties must sacrifice equally relative to their status quo positions. According to this *equal sacrifice* variant of the status quo doctrine, the status quo is legitimate, but everyone acknowledges that sacrifices must be made for the common good. So, for example, each country's current rate of emissions might be reduced by an equal amount per capita, or by a fixed percentage per capita, or perhaps according to a progressive schedule, with the greatest percentage cuts imposed on those with the highest emissions rates.

Practical Implications

Now let's consider how these three doctrines would actually parcel out emissions permits. Table 1 shows the shares of population, gross national product, and CO_2 emissions in the industrialized countries, as compared with the rest of the world. The industrialized nations are responsible for roughly 60 percent of current CO_2 emissions and 70 percent of cumulative emissions, though they account for less than 25 percent of the world's population. Under an egalitarian regime, the industrialized nations would accordingly be granted only one-third of the permits that they need to continue business as usual. (If cumulative liabilities are counted, they would receive even fewer.) The less developed countries, on the other hand, would hold nearly twice as many entitlements per capita as they currently need.

Table 1

Shares of CO_2 Emissions, Population, and GNP

	CO_2 Emissions			
	Cumulative	Current	Population	GNP
Industrial	70%	60%	23%	84%
Less Developed	30	40	77	16

Cumulative emissions 1860-1986; current emissions total is mean of 1980-86; 132 countries covered. Industrial countries are those with 1986 per capita GNP above $4,000. Population and GNP data (125 countries covered) do not correspond precisely with emissions data. Sources: Suback, 1990; World Bank, 1988; *Information Please Almanac*, 1990.

In theory, the less developed countries would be willing to sell the industrialized world a large portion of their current entitlements (though not necessarily their future ones) at a price reflecting the cost of reducing CO_2 emissions at the source. This could involve the transfer of many billions of dollars from the industrialized to the nonindustrialized countries. Moreover, the latter might form a cartel and use their permits to gain political and economic leverage. The industrialized countries would then be forced to choose between paying the price demanded, making drastic production cuts, or reneging on the agreement. Considering its potential to cause significant hardship, the strictly egalitarian approach seems unattractive, even though it may be justifiable in theory.

The status quo doctrine, which says that the industrialized world is entitled to its current per capita emissions rate, carries a different kind of risk. Even if the rate were frozen as of some date and the less developed nations permitted to rise to that level, and even if the populations of those countries were fixed, or the per capita emissions level adjusted downward to compensate for population increases, the developing world's CO_2 emissions would still expand over sixfold. As a result, global emissions would expand over threefold. So large an increase could pose a serious threat to the environment.

A Proposed Compromise

The status quo doctrine allows too little flexibility for capping greenhouse-gas emissions while still meeting goals of equity, whereas the egalitarian and cumulative liability doctrines take too little account of the hardships attending adjustment, and therefore also fail to be fair. These considerations suggest that we need to find a compromise between the three methods of distributing entitlements.

One approach would be to move, in a series of steps, from a status quo to an egalitarian regime. Say, for example, that a particular year is chosen as the baseline from which adjustments are to be made, and the goal is to keep total emissions of each type of gas below some established ceiling. This would require setting a target rate of emissions per capita for each gas. The entitlements would then be allotted as follows: Countries above the target rate would have their entitlements reduced by a specified amount per capita (or by a specified percentage per capita) over a series of years. Countries below the per capita target rate would be allowed to rise until reaching it.

Emissions entitlements would be allotted to each nation en bloc, with the internal distribution of entitlements to be determined by the country's own policies. The end result would be a regime where emissions per capita are equal, but the phased transition would rest on the idea that everyone should sacrifice equally in moving toward this regime, except for those who are already disadvantaged.

Note that emissions would be limited absolutely, and not merely on a per capita basis. Since world population ranks among the most important factors driving the current increase in greenhouse-gas emissions, entitlements would have to be granted, once and for all, on the basis of each country's current population. Future generations would "inherit" these entitlements as they would other forms of property. The larger the number of descendants, the fewer the shares that each, on average, would inherit. Additional entitlements would not be granted as the number of claimants grows.

Table 2 shows how such a scheme would work if it were to begin now. From 1990 until 2000, developing-country emissions are allowed to grow at 4 percent, while industrialized-country emissions are reduced so that total worldwide emissions remain at the base-year level. Industrial countries reduce their emissions 3.3 percent annually from 1990 to1995, and 5 percent annually from 1995 to 2000. During the ten-year period, total industrial-country emissions decline 35 percent, while developing-country emissions rise 48 percent. In terms of emissions per capita, the industrial countries cut back 40 percent, and the developing countries expand 21 percent.

The proposed solution represents a compromise between radical insistence on absolute equality and conservative commitment to the status quo. Yet it still ig-

Table 2

Phased Transition from the Status Quo in CO_2 Emissions to an Egalitarian Regime, 1990-2000

	1990		1995		2000	
	Total (10^9 tons)	Per Capita (tons)	Total (10^9 tons)	Per Capita (tons)	Total (10^9 tons)	Per Capita (tons)
Industrial	3.88	3.37	3.27	2.72	2.52	2.02
Less Developed	2.86	0.71	3.47	0.78	4.22	0.86

Annual emissions totals based on 1986 estimates (Suback, 1990). Industrial countries are those with per capita GNP above $4,000. Per capita calculations based on World Bank population data (1988).

nores the most troubling aspect of the case—namely, the historical contributions of the industrialized world to the present buildup of greenhouse gas.

As we have already argued, any attempt to assess past contributions to the problem must factor in the benefits that resulted from the laissez-faire regime. But since those benefits are so widely diffused and difficult to quantify, the quest for a reliable measure of cumulative liability seems hopeless. A better solution, suggested by the Montreal accord, would be for industrialized countries to establish a joint fund that would invest in research and technology transfer and financial aid to help developing countries adjust to the new regime.

Even relatively modest levels of investment could produce substantial benefits. For example, the fund could support the development of improved world climate models, as well as basic research into the chemical and biological processes related to the greenhouse effect. The fund might also award prizes for inventions and discoveries that could help to remedy global warming. At a more ambitious level, the fund could provide credits to developing countries that adopt technologies expected to reduce greenhouse-gas emissions.

A reasonable basis for sharing the costs of such a fund would be a commonly accepted measure of ability to pay—such as gross domestic product or the United Nations contributions scale. By any such formula, the burden of costs would fall squarely on the developed countries. Not only would this be widely regarded as fair, it could prove of strategic value in generating an agreement. The developed world must make a serious commitment, not only to cutting back its own emissions, but also to helping less developed countries deal with a problem that industrialized countries are largely responsible for creating.

— H.P. Young

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Greenhouse Economics: Think Before You Count

Most people agree that the greenhouse gases produced by modern society are changing the make-up of the earth's atmosphere. Most people also agree that these changes will cause a rise in average temperatures near the planet's surface. Granted, there continue to be uncertainties about the size and speed of the temperature increase, its implications for human activities, and its ecological effects, all of which have been stumbling blocks to forging an agreement on global warming. But an equally important stumbling block has attracted comparatively little attention: the fact that different decision-making frameworks have been brought to bear on the discussion of what our policies should be.

One of these—the utilitarian market framework (UMF)—attempts to use the conceptual apparatus of welfare economics to assess environmental policy options. A good example of this approach can be found in the writings of William Nordhaus, John Musser Professor of Economics at Yale. In "How Fast Should We Graze the Global Commons?" Nordhaus recommends that alternative strategies for controlling greenhouse-gas emissions "be weighed by examining their implications for consumption (or real income) of different generations." On this view, how much we would be willing to pay to control emissions "must equate discounted costs and benefits of. . . abatement in terms of consumption." Costs and benefits are discounted back to their present value so that they may be compared with one another. We then choose the strategy that maximizes the benefits over the costs.

The UMF's key assumption is stated explicitly in "To Slow or Not To Slow: The Economics of the Greenhouse Effect." "We assume," Nordhaus writes, "that it is desirable to maximize a social welfare function that is the discounted sum of the utilities of per capita consumption." According to the UMF, we should maximize the benefits of actions taken over the costs of

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