AN ECONOMIC FRAMEWORK FOR THE CONSIDERATION OF CLIMATE CHANGE POLICY

Joel Darmstadter
Energy and Natural Resources Division
Resources for the Future
1616 P Street, N.W.
Washington, DC 20036

Keywords: Climate change policy, costs, benefits

BACKGROUND

While lacking unanimity, an emerging scientific consensus suggests that unconstrained trends in the growth of greenhouse gas emissions might, before the end of the next century, raise global mean temperature by 2-5^{0} Celsius, raise sea levels by 30-100 cm, and significantly alter weather patterns. Through damage to coastal infrastructure and settlements, impaired agricultural productivity, and a variety of impacts on both unmanaged ecosystems and manmade assets, these consequences of greenhouse gas emissions could seriously threaten social well-being. The offending gases principally include carbon dioxide (CO_2)--whose elevated presence in the atmosphere is attributed primarily to fossil-fuel combustion and secondarily to deforestation--nitrous oxide (N_2O), methane (CH_4), and chlorofluorocarbons (CFCs). Notwithstanding CFCs' assault on the stratospheric ozone layer, their pending phaseout under the Montreal Protocol and succeeding restrictions and recent scientific judgments questioning the severity of their contribution to greenhouse warming puts the spotlight on the other gases, principally CO_2, estimated to account for about half of the greenhouse warming that may now be materializing.

Given the public prominence accorded to the greenhouse question at UNCED in June 1992 and other forums, it seems almost superfluous to note the many interrelated ways--scientific, political, economic--in which this issue confronts us with an environmental challenge of truly formidable dimensions:

- On the ***scientific*** front, notwithstanding broad agreement as to the likelihood of increases in global mean temperature, there are widely acknowledged uncertainties, notably the regional nature of climatic change and the feedbacks (positive or negative) set in motion by greenhouse warming.

- Such uncertainties and the fact that there are at least some doubters about the general expectation of global warming undermine, or can be used to undermine, the basis for response strategies. In part, this feeds the ***political*** circumspection regarding greenhouse mitigation initiatives, which policy makers are loath to embrace, fearing unacceptably high costs to constituents and reluctant to address problems likely to manifest themselves over time scales that seem light years in the future.

- Questions of cost and time horizons underscore as well the important ***economic*** aspect of managing the greenhouse problem. Simply put, and in the disembodied language of benefit-cost analysis, efforts to lessen the severity or prospect of climatic change entails

spending money--mostly in the near term--on mitigating activities responsible for a heightened greenhouse effect or deploying measures to adapt to such degree of warming as may be inevitable or deemed tolerable. Such mitigation or adaptation investments should be weighed against the benefits thereby obtained; the value of those benefits is reckoned in terms of the avoidance of damage due to global warming.

The economic perspective on the greenhouse dilemma is, of course, largely an abstract formulation. Yet, even within such a limited conceptual framework, some important points can be usefully highlighted. The balance of these remarks will focus on greenhouse warming in its economic orientation.

RECKONING COSTS

An unexceptional statement that can be made right at the start is that, to the extent that emission reduction efforts are costless or even profitable (the so-called "win-win" or "no regrets" strategy), the benefit-cost conundrum dissolves: we can only be better off economically and environmentally if greenhouse gases and other pollutant emissions can be curtailed at minimum expense. (Proponents of the efficacy of a warmer climate--probably a very small minority--and those perceiving as great a likelihood of global cooling as warming would question that observation.) This self-evident statement of principle takes on practical significance when we take cognizance of a number of studies that attempt to show the feasibility of actually realizing such potential savings. As an example, a widely-publicized National Academy of Sciences (1991) report, assessing greenhouse gas mitigation possibilities in the United States, identified significant opportunities for emission reduction at negative, zero, low, or moderate cost. Depending on how aggressive an effort was mounted to exploit these available opportunities, between around 12-25 percent of this country's greenhouse gas emissions could be eliminated at negative or zero cost. Under the most favorable circumstances--100 percent implementation and marginal costs not exceeding $2.50 per ton of carbon equivalent reduction--emissions might be reducible by as much as 60 percent below levels otherwise prevailing. (That $2.50 translates into, say, 13¢ per gallon of gasoline.) It is important to note that the National Academy's graphic representation of these possibilities, many of which involve enhanced energy efficiency in transportation and housing, depicts a "timeless"--but otherwise unspecified--long-run adjustment path, presumably sufficient to allow capital turnover, behavioral change, and policy changes needed to realize the projections. All that might easily require 2-3 decades to accomplish.

To a greater or lesser extent, opportunities for emission reductions exist throughout the world--perhaps somewhat less in a place like Japan, with its energy-efficient industrial operations; but no doubt more in countries emerging from communist dictation, with their lack of economic incentives and rampant inefficiency, as well as in numerous developing countries. But to point to elimination of prevailing economic waste and energy inefficiency as priority routes to greenhouse gas mitigation does not remove the prospect that, sooner or later, attempts to limit emissions to some maximum level may mean rising marginal costs--whether due to a shift to costlier low- or non-carbon fuels or other economic losses attributable to greenhouse gas constraints. Of course, induced technological advances might blunt, and in the extreme case, offset these cost increases.

RECKONING BENEFITS

To the extent that some considerable cost increases would follow in the wake of greenhouse gas mitigation policies, the problem shifts to one of valuing of the benefits--that is, what damages are avoided?--so obtained. Only limited analysis has focused on that question. The principal effort along this line has been that by Yale economist, William Nordhaus (1991). Nordhaus, concentrating principally on the United States, but then broadening his discussion (to the extent data allow) to the world as a whole, spotlights those economic sectors particularly vulnerable to the degree of global warming associated with a doubling of CO_2-equivalent atmospheric concentrations: agriculture, forestry, energy, and several other sectors assumed to be more moderately affected. Considering the weight of each of these activities in the overall economy and subjecting them to net damage impacts leads, in the author's own words, "to a surprising conclusion:"

> ...Our best guess is that CO_2-induced climate change will produce a combination of gains and losses with no strong presumption of substantial net economic damages. However, these changes are likely to take place over a period of a half century or more and may get lost in the background noise of social, economic, and political change. This conclusion should not be interpreted as a brief *in favor of* climate change. Rather, it suggests that those who paint a bleak picture of desert Earth devoid of fruitful economic activity may be exaggerating the injuries and neglecting the benefits of climate change.

In Nordhaus' assessment, those surprisingly mild damage estimates content with greenhouse gas control costs that, as he suggests, grow rapidly and become extreme for substantial reductions. Thus, while 10 percent of worldwide CO_2 emissions can be reduced at the modest cost of $10 per ton, a 50 percent reduction entails a cost of $150 per ton and a drain on world GNP of about $180 billion--or around one percent of prevailing price and output levels. The moral of the story: "count before you leap," which, as it happens, was the title assigned to a short summary article Nordhaus wrote on the climate-change question in The Economist a couple of years ago (Nordhaus 1990).

Notwithstanding Nordhaus' welcome effort to frame the greenhouse dilemma in benefit-cost terms, it must be emphasized that the scope of such an analysis lends itself to greater or narrower latitude, with potentially marked effect on the numerical outcome. For example, economists' kit of tools are much more congenial to the valuation of resources denominated in market prices than to those things which, while highly prized, are not easily amenable to dollar estimation that would allow them to be combined with market assets. Unmanaged forests, wetlands, and other ecosystems, biodiversity, endangered species--all of which may be perturbed by climatic change--fall into this "difficult to measure" category. Whether, and to what extent, their inclusion would alter Nordhaus' more restrictive benefit-cost calculus is open to question. It should be noted that efforts and techniques to allow for consideration of these non-market assets need not be unavailing, although progress along these lines presupposes close collaboration between physical and social scientists. (A workshop conducted at Resources for the Future in March 1992 focused precisely on this issue.)

What may be another limitation in Nordhaus' perspective--though, again, one not easily handled--is that of the assumed time horizon. By restricting the analysis to the doubled CO_2-

equivalent atmospheric concentrations likely to materialize around the middle of the 21st century, one ignores the prospects for and consequences of steadily rising concentrations in the decades--indeed, centuries--beyond that milestone. Insofar as subsequent impacts may be nonlinear--coastal resources may be resilient to a one-meter sea-level rise but devastated by greater increases--the question of what time perspective to employ can become critical.

A recent study by William Cline (1992) begins to confront these problems. Cline extends his analysis 300 years into the future. By varying such parameters as discount rates, temperature increases, and damage functions, he develops multiple trajectories over this period, but settles on a "central" estimate based on 10^{o} Celsius warming and a damage estimate approximating 6 percent of world GNP. Incorporating those factors in a benefit-cost analysis, Cline derives an overall benefit-cost ratio of 1.3, stating that "if policy makers are risk averse...this study finds that aggressive action to restrain global warming is desirable from the standpoint of social benefit-cost analysis."

THE ROLE OF ADAPTATION

Although, in the somewhat stark schematics presented here, the choices pit emission reduction against damage avoided, there is bound to be a role for adaptation in steps taken to deal with climate change. Adaptation could, in principle, be a purposeful least-cost rational strategy: it's cheaper to build seawalls or inhibit coastal development than to limit emissions leading to sea-level rise. But more realistically, adaptation is likely to involve the ability to cushion climatic impacts across a range of affected activities--e.g., farmers' ability to shift to crop varieties more resilient to climatic stress, thereby substantially (though not totally) offsetting the reductions in crop yield they would otherwise face under climatic change. (See Rosenberg and Crosson 1991). Of course, such adaptation presupposes an evolutionary process whereby one is always forced to adjust to new circumstances, climatic or otherwise. But if climatic change were sudden, severe and triggering major discontinuities in economic and social affairs, this presumption of adaptive capabilities would be a very fragile one.

CONCLUDING REMARKS

The principal purpose here has been to sketch out a simple economic framework as one way of viewing the global warming problem. The idea has been to sharpen our thinking, certainly not to use such a framework as a unifying device to integrate the many strands--scientific, economic, political--that make up the problem. Indeed, the political impediment to addressing the issue forthrightly may be the thorniest one of all. That is understandable in situations where many resource needs compete for policy makers' attention. It is also understandable--but a lot more disheartening--where the policy process, operating within its own glaze of myopia and by its own set of rules, finds it impossible to focus far beyond the elective term of office, let alone over the time horizon that a problem such as greenhouse warming demands.

REFERENCES

(1) Cline, William R. 1992. Global Warming: The Economic Stakes (Washington, DC, Institute for International Economics).

(2) National Academy of Science. 1991. Policy Implications of Greenhouse Warming (Washington, DC, National Academy Press).

(3) Nordhaus, William D. 1991. "Economic Approaches to Greenhouse Warming," in Rudiger Dornbusch and James M. Poterba, eds., Global Warming: Economic Policy Responses (Cambridge, MA, MIT Press), pp. 33-66.

(4) Nordhaus, William D. 1990. "Count Before You Leap," The Economist, July 7, pp. 21-23.

(5) Rosenberg, Norman J. and Pierre R. Crosson. 1991. "Processes for Identifying Regional Influences of and Responses to Increasing Atmospheric CO_2 and Climate Change - The MINK Project," U.S. Department of Energy, Document DOE/RL/08180T-H5, August.

PREPRINT NOT AVAILABLE AT TIME OF PUBLICATION

THESE PAGES INTENTIONALLY LEFT BLANK

PREPRINT NOT AVAILABLE AT TIME OF PUBLICATION

THESE PAGES INTENTIONALLY LEFT BLANK