

BOOK REVIEW
Three Books on Global Climate Change

by

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Counting the Cost of Global Warming. BY JOHN BROOME. Cambridge, UK: White Horse Press, 1992.

The Economics of Global Warming. BY WILLIAM R. CLINE. Washington: Institute for International Economics, 1992.

Buying Greenhouse Insurance: The Economic Costs of CO₂ Emission Limits. BY ALAN S. MANNE AND RICHARD G. RICHELIS. Cambridge, MA: MIT Press, 1992.

These three books deal with various aspects of the economics of global climate change -- an issue of global scope involving potentially huge stakes, time horizons measured in centuries, and deep scientific and economic uncertainties. William Cline's book provides a critical assessment of much of the literature and an analysis of policy options. The shorter monographs by John Broome and by Alan Manne and Richard Richels focus in more depth on intertemporal comparisons and the costs of emissions reduction, respectively. Cline's book is essential reading for economists any interest in global climate change, while the other two studies deserve the attention of those with a research interest in this issue.

All three books begin with discussions of the large and diverse scientific literature on global warming. Cline's is the most comprehensive discussion, but Cline's concern for bottom-line policy conclusions often leads him to understate scientific uncertainty. For instance, even though most scientists do not believe that it will be possible for years (for computational and other reasons) to generate reliable long-term forecasts of regional climate changes, Cline sometimes (e.g., p. 61-72) treats this problem as solved. Cline does not always make it clear when he undertakes to settle debates among scientists or to extrapolate beyond the scientific literature.

Cline argues persuasively that a long time horizon is appropriate in the analysis of climate change. Most scientists agree that today's emissions of carbon dioxide (CO₂) will increase the net amount of solar radiation absorbed by the earth (radiative forcing) for a

century or more, and climate change appears likely to lag changes in radiative forcing by decades. Analyses that do not look beyond the middle of the next century thus neglect much of the climatic impact of even today's emissions. Unfortunately, the farther into the future one tries to look, the greater the scientific and economic uncertainty one encounters. Cline's best estimate (a serious extrapolation beyond the literature) is that without significant policy changes, global average warming would peak at about 10°C (18°F) in about the year 2275, but the corresponding subjective probability distribution is necessarily quite flat. Moreover, global average warming is of little policy interest, and the regional changes that do matter are considerably more uncertain.

Whether extending the horizon from 2050, say, to 2275 is likely to affect policy conclusions materially depends critically on the discount rate employed. More generally, if only because CO₂ emissions have very long-lived effects on the atmosphere, choice of a discount rate is critical to the analysis of climate change policy. Cline devotes a provocative chapter to this issue and concludes that a relatively low real discount rate of 1.5% should be used in this context.

Broome's monograph, the outgrowth of a "desk study" that he and David Ulph prepared for the Economic and Social Research Council (UK), treats in more depth discounting and related welfare-theoretic issues in the context of climate change. The original study was apparently done under significant time pressure, and Broome's book provides more of a critical survey than an attempt to break new ground. Whereas Cline puts bridges of one sort or another across all swamps he encounters, Broome is generally content to erect warning flags, indicating the need for more research, where solid bridges do not already exist.

Broome attempts, with a good deal of success, to integrate the relevant philosophical literature into a relatively non-technical and very clear exposition aimed primarily at economists.

Broome notes that policies to reduce greenhouse gas emissions generally involve inter-generational redistribution and that one cannot presume that either climate change or policies to deal with it will have only a marginal impact on society. If only because catastrophic shifts in weather patterns are at least conceivable, population sizes and average lifetimes are logically endogenous. Broome's analysis begins with an illuminating general discussion of relations among such concepts as justice, wellbeing, and preferences in such settings. If nothing else, this discussion reveals how heavily conventional welfare economics depends on generally unexamined philosophical conclusions.

Broome devotes a 60-page chapter to the question of discounting in the climate change context. He argues that discounting costs and benefits using the consumer interest rate is unjustifiable for several reasons, most importantly because future people do not participate in today's markets and because global warming is (at least with some probability) not marginal. He objects to using the producer interest rate even when government investment displaces private investment, largely on the grounds that observed private rates of return exceed the corresponding social rates of return because of unpriced externalities -- an objection that seems to have more to do with practicality than with principle. Broome then deals with the "pure" discount rate, the rate at which wellbeing is discounted in the objective function. He argues from first principles that this rate should be zero. The analysis finishes with a discussion of the treatment of population and lifetimes in the objective function; this provocative discussion leads to no sharp conclusions.

On the whole, Broome succeeds in his attempt "to bring some order to the questions, rather than find answers." His monograph does not contain much specific methodological guidance, but it should serve as a useful starting point for necessary welfare-theoretic research on the proper treatment of intertemporal and, critically, intergenerational comparisons in the context of climate change.

Cline devotes about 40% of his book to estimates of the costs and benefits of reducing greenhouse gas emissions relative to baseline levels. Relatively little serious quantitative work has been done on benefits -- that is, on the differences in the costs that would be imposed by various rates and levels of climate change. Almost no quantitative analysis has attempted to look beyond the next century or to value impacts of climate change on unmanaged ecosystems. Cline tends to treat as likely the worst possibilities discussed in a thin literature mainly concerned with what might happen in the 21st century. He then inflates the corresponding damages to reflect the much greater warming he predicts over the following 200 years. While Cline's treatment is thus not exactly inconsistent with the existing literature, his damage/benefit estimates seem clearly on the high end of the supportable range.

Cline's discussion of the costs of slowing climate change (and, in the very distant future, perhaps reducing the peak change) considers both engineering and economic estimates of the cost of reducing CO₂ emissions. (Because there is essentially no literature on the costs of reducing emissions of other greenhouse gases, Cline is forced to account for these costs by scaling up the CO₂ abatement cost estimates.) Cline attaches considerable weight to the results in the Manne-Richels monograph, though he adjusts those cost estimates downwards to reflect the large untapped potential for zero-cost energy conservation that engineers tend to

see and economists tend to argue must be an illusion. Cline discusses transitional forestry options at some length. (Only growing forests remove CO₂ from the atmosphere; mature forests store carbon.)

The Manne-Richels monograph describes Global 2100, a five-region, long-term, energy-economy model, and uses it to analyze the effects of a range of emission reduction scenarios during the 1990-2100 period. Even though Global 2100 is necessarily complex, Manne and Richels present the main structural assumptions it embodies and the roles of its key parameters very clearly. The Manne-Richels monograph is thus useful both because it presents important and well-defended quantitative results and because it provides clear discussions of important modeling issues.

Attempts to forecast the structure of the global economy through the end of the next century necessarily involve a mixture of extrapolation and technology forecasting. Computational and data constraints require that any global model embody significant simplifications. In Global 2100, each region is modeled as a single regional individual with perfect foresight using capital, labor, electrical energy, and non-electrical energy to produce GDP using a putty-clay technology. Each regional individual maximizes the discounted logarithm of consumption, using a 3% "pure" discount rate. Key production parameters are the elasticity of substitution between energy and capital-labor aggregates (ESUB) and the rate of autonomous energy-augmenting technical change (AEEI). The model is benchmarked so that GDP growth rates in the absence of policy change equal the average of rates projected by Working Group III of the Intergovernmental Panel on Climate Change (IPCC).

Global 2100 has a relatively detailed energy sector. Electrical energy may be

produced by five existing technologies and four future technologies, two of which are carbon-free backstops available in unlimited supply. There are nine technologies for producing non-electrical energy, one of which is a carbon-free backstop. The costs assumed for the backstop technologies (which are not otherwise described) act as important upper bounds on the costs of reducing CO₂ emissions. The model allows for depletion and discovery of oil and gas reserves and for international trade in oil and, in some runs, in rights to emit CO₂.

Manne and Richels forecast baseline global CO₂ emissions to increase by nearly a factor of 7 between 1990 and 2100. U.S. emissions are projected to increase by about a factor of 5; about 75% of global emissions growth is projected to occur outside the OECD and the former USSR, most importantly in China and India.

Manne and Richels analyze the effects of restricting U.S. emissions to their 1990 level through 2000, reducing them to 80% of this level by 2010, and stabilizing them thereafter. In their base case, the relative GDP loss involved in satisfying this constraint at least cost (most naturally by imposing a carbon tax) climbs to just over 2% by 2020, rises slowly to 2.5% by 2040, and, because of the availability of backstop supply technologies, remains roughly constant thereafter. Manne and Richels show that these costs are quite sensitive to assumptions about backstop parameters and the AEEI. Like most other contributors to the abatement cost literature, Manne and Richels do not consider alternatives to cost-minimizing policies, even though recent debates about energy policy and energy taxes in the U.S. and the E.C. suggest very strongly that a simple tax on CO₂ emissions is likely to be considerably less attractive politically than more costly regulatory alternatives, such as stringent vehicle and appliance efficiency standards.

In another experiment, Manne and Richels treat total allowable U.S. emissions through 2050 as uncertain until 2020 and show that, depending on the probabilities attached to alternative emissions limits, the value of improved information may be high. The Global 2100 model is shown to imply substantial international differences in the costs of CO₂ emissions stabilization and significant potential gains from moving from national to global emissions constraints (most naturally, by international trade in rights to emit CO₂). Manne and Richels also note that realizing those gains is likely to require a significant flow of resources from developed to developing nations.

Cline's comprehensive analysis culminates in a detailed, clearly presented evaluation of an "aggressive" policy of reducing current global emissions (again, at least cost) by about 40% and holding them stable indefinitely. This policy goes well beyond those that have dominated recent intergovernmental discussions. In Cline's preferred case, the benefit/cost ratio is only 0.74, though it exceeds unity for some parameter combinations he considers plausible. (Much depends on the discount rate and on how available damage estimates are inflated to reflect greater warming in the distant future.) Cline argues that allowing for risk-aversion serves to justify his aggressive policy.

In his final chapter, Cline discusses the serious obstacles to international implementation of abatement policy and advocates focusing on relatively inexpensive actions in the near term. Cline's discussion of what is feasible seems optimistic. Developing nations typically have much more urgent concerns and are uninterested in devoting resources to improving the climate their great-great-grandchildren will face. Only a few developed nations have done anything but talk (in some cases loudly and at length) about reducing their own

CO₂ emissions. (Cline's assertion that the E.C. has adopted a carbon tax is, at best, premature.) No donor nations have agreed to pay billions to help China and India use their vast coal reserves more efficiently.

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