Managing the commons: The economics of climate change. 1994.

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William Nordhaus has gone further than any economist to date at building a dynamic integrated model of the world's climate and economic systems, with some one-way linkages to agricultural systems and ecosystems. "Managing the commons" is an admirably readable description of this effort which, in his words, "balances the costs of emissions controls in energy policies and other areas against the impacts to agriculture, coastlines, and ecosystem values". In addition to a detailed description of the Dynamic Integrated Climate and the Economy (DICE) model and several scenarios produced by the model, the book includes large sections on sensitivity analysis of the model's parameter uncertainty and an analysis of the value of information gained at various times in the future to the decision process.

While there is much of interest in the book, and it is laudable both in its technical competence and simply for making the heroic attempt to integrate economic and climate models, I'll concentrate in this review on some critiques.

First, the title is a bit overreaching. The book is actually a detailed description of a single computer model, not a comprehensive treatment of managing the global commons, or even of the economics of climate change. A more descriptive title would have been; "Managing the DICE model: a neoclassical view of some of the economic impacts of climate change".

Second, as Nordhaus has himself pointed out, any model is only as good as the assumptions that go into it. In the case of the DICE model, a thorough job was done in analyzing the model's sensitivity to uncertainty about the parameters, but no effort went into analyzing sensitivity to some of the more basic, and more important, assumptions. For example, "The basic approach of the DICE model is to use a Ramsey model of optimal economic growth with certain adjustments and to calculate the optimal path for both capital accumulation and GHG-emissions reductions" (pp. 5). This model assumes that economic growth is not limited by natural resources or environmental changes. Economic output in DICE is
estimated using a production function which includes only reproducible capital, labor, and technology in its arguments. Population growth and technological change are exogenous and natural capital is completely missing. These are rather strong assumptions, given that one of the purposes of the DICE model is to integrate economic models with the rest of the natural world. In DICE, the economy goes on its merry way with no real feedback from the natural world. There is only the one-way flow of impacts on climate, and only through that on agriculture and ecosystems. Recent preliminary work on an economic growth model with natural resources in the production function and endogenous population growth shows some very different results (Brown and Roughgarden 1995), so we can assume that adopting something other than the standard neoclassical growth model would make a big difference to the conclusions.

Third, the only "nonconventional" part of the DICE model is its link to climate change. This was done by incorporating a greatly simplified depiction of the global atmospheric circulation models to form a set of climate-emissions-damage equations. While the simplified climate equations might pick up the major features of the emissions-climate link, the link in the model between climate change and economic impact on human and natural systems is by far the weakest one. To pick this up, the DICE model assumes a very simple relationship between global mean temperature (as a proxy for climate change) and damage: \( \frac{D(t)}{Q(t)} = 0.00144 T(t)^2 \), where \( D \) is the loss of global output, \( Q \) is global output, and \( T \) is global mean temperature, all at time \( t \) (eq. 2.11, pp. 18). The missing links are the actual feedbacks between climate change (including the more important features of precipitation change and especially the geographic distribution of changes) and ecosystem changes, and between ecosystem changes and economic performance. These links are complex, yet they are the essence of the problem being addressed. While integrated climate-economy-ecosystem models are still relatively rare (Parson and Fisher-Vanden 1995), there is at least one, the IMAGE model1 (Rotmans 1990, Alcamo 1994) which does a fairly elaborate, spatially explicit, job of estimating the climate-ecosystem linkages, and the results are anything but simple.

Fourth, both the spatial and temporal resolution of the DICE model are ludicrously low, given the problem at hand. DICE is globally averaged and uses a time step of 10 years. Given that most of the underlying relationships are probably highly non-linear and spatially discontinuous, this level of aggregation has got to cause some serious problems. As Nordhaus has himself pointed out elsewhere: "The main result of aggregation theory is that aggregation is generally possible only when the underlying micro relations are linear" (Nordhaus 1973, pp 1160). This, combined with the simple basic structure of DICE, means that there are no real possibilities for "surprises" in DICE like the kind we have come to expect in the real world. Yet, there is no discussion of the possibly huge impacts of aggregation error other than Nordhaus's contention that the level of aggregation used was necessary in order that "the theoretical model is transparent and the optimization model is empirically tractable." In other words, he wanted it to be simple and runnable on a PC. Nice goals, but hardly justification for a model intended to be used to set realistic global policies on greenhouse warming.

Fifth, DICE assumes that consumption equals welfare: "We assume that the purpose of our policies is to improve the living standards or consumption of humans now and in the future." (pp. 10). This is one purpose, but consumption is not always correlated with overall human well-being or welfare, more broadly defined (eg. Easterlin 1974, Daly and Cobb 1989, Ekins and Max-Neef 1992). There is some attempt to broaden the concept of consumption beyond conventional GNP by stating that consumption "includes not only traditional market purchases of goods and services like food and shelter but also nonmarket items such as leisure, cultural amenities, and enjoyment of the environment" (pp. 10). After saying this, these non-traditional components are quickly forgotten, and the productive values of natural capital (which are probably more important) are never even considered. The problem is that material
growth in the economy can become "anti-economic" if the many uncounted costs of additional growth begin to outweigh the counted benefits (Daly 1987, Daly and Cobb 1989). The DICE model, through its simple damage function, includes only a very crude estimate of some of these costs, but it has no way of picking up any non-consumption welfare effects or feedback effects from the environment to the economy. Yet Nordhaus blithely talks about the "welfare" effects of various policy scenarios. What DICE actually models is (at best) the marketed, and some small piece of the nonmarketed, consumption effects, and these may in fact be opposite to the true welfare effects as the planet's natural capital base continues to erode.

In closing, I am tempted to quote a noted expert in his criticism of an earlier integrated, global, computer simulation model:

"...there is some lack of humility toward predicting the future. Can we treat seriously Researcher X's (or anybody's) predictions in economics and social science for the next 130 years? Long-run economic forecasts have generally fared quite poorly. Marx predicted the immiseration of the working class under capitalism; Keynes guessed that capital could have no net productivity by the present year; Galbraith assured us that scarcity is obsolete."

The noted expert was Nordhaus himself (Nordhaus 1973, pp. 1183) and "Researcher X" was Jay Forrester and his World Dynamics model (Forrester 1971). Nordhaus has fallen into many of the same traps he so vehemently criticized Forrester for. To paraphrase Nordhaus's earlier summary dismissal of Forrester after listing the failed predictions above: and now Nordhaus tells us that global climate change is not a big problem.

While both Nordhaus and Forrester produced admirable pieces of work in their own ways, in both cases we need to interpret them carefully and not take the results too literally in designing policies for such high stakes as the future of the planet. We need integrated models that combine the best of economics, climatology, and ecology at temporal and spatial scales that are appropriate to the task, and with humility and caution that is appropriate to the stakes. Nordhaus has gone further than almost any economist in bringing climate and nature into a conventional neoclassical framework, but in so many ways it is not nearly enough.

References


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Notes


2. Thanks to Herman Daly, Paul Ehrlich, and Steve Schneider for helpful comments on earlier drafts.