

Gambling with Civilization*

by Paul Krugman[†]

EES 2110: Introduction to Climate Change

The Climate Casino: Risk, Uncertainty, and Economics for a Warming World

by William D. Nordhaus

Yale University Press, 378 pp., \$30.00

Forty years ago a brilliant young Yale economist named William Nordhaus published a landmark paper, “The Allocation of Energy Resources,” that opened new frontiers in economic analysis.* Nordhaus argued that to think clearly about the economics of exhaustible resources like oil and coal, it was necessary to look far into the future, to assess their value as they become more scarce—and that this look into the future necessarily involved considering not just available resources and expected future economic growth, but likely future technologies as well. Moreover, he developed a method for incorporating all of this information—resource estimates, long-run economic forecasts, and engineers’ best guesses about the costs of future technologies—into a quantitative model of energy prices over the long term.

The resource and engineering data for Nordhaus’s paper were for the most part compiled by his research assistant, a twenty-year-old undergraduate, who spent long hours immured in Yale’s Geology Library, poring over Bureau of Mines circulars and the like. It was an invaluable apprenticeship. My reasons for bringing up this bit of intellectual history, however, go beyond personal disclosure—although readers of this review should know that Bill Nordhaus was my first professional mentor. For if one looks back at “The Allocation of Energy Resources,” one learns two crucial lessons. First, predictions are hard, especially about the distant future. Second, sometimes such predictions must be made nonetheless.

Looking back at “Allocation” after four decades, what’s striking is how wrong the technical experts were about future technologies. For many years all their errors seemed to have been on the side of overoptimism, especially on oil production and nuclear power. More recently, the surprises have come on the other side, with fracking having the biggest immediate impact on markets, but with the growing competitiveness of wind and solar power—neither of which figured in “Allocation” at all—perhaps the more fundamental news. For what it’s worth, current oil prices, adjusted for overall inflation, are about twice Nordhaus’s prediction, while coal and especially natural gas prices are well below his baseline.

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**Brookings Papers on Economic Activity*, Vol. 3 (1973).

So the future is uncertain, a reality acknowledged in the title of Nordhaus's new book, *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World*. Yet decisions must be made taking the future—and sometimes the very long-term future—into account. This is true when it comes to exhaustible resources, where every barrel of oil we burn today is a barrel that won't be available for future generations. It is all the more true for global warming, where every ton of carbon dioxide we emit today will remain in the atmosphere, changing the world's climate, for generations to come. And as Nordhaus emphasizes, although perhaps not as strongly as some would like, when it comes to climate change uncertainty strengthens, not weakens, the case for action now.

Yet while uncertainty cannot be banished from the issue of global warming, one can and should make the best predictions possible. Following his work on energy futures, Nordhaus became a pioneer in the development of “integrated assessment models” (IAMS), which try to pull together what we know about two systems—the economy and the climate—map out their interactions, and let us do cost-benefit analysis of alternative policies.* At one level *The Climate Casino* is an effort to popularize the results of IAMS and their implications. But it is also, of course, a call for action. I'll ask later in this review whether that call has much chance of succeeding.



Greenland, photographed from a boat navigating the melt where dog sleds used to travel across the ice, October 2009. Photo Credit: Stanley Greene/NOOR/Redux

2.

Stylistically, *The Climate Casino* reads like a primer rather than a manifesto—something that will no doubt frustrate many climate activists. This is, one has to say, something of a characteristic position for Nordhaus: within the community of reasonable people who accept the reality of global warming and the need to do something about it, he has often taken on the role of debunker, criticizing strong claims that he doesn't think are justified by theory or evidence. He has raised hackles by expressing relative optimism about our ability to adapt to moderate global warming. He harshly criticized Nicholas

*See, for example, William D. Nordhaus and Joseph Boyer, *Warming the World: Economic Models of Global Warming* (MIT Press, 2000).

Stern's widely publicized report on the economics of climate change for arguing that we should not discount the costs imposed by fossil fuel consumption on future generations at all compared with cost imposed on the current generation.* And he has taken a skeptical line toward the widely circulated arguments by Harvard's Martin Weitzman that the risk of catastrophic climate effects justifies very aggressive and early action to limit greenhouse gas emissions.†

As I said, Nordhaus's part in these controversies has frustrated some climate activists, not least because opponents of any kind of climate action have seized on some of his work in support of their position. So it's important to realize that *The Climate Casino* is in no sense the work of someone skeptical about either the reality of global warming or the need to act now. He more or less ridicules claims that climate change isn't happening or that it isn't the result of human activity. And he calls for strong action: his best estimate of what we should be doing involves placing a substantial immediate tax on carbon, one that would sharply increase the current price of coal, and gradually raising that tax, more than doubling it by 2030. Some might consider even this policy inadequate, but it's far beyond anything currently on the political agenda, so as a practical matter Nordhaus and the most hawkish of climate activists are entirely on the same side.

And one of the nice things that those of us who deeply respect both Nordhaus and Stern will discover in this book is Nordhaus's conclusion (to his own surprise), based on his models, that the whole issue of how much to discount costs to future generations is something of a red herring—it turns out that the rate at which you discount the distant future doesn't make much difference to optimal policy, only slightly raising the amount of global warming that we should, in the end, allow to take place.

SO, what does Nordhaus tell us in this primer? First, he reviews basic climate science. By burning huge amounts of fossil fuels, we have greatly increased the concentration of carbon dioxide in the atmosphere, and will almost surely increase it much more in the next few decades. The problem is that CO₂ is a greenhouse gas (as are several other gases also released as a consequence of industrialization): it traps heat, raising the planet's temperature.

How big a rise are we talking about? Nordhaus more or less goes along with the scientific consensus as expressed in the latest report of the Intergovernmental Panel on Climate Change, which puts the likely increase at between 1.8 and 4°C Centigrade by 2100, or between 3 and 7.5 degrees Fahrenheit. Nordhaus's "baseline run" is actually toward the high end of this range, and he shows the temperature rise at almost 6°C Centigrade—more than 10°F Fahrenheit—by 2200. He also notes the possibility of nasty surprises, for example if warming leads to the release of substantial amounts of methane—a powerful greenhouse gas—from thawing tundra.

Warming, in turn, has a number of consequences going beyond a simple rise in temperatures. Sea levels will rise, both from the expansion of the water itself and from melting ice—and here, too, there is a possibility of nasty surprises if, for example, the melting of the Greenland ice sheet in turn causes more melting. Hurricanes will

*William D. Nordhaus, "A Review of the 'Stern Review on the Economics of Climate Change,'" *Journal of Economic Literature*, Vol. 45, No. 3 (September 2007).

†See Martin L. Weitzman, "On Modeling and Interpreting the Economics of Catastrophic Climate Change," *The Review of Economics and Statistics*, Vol. 91, No. 1 (2009); and William D. Nordhaus, "The Economics of Tail Events with an Application to Climate Change," *Review of Environmental Economics and Policy*, Vol. 5, No. 2 (2011).

become more intense, because they are fed by warm water. Local climates may shift drastically, e.g., with wet areas becoming even wetter or going dry.

There is also one important consequence of rising CO₂ levels that isn't tied directly to warming: the oceans become more acidic, with adverse effects on sea life. Devastating effects on coral reefs are probably already inevitable.

How much harm will this do? Nordhaus draws a contrast between what he calls "managed systems"—things like agriculture and public health, which are basically human activities affected by climate—and "unmanageable systems," like sea level, ocean acidification, and species loss. Compared with some climate writers, Nordhaus is relatively sanguine about the impact of rising temperatures on the managed systems. In fact, he summarizes studies suggesting that agricultural yields will probably rise a bit thanks to one or two degrees of warming, and declares, "It is striking how this summary of the scientific evidence contrasts with the popular rhetoric." (You see what I mean about his role as debunker—although he concedes that the costs become serious once temperatures reach levels that on current trends they are likely to hit late this century, and much more so at temperatures likely next century.) Health impacts, too, he views as modest, at least for the warming likely this century, declaring his overall assessment "similar to that for agriculture."

The bigger costs, Nordhaus argues, come from the unmanageable systems: rising seas, more powerful hurricanes, loss of species diversity, increasingly acidic oceans. The trouble is how to put a number on these costs—something he needs to do because, as I already suggested, his goal is to do cost-benefit analysis.

In the end, and despite the debunkery, Nordhaus concludes that there will be mounting costs as the temperature rise goes beyond 2°C—and a rise of at least that much seems, at this point, almost impossible to avoid. When one takes into account the risk of surprising rises in temperature, there is an overwhelming case for action to limit the temperature rise. The questions then become how much action, and what form it should take.

3.

There's a faction in the climate debate that acknowledges the reality of global warming and its costs, but rejects the notion of trying to limit greenhouse gas emissions—either because it views such limits as too costly, or (one suspects) because limiting human impacts on the environment strikes some people as a wimpy, hippie-type thing to do. Instead, this faction calls for geoengineering: rather than limiting human impacts, we should offset them with deliberate impacts in the opposite direction.

Many environmentalists reject geoengineering out of hand. Nordhaus doesn't; he suggests that schemes like pumping reflective aerosols into the upper atmosphere could offset global warming from greenhouse gases relatively cheaply. Yet as he points out, geoengineering wouldn't actually reverse the effects of greenhouse gases, just offset one of their effects, and even that only at a global level. Ocean acidification, for example, would continue; and even if the average global temperature could be stabilized, there might be major disruptions from changes in local temperatures and climates.

In the end, Nordhaus makes a pretty good case that geoengineering should be studied, and in effect held in reserve, the same way that doctors study and bear in mind

dangerous but potentially life-saving treatments to be risked if, but only if, all else has failed. The first line of defense should be an effort to limit global warming by limiting emissions. How should this be done?

Every introductory textbook in economics covers the concept of “negative externalities”—costs that people impose on others through actions, yet have no individual incentive to take account of in their own decisions. Pollution and traffic congestion are the classic examples, and emissions of greenhouse gases are, at a conceptual level, just a kind of pollution. True, there are some unusual aspects to greenhouse gases: the harm they do is global, not local, the costs extend very far into the future rather than occurring contemporaneously with the emissions, and there is at least some risk that emissions will lead not just to costs but to civilizational catastrophe.



*A miner coating the wall of a coal mine with fine limestone dust, a process that helps prevent fires from igniting on exposed surfaces of coal, McDowell County, West Virginia, 2006.
Photo Credit: Ken Light/Contact Press Images*

Despite these unusual aspects, however, much of the standard textbook analysis ought to apply. And what this textbook analysis says is that the best way to control pollution is to put a price on emissions, so that individuals and firms have a financial incentive to cut back.

How do you put a price on emissions? The most obvious way is via an emissions tax—a Pigouvian tax, in the economics jargon. An alternative, however, is to issue a limited number of licenses to pollute, and let people buy and sell those pollution permits—a so-called cap-and-trade system. The United States has limited acid rain with a highly successful cap-and-trade program on sulfur dioxide since 1995; the Waxman-Markey climate change bill, which passed the House in 2009 but died in the Senate, would have established a broadly similar system for carbon dioxide. Not surprisingly, then, Nordhaus advocates a carbon tax and/or cap-and-trade for greenhouse gases. (As he explains, it's possible to construct hybrid systems.)

Why is putting a price on carbon better than direct regulation of emissions? Every economist knows the arguments: efforts to reduce emissions can take place along many “margins,” and we should give people an incentive to exploit all of those margins. Should consumers try to use less energy themselves? Should they shift their consumption toward products that use relatively less energy to produce? Should we try to produce energy from low-emission sources (e.g., natural gas) or non-emission sources (e.g., wind)? Should we try to remove CO₂ after the carbon is burned, e.g.,

by capture and sequestration at power plants? The answer is, all of the above. And putting a price on carbon does, in fact, give people an incentive to do all of the above.

By contrast, it would be very hard to set rules to accomplish all these goals; in fact, even figuring out the comparative emissions from a simple choice, like whether to drive or fly to a city a few hundred miles away, is by no means a simple problem. So carbon pricing, says Nordhaus, is the way to go. And I, of course, agree—they'd probably revoke my economist card if I didn't.

AND yet there is a slightly odd dissonance in this book's emphasis on carbon pricing. As I've just suggested, the standard economic argument for emissions pricing comes from the observation that there are many margins on which we should operate. Yet as Nordhaus himself points out, studies attempting to analyze how we might most efficiently reduce carbon emissions strongly suggest that just one of these margins should account for the bulk of any improvement—namely, we have to sharply reduce emissions from coal-fired electricity generation. Certainly it would be good to operate on other margins, especially because these studies might be wrong—maybe, for example, it would be easier than we think for consumers to shift to a radically lower-energy lifestyle, or there might be radical new ideas for scrubbing carbon from the atmosphere. Nonetheless, the message I took from this book was that direct action to regulate emissions from electricity generation would be a surprisingly good substitute for carbon pricing—not as good, but not bad.

And this conclusion becomes especially interesting given the current legal and political situation in the United States, where nothing like a carbon-pricing scheme has a chance of getting through Congress at least until or unless Democrats regain control of both houses, whereas the Environmental Protection Agency has asserted its right and duty to regulate power plant emissions, and has already introduced rules that will probably prevent the construction of any new coal-fired plants. Taking on the existing plants is going to be much tougher and more controversial, but looks for the moment like a more feasible path than carbon pricing.

However it's done, how ambitious should an emissions reduction program be? There's an international consensus that we should aim to limit the temperature rise to 2°C; sure enough, Nordhaus goes into full debunking mode here: "The scientific rationale for the 2°C target is not really very scientific." Instead, he argues for cost-benefit analysis—but this leads him to an only slightly higher target: his best estimate of the optimal climate policy *if done right* would limit the temperature rise to 2.3°C.

The qualifier "if done right" is important. Stabilizing temperature rise in the 2-3 degree range already requires very large reductions in CO₂ emissions, albeit reductions that Nordhaus (and just about all serious energy economists) believe can be achieved at only moderate cost, given sufficient lead time. But what if some major nations refuse to participate in the effort? What if domestic policy is poorly designed, so that the costs of emission reductions are higher than they should be? In such cases, Nordhaus concludes, the target temperature should be considerably higher, possibly close to 4°C.

Personally, I think Nordhaus is being too pessimistic here. Start with the issue of international cooperation. It seems fairly clear that if the United States were to get serious about climate policy, Europe and Japan would quickly follow suit, so that we would have what amounted to a solid bloc of wealthy nations committed to emissions cuts. The wealthy nations would, in turn, be able to deploy both sticks and carrots to induce developing countries, above all China, to join in.

On one side, “carbon tariffs” on imported goods from nonparticipating countries would provide a powerful inducement to join in. My reading of international trade law is that such tariffs would probably be ruled legal by the World Trade Organization—and if not, so much for the WTO. Saving the planet trumps free trade. On the other side, cap-and-trade offers a natural way to compensate countries for the costs of emissions reduction: simply grant them enough permits that they can sell some of the permits to the extent that the countries do, in fact, reduce emissions, and they’ll have a powerful incentive to make the reductions bigger.

As for the problem of inefficient domestic policies, I come back to the point that despite the complexity of our economy, most of the emissions problem seems to be quite simple: stop burning coal to generate electricity. Given the basic political will to take on the problem at all, this really shouldn’t be that hard. The problem, of course, is that such political will is lacking in the country that must lead on this issue: our own.

4.

I enjoyed *The Climate Casino*, and felt that I learned a lot from it. Yet as I read it, I couldn’t help wondering whom, exactly, the book was written for. It is, after all, a calm, reasoned tract, marshaling the best available scientific and economic evidence on behalf of a pragmatic policy approach. And here’s the thing: just about everyone responsive to that kind of argument already favors strong climate action. It’s the other guys who constitute the problem.

Nordhaus is, of course, aware of this, but I think downplays just how bad things are. He notes that the book *The Greatest Hoax: How the Global Warming Conspiracy Threatens Your Future* was written by “a US senator”; he doesn’t point out that the senator in question, James Inhofe, was the chairman of the Senate Committee on Environment and Public Works from 2003 to 2007, and that someone with similar views will probably take that position if Republicans regain the Senate next year. He tells us that a manifesto titled “Cap and Trade—Taxing Our Way to Bankruptcy” came from “an advocacy group,” but doesn’t point out that this advocacy group, the Heartland Foundation, is a lavishly financed enterprise largely devoted to promoting climate science denial; it’s secretive about its funding, but appears to be backed both by major corporations and by wealthy individuals.

The point is that there’s real power behind the opposition to any kind of climate action—power that warps the debate both by denying climate science and by exaggerating the costs of pollution abatement. And this isn’t the kind of power that can be moved by calm, rational argument.

Why are some powerful individuals and organizations so opposed to action on such a clear and present danger? Part of the answer is naked self-interest. Facing up to global warming would involve virtually eliminating our use of coal except to the extent that CO₂ can be recaptured after consumption; it would involve somewhat reducing our use of other fossil fuels; and it would involve substantially higher electricity prices. That would mean billions of dollars in losses for some businesses, and for the owners of these businesses subsidizing climate denial has so far been a highly profitable investment.

Beyond that lies ideology. “Markets alone will not solve this problem,” declares

Nordhaus. “There is no genuine ‘free-market solution’ to global warming.” This isn’t a radical statement, it’s just Econ 101. Nonetheless, it’s anathema to free-market enthusiasts. If you like to imagine yourself as a character in an Ayn Rand novel, and someone tells you that the world isn’t like that, that it requires government intervention—no matter how market-friendly—your response may well be to reject the news and cling to your fantasies. And sad to say, a fair number of influential figures in American public life do believe they’re acting out *Atlas Shrugged*.

Finally, there’s a strong streak in modern American conservatism that rejects not just climate science, but the scientific method in general. Polling suggests, for example, that a large majority of Republicans reject the theory of evolution. For people with this mind-set, laying out the extent of scientific consensus on an issue isn’t persuasive—if anything, it just gets their backs up, and feeds fantasies about vast egghead conspiracies.

Hence my worries about the usefulness of books like *The Climate Casino*. Given the current state of American politics, the combination of self-interest, ideology, and hostility to science constitutes a huge roadblock to action, and rational argumentation isn’t likely to help. Meanwhile, time is running out, as carbon concentrations keep rising.

Throughout this book, Nordhaus’s tone is slightly cynical but basically calm and optimistic: this is ultimately a problem we should be able to solve. I only wish I could share his apparent conviction that this upbeat possibility will translate into reality. Instead, I keep being haunted by a figure he presents early in the book, showing that we have been living in an age of unusual climate stability—that “the last 7,000 years have been the most stable climatic period in more than 100,000 years.” As Nordhaus notes, this era of stability coincides pretty much exactly with the rise of civilization, and that probably isn’t an accident.

Now that period of stability is ending—and civilization did it, via the Industrial Revolution and the attendant mass burning of coal and other fossil fuels. Industrialization has, of course, made us immensely more powerful, and more flexible too, more able to adapt to changing circumstances. The Scientific Revolution that accompanied the revolution in industry has also given us far more knowledge about the world, including an understanding of what we ourselves are doing to the environment.

But it seems that we have, without knowing it, made an immensely dangerous bet: namely, that we’ll be able to use the power and knowledge we’ve gained in the past couple of centuries to cope with the climate risks we’ve unleashed over the same period. Will we win that bet? Time will tell. Unfortunately, if the bet goes bad, we won’t get another chance to play.