

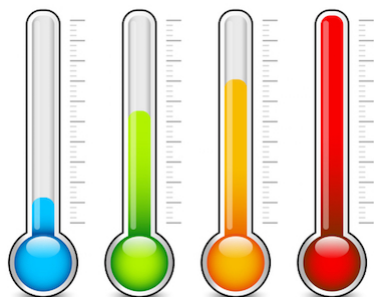
# William Nordhaus versus the United Nations on Climate Change Economics

By Robert P. Murphy



By Robert P. Murphy, Nov 5 2018

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**W**illiam Nordhaus was a co-recipient of this year's Nobel Prize in economics for his pioneering work on the economics of climate change. On the day of the Nobel announcement, the United Nations' Intergovernmental Panel on Climate Change (UN IPCC) released a special report<sup>1</sup> advising

the governments of the world on various steps necessary to limit cumulative global warming to 1.5 degrees Celsius. The major media coverage treated the two events as complementary.<sup>2</sup> In fact, they are incompatible. Although Nordhaus favors a carbon tax to slow climate change, his own model shows that the UN's target would make humanity poorer *than doing nothing at all* about climate change.

Indeed, we can use Nordhaus's and other standard models to show that the now-championed 1.5°C target is ludicrously expensive, far more costly than the public has been led to believe. This is presumably why the new IPCC special report does not even attempt to justify its policy goals in a cost/benefit framework. Rather, it takes the 1.5°C target as a politically "given" constraint and then discusses the pros and cons of various mechanisms to achieve it.

It is ironic that in the context of accusations that opponents of government intervention are "science deniers," the latest UN report largely ignores the peer-reviewed publications in climate-change economics, including those of the man who just won the Nobel Prize in the field.<sup>3</sup>

## Nordhaus's "DICE" Model

Nordhaus is arguably the inventor of the modern economics of climate change, with contributions going back at least to his 1979 book.<sup>4</sup> Then, in the 1990s, he, along with others, developed the Dynamic Integrated Model of Climate and the Economy (DICE). Nordhaus and co-author Joseph Boyer, in a 2000 book, outlined the DICE model as well as a regional version called RICE and in 2008, Nordhaus published a book summarizing the model as of 2007. He updated his model in 2016 and published technical papers in 2017 based on its latest findings.

Nordhaus subscribes to the standard view that greenhouse gas emissions from human activities constitute a negative externality and, therefore, recommends that the governments of the world implement a carbon tax. One of his major purposes in developing and refining his DICE model is to estimate the "social cost of carbon." The social cost of carbon is the present value of the net future harms from an additional ton of emissions in a particular year. A related purpose of Nordhaus's DICE model is to estimate the trajectory of the optimal carbon tax over time. (Note that the "social cost of carbon" trajectory depends on government policy. In the presence of an optimal carbon tax, the volume of future emissions will be lower than otherwise. Thus, on the margin, an additional ton of carbon dioxide emitted in, say, 2050 will be less damaging than it would have been in the *laissez-faire* baseline.)

I endorse neither Nordhaus's diagnosis of "market failure" nor his prescription for a carbon tax. Indeed, I have critiqued Nordhaus's model elsewhere,<sup>5</sup> and I have co-authored a study with climate scientists in which we make the case *against* a generic U.S. carbon tax.<sup>6</sup>

For the purposes of the present article, however, I stipulate Nordhaus's work as representative of the state of the art when it comes to the mainstream economics of climate change. That is all we need to show that the UN's special report on climate change is utterly at odds with the literature.

## Nordhaus's 2007 Results Showed Current UN Target Much Worse Than "Doing Nothing"

As I explain in greater detail in my 2009 journal article, the exposition Nordhaus gave for his 2007 model runs was useful in showing the consequences of various climate policy goals. Below, I reproduce a table from my article, which I adapted from a table in Nordhaus's 2008 book.

Table 1. Relative Benefits and Costs of Various Climate Policies According to DICE-2007 (Trillions of 2005 US\$)

**Table 4**  
**DICE's Relative Benefits of Different Climate Policies**  
**(in Trillions of 2005 U.S.\$)**

Climate Policy	PDV Difference from Baseline	PDV of Environmental Damages	PDV of Abatement Costs	Sum of Damages and Costs
No controls baseline	0.00	22.55	0.04	22.59
Optimal tax	+3.07	17.31	2.20	19.52
Limit CO <sub>2</sub> to 560 ppm	+2.67	15.97	3.95	19.92
Kyoto with the United States	+0.63	21.38	0.58	21.96
Kyoto without the United States	+0.10	22.43	0.07	22.49
<i>Stern Review</i> discount rate	-14.18	9.02	27.74	36.77
Limit temp. to 1.5°C	-14.44	9.95	27.08	37.03
Limit CO <sub>2</sub> to 420 ppm	-14.60	9.95	27.24	37.19
Gore's 90 percent emissions cut	-21.36	10.05	33.90	43.96

*Note:* PDV = present discounted value.

*Source:* Adapted from Nordhaus 2008, 89.

Source: Table 4 from Murphy (2009), p. 211.

The first row of the table shows what the DICE model—as of its 2007 calibration—estimated would happen if the governments of the world took no major action to arrest greenhouse gas emissions. There would be significant future environmental damages, which would have a present-discounted value of \$22.55 trillion.

In contrast, the second row shows what would happen if the governments implemented an optimal carbon tax. Because emissions would drop, future environmental damages would fall as well; that's why the PDV of such damage would be only \$17.31 trillion. However, even though the *gross* benefits of the optimal carbon tax would be some \$5 trillion as a result (because of the reduction in environmental harms), these gross benefits would have to be offset by the drag on conventional economic growth, or what is called "abatement costs." Those come in at a hefty \$2.20 trillion (in PDV terms), so that the *net* benefits of even the optimal carbon tax would be "only" \$3.07 trillion.

Consider, now, the scenario "Limit temp. to 1.5°C." Recall that this is the IPCC's current policy goal and that various environmental analysts and pundits also embrace it. Because Nordhaus just won the Nobel Prize for his work on climate change, one might suppose that his model would provide support for the UN's goal. It doesn't.

As Table 1 indicates, Nordhaus's model—at least as of its 2007 calibration—estimated that such a policy goal would make humanity \$14 trillion poorer *compared to doing nothing at all* about climate change. Moreover, the \$14 trillion magnitude of the net damages from the *wrong* policy—including what is now the UN's goal—dwarfs the \$3.07 trillion size of the net benefits from even the best theoretically possible policy.

Notice, also, that two of the *other* impoverishing policies considered by Nordhaus were not the product of his fanciful imagination but, instead, were proposals that either other economists (Nicholas Stern) or famous political figures (Al Gore) offered. The difference in the two Kyoto scenarios also showcases the sensitivity of the calculations to the participation of the world's major emitters; the \$3.07 trillion net benefits from a carbon tax accrue *only* if all of the governments enact the textbook carbon tax profile for more than a century.

In light of Nordhaus's calculations shown above, the apparently urgent need for "climate action" is not so urgent. It now looks more analogous to economists discovering the *theoretical possibility* of an "optimal tariff" but still understanding that free trade is the safest rule of thumb.

## Nordhaus's 2016 Results Recommend a Ceiling of 3.5°C

Over the years, Nordhaus has updated his model, and he now believes, due to developments in the physical sciences, that the potential harms from climate change are worse than he believed back in 2007. In 2009, for example, Nordhaus estimated the social cost of carbon in the year 2025 at \$16 per ton of CO<sub>2</sub> (measured in 2010 U.S.\$). In contrast, according to his 2016 projections, Nordhaus puts the 2025 social cost of carbon at \$44 per ton (in 2010 \$)—which means the estimate has almost tripled in less than a decade.

Before proceeding, it's worth noting that this outcome shows just how fluid the "economics of climate change" literature really is. Imagine physicists inflating their estimates of the charge on an electron, or the mass of the moon, by such a large amount in such a short time span. Rather than justifying

aggressive new government policies that would carry a huge price tag, such shifting “consensus science” might understandably make us pause because even the scientists in the area clearly don’t understand the field very well.

But let’s put aside these concerns and take Nordhaus’s 2016 version of his model at face value. Despite the huge increase in the estimated harms of future climate change, Nordhaus still recommends a relatively modest deviation from the laissez-faire baseline, as the following diagram indicates.

Figure 1. Cumulative Global Warming Under Various Policy Options, According to DICE-2016.<sup>7</sup>

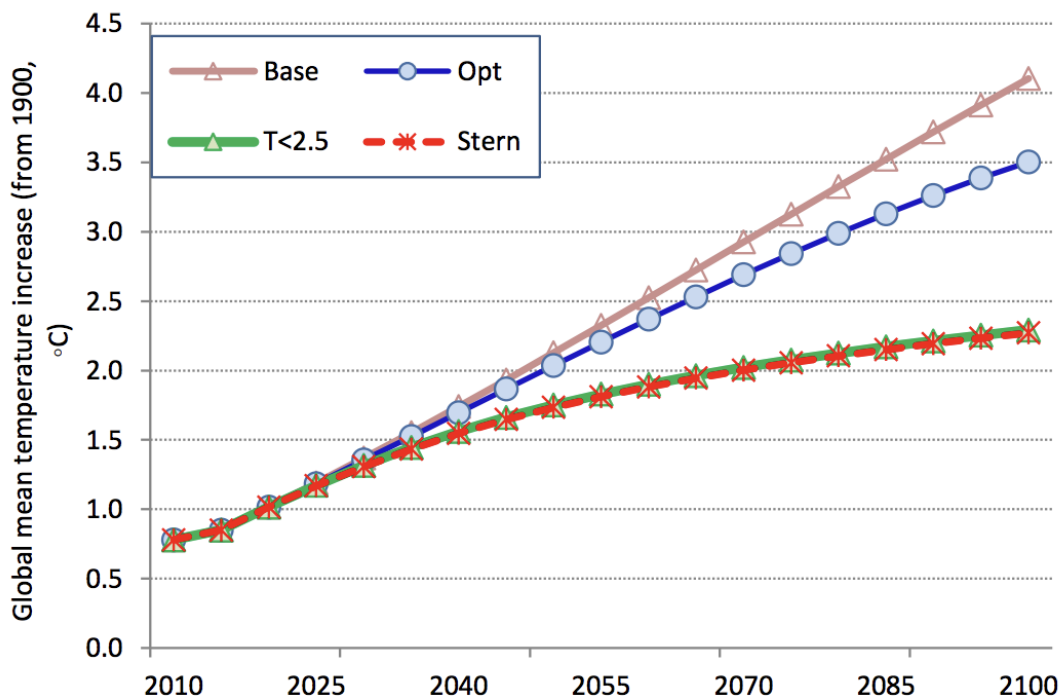


Figure 4. Temperature change in different scenarios

The most ambitious scenarios cannot limit temperature to 2 ½ °C, and the cost-benefit optimum with standard parameters has sharply rising temperatures.<sup>iii</sup>

Source: Figure 4 from Nordhaus (2017).

As Figure 1 indicates, as of 2016, Nordhaus’s model (using the median settings on various parameters) projected that unabated global warming would reach a little above 4°C by 2100. In contrast, if the governments of the world implemented an optimal carbon tax, warming would be constrained to 3.5°C.

To get a sense of the significance of this temperature gap, consider: Nordhaus calculates that to justify a 2.5°C ceiling, the implied social cost (or what is often, though misleadingly, referred to as the “shadow price”) of carbon in 2025 would be \$284 per ton, which is more than *six times* Nordhaus’s own estimate

of a social cost of carbon that year of \$44 per ton.<sup>8</sup> (A carbon tax of \$284 per ton of CO<sub>2</sub> works out to a gasoline tax of about \$2.50 per gallon.) And remember that this chasm in the implied harm of carbon dioxide emissions relates to the difference between a ceiling of 3.5°C and one of 2.5°C. The gap would be much bigger still for a ceiling of 1.5°C. In the next section, we spell out how large the negative externality from carbon dioxide would have to be to justify a 1.5°C ceiling.

## Estimates of the Social Cost of Carbon versus the UN's Implied "Shadow Price"

In the previous section, we saw that the latest version of Nordhaus's model suggests that the "optimal" amount of global warming is far higher than what the UN and many in the media are now recommending as necessary in order to avert catastrophe. In this section, we can use a different approach to illustrate the enormous gulf between the UN's 1.5°C goal and the findings of the literature on the economics of climate change.

In its earlier mentioned special report, the UN stated:

### **Cross-Chapter Box 5: Economics of 1.5°C Pathways and the Social Cost of Carbon**

... In CEA [cost-effectiveness analysis], the marginal abatement cost of carbon is determined by the climate goal under consideration. It equals the shadow price of carbon associated with the goal which in turn can be interpreted as the willingness to pay for imposing the goal as a political constraint. Emissions prices are usually expressed in carbon (equivalent) prices.... **Since policy goals like the goals of limiting warming to 1.5°C or well below 2°C do not directly result from a money metric trade-off between mitigation and damages, associated shadow prices can differ from the SCC [social cost of carbon] in a CBA [cost-benefit analysis].** In CEA, value judgments are to a large extent concentrated in the choice of climate goal and related implications, while more explicit assumptions about social values are required to perform CBA. [UN IPCC Special Report, pp. 2-76 and 2-77, citations removed, bold added.]

In other words, the UN's special report explains that it will *not* try to quantify the costs and benefits of emissions and then recommend an appropriate carbon tax (or other mitigation policies) in order to equate marginal benefits with marginal costs. Rather, the UN is *taking as given* that the goal is to limit global warming to 1.5°C and, based on that assumption, will consider the costs of various possible means of achieving that goal.



If one wants to relate the UN's analysis to the published literature on cost-benefit analysis, we can back out the *implied* “shadow price” of, or implicit tax on, carbon from the various measures. But the text warns the reader that these implied “carbon prices” will not necessarily line up with the published estimates of the social cost of carbon, which, as noted earlier, quantifies the negative externality of emissions.

So just how big *is* this discrepancy between the optimal tax and the “carbon price” implied by the UN's desired goal? Consider the following comment from a Resources for the Future (RFF) essay, which is very sympathetic to the UN special report:

By design, the IPCC report is not policy-prescriptive. However, it does present a range of carbon prices necessary to keep emissions on track to meet the 1.5°C target. The level and significant range of prices—**from \$135 to \$5,500 per ton of carbon dioxide emissions in 2030**—have caught our attention.... [RFF, bold added.]<sup>9</sup>

To translate this into plain English, the RFF writers are explaining that the measures considered in the latest UN report are going to reduce particular units of emissions at a cost to the conventional economy of up to \$5,500 per ton in 2030. (A carbon tax of \$5,500 per ton works out to a gasoline tax of \$48 per gallon.) In a standard cost-benefit approach, this would be economically efficient only if the estimated social cost of carbon were also in this range.

What does the economics of climate change literature have to say about the social cost of carbon? The Obama Administration established an Interagency Working Group on the Social Cost of Carbon (SCC), in which it used leading models—including Nordhaus's DICE, along with two others—to estimate the SCC through the middle of the 21st century. According to its last update, published in early 2017, the Obama EPA reported that the SCC in 2030, using the standard 3% discount rate, would be \$50 per ton. Thus, the UN's target of 1.5°C is implicitly treating the marginal units of greenhouse gas emissions as being anywhere from *1.6 to 100 times more damaging* than the Obama Administration's team estimated.

## Conclusion

Both fans and critics of William Nordhaus's computer model of the global economy and climate acknowledge that it is a crude approach that omits many crucial real-world considerations. Even so, it is surely significant that the work that won Nordhaus the Nobel Prize says quite plainly that the UN's special report on climate change is full of proposals that are ludicrously expensive. In an interview after Nordhaus accepted his prize, he diplomatically handled the situation by saying that the 1.5°C target is impossible to achieve at this point.<sup>10</sup> Yet we can go further. Nordhaus's work shows that such an aggressive goal would make humanity much worse off than if we simply adapted to climate change with *no* government measures.

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## Footnotes

[1] United Nations Special Report, **“Global Warming of 1.5°C,”** Intergovernmental Panel on Climate Change (IPCC).

[2] See for example Binyamin Appelbaum, **“2018 Nobel in Economics Is Awarded to William Nordhaus and Paul Romer,”** *New York Times*, October 8, 2018.

[3] In this article, I focus on the published model results of Nobel laureate William Nordhaus, which are consistent with other models of the global economy and climate. However, the reader should be aware that climate change economists such as Martin Weitzman have developed frameworks that place greater weight on unlikely but catastrophic outcomes. In these approaches, it is efficient to engage in more aggressive government action against climate change than in the more conventional cost/benefit framework used by Nordhaus and others. See for example Martin Weitzman, **“Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change,”**

[4] William Nordhaus. (1979) *The Efficient Use of Energy Resources*. New Haven, Conn: Yale University Press.

[5] Robert P. Murphy. (2009) **“Rolling the DICE: William Nordhaus’ Dubious Case for a Carbon Tax,”** *The Independent Review*, vol. 14, no. 2, Fall 2009, pp. 197-217.

[6] Robert P. Murphy, Patrick J. Michaels, and Paul Knappenberger. (2016) **“The Case Against a U.S. Carbon Tax,”** Cato Institute Policy Analysis No. 801, October 17, 2016.

[7] The diagram in Figure 1 comes from William Nordhaus, **“Projections and Uncertainties About Climate Change in an Era of Minimal Climate Policies,”** NBER Working Paper 22933, Revised September 2017.

[8] See Table 1 from William Nordhaus, **“Revisiting the social cost of carbon,”** *Proceedings of the National Academy of Sciences (PNAS)*, January 30, 2017.

[9] Kevin Rennert and Marc Hafstead, **“Latest IPCC Report Sounds New Alarm on Global Climate Policy,”** Resources for the Future (RFF) Online Magazine, Issue 199, Fall 2018.

[10] Coral Davenport, **“After Nobel in Economics, William Nordhaus Talks About Who’s Getting His Pollution-Tax Ideas Right,”** *The New York Times*, October 13, 2018.

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