Climate policy based on economics or reality?

It is clear that some economists and climate scientists in the natural sciences have very different views on the severity of the climate crisis.

Nobel Laureate in economics William Nordhaus published a report in 2017 in which he and a colleague Andrew Moffat looked at results from 38 different studies on the economic impact of a warmer planet. They looked at what effects different degrees of warming would have on the world economy. The studies used different *integrated assessment models* to estimate how climate change and the economy fit together. These models typically make assumptions about the development of human population, technology, greenhouse gases, and sometimes even other pollutant emissions to drive calculations of how much the planet will warm. They then calculate the economic impacts of this warming based on an assumed relationship between warming and a metric of economic activity such as gross domestic product (GDP). The climate economic models used in the studies examined by (Nordhaus & Moffat, 2017) show that GDP would decrease by a few percentage points as a result of global warming between 3 and 4 degrees. Their general conclusion was that GDP would decrease by 2.04% for a 3°C warming and 8.06% for a 6°C warming. Note the one-hundredth of a percentage point precision with which these calculations are reported, the precision of which a scientist making measurements on Earth must think long and hard about.

Commonly-used climate economic models thus conclude that the economy will shrink by a modest 2% on average if we turn up the Earth's thermostat by three degrees. Climate scientists have a different view of the consequences of such strong warming. The contrasts can be seen in the figure below.

The figure at the lower left panel shows the *damage functions* from different models of climate economics. The horizontal axis is the amount of global heating, and the vertical axis shows the calculated reduction in economic output that is a result of different amounts of warming. The results preferred by Nordhaus & Moffat are shown as the uppermost thick black line, with a 2% reduction in economic output at a 3°C increase in global temperature. It is worthwhile to note that there are other economic estimates of damages that are larger (shown in the four other curves in the figure), but these were not considered by Nordhaus and Moffat to be particularly reliable. At the same time, the Nordhaus damage function has not been included in the latest update of the Climate Interactive En-ROADS integrated assessment model because it was considered “unrealistic” (Siegel et al., 2023). Clearly there are differences of opinion among modelers of climate economics as to just how damaging global heating will be.

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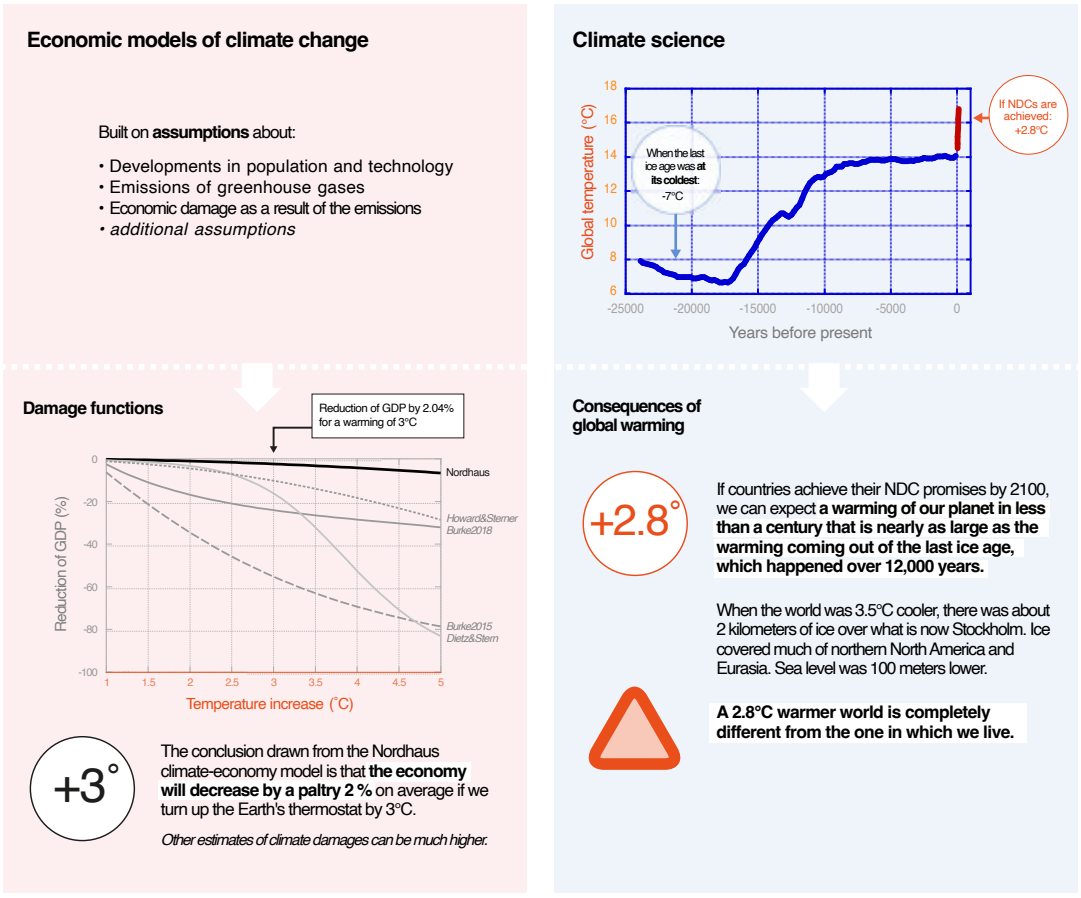

It is very risky to only use climate economics models when developing climate policy.

The logic behind our scepticism of these economic calculations can be illustrated in the panels on the right side of the figure.

The plot at the upper right shows a time series of global temperature from 22,000 years before present to the end of this century. The data depicted in the blue curve come from a scientific study that assembled measurements from all around the globe to arrive at an estimate of global temperature from just over 20,000 years in the past to almost the present time (Osman et al., 2021). These data show that when the previous ice age was at its coldest, the average global temperature was 7°C cooler than the 1000-1850 period. The red line at the right in the figure comes from calculations performed with the Climate Interactive En-ROADS integrated assessment model and shows the expected temperature increase if all of the current promises about emissions reductions that have been submitted to the United Nations as part of the Paris Agreement the so-called *Nationally Determined Contributions* – are actually fulfilled (and there is no guarantee that they will be). This shows an expected increase in temperature of 2.8°C. This means a warming of the planet nearly equal to about half the transition from an ice age to an interglacial period in less than a century as compared to 12,000 years it took for the planet to

warm from roughly 7 to 14°C. Keep in mind that when the world was 7°C cooler, much of northern North America and northern Eurasia was covered with ice. Stockholm Sweden (where the three of us live) was covered by about 2 kilometers of ice at that time, and global sea level was about 100 meters lower.

For us scientists, it is difficult to imagine that climate change of this magnitude would disrupt the global economy by no more than a small and precise 2.04%. For example, based on the findings of the latest IPCC report, we can calculate that the kind of extreme heatwave which would normally occur once-in-a-lifetime (more precisely, once every 50 years), would likely happen every other year at 3°C warming. This is the kind of heatwave that caused the wildfires that burned almost 1 million acres of Europe this summer and were estimated to have cost €4.1 billion.

In addition, the time aspect plays a role - almost like a double-edged sword. Consequences of a 2.8°C warmer planet have a lag time - for example, sea levels will continue to rise well beyond 2100. The costs of such consequences can, in fact, be projected in climate economic models. On the other hand, we *homo sapiens* - and the ecosystems we share the planet with - have never experienced such a large change in such a short time. Moreover, we have good evidence that during the last warm period on Earth - when the global average temperature was about 2°C warmer than preindustrial times, sea level was about 6 meters higher than it is today. This means that if we actually manage to meet the Paris Agreement's goal of keeping global warming to two degrees, we will still have to expect a sea level several meters higher than today in a few hundred years. Almost half a billion people could be affected. It is difficult to reconcile such a huge change to the planet with only a few percentage points loss in economic output.

The climate economic models are consistent in the sense that the results obtained are consistent with the formulas used in the calculations. The problem is that these formulas are based on assumptions that are not all rooted in the physical, bio-geo-chemical world we scientific researchers live in. From our perspective, we can conclude that a warming of 2.8 °C means a completely different world in the future. Climate policy now and in the future needs to move away from the norm of relying only on the results of economic models to make policy decisions. Instead, it needs to take into account all the studies that show that global warming already above 1.5 degrees will have serious consequences on Earth, and act accordingly.

We hope that the voice of science will be given at least as much weight as the voice of economics in future policy decisions.

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