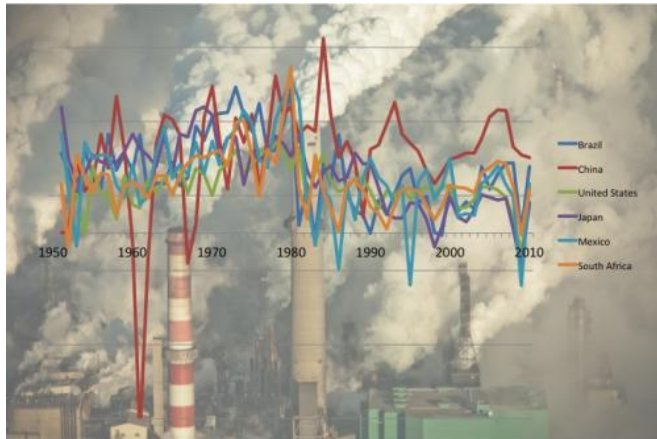


Social cost of climate change too low, scientists say

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Economic growth for nations has historically fluctuated over time. A new Stanford study suggests the long-term impacts of climate change could perturb GDP growth rates even further. Credit: Delavane Diaz

The economic damage caused by a ton of CO₂ emissions—often referred to as the "social cost of carbon"—could actually be six times higher than the value that the United States uses to guide current energy regulations, and possibly future mitigation policies, Stanford scientists say.

A recent U.S. government study concluded, based on the results of three widely used economic impact models, that an additional ton of CO₂ emitted in 2015 would cause US\$37 worth of economic damages. These damages are expected to take various forms, including decreased agricultural yields and harm to human health related to [climate change](#).

But according to a new study, published online this week in the journal *Nature Climate Change*, the actual cost could be much higher. "We estimate that the social cost of carbon is not \$37, as previously estimated, but \$220," said study coauthor Frances Moore, a PhD candidate in the

Emmett Interdisciplinary Program in Environment and Resources in Stanford's School of Earth Sciences.

Based on the findings, countries may want to increase their efforts to curb greenhouse gas emissions, said study coauthor Delavane Diaz, a PhD candidate in the Department of Management Science and Engineering. "If the social cost of carbon is higher, many more mitigation measures will pass a cost-benefit analysis," Diaz said. "Because carbon emissions are so harmful to society, even costly means of reducing emissions would be worthwhile."

For their study, Moore and Diaz modified a well-known model for calculating the economic impacts of climate change, known as an integrated assessment model, or IAM. Their alternative formulation incorporated recent empirical findings suggesting that climate change could substantially slow economic growth rates, particularly in poor countries.

IAMs are important policy tools. Because they include both the costs and benefits of reducing emissions, they can inform governments about the optimal level of investment in emission reduction. The U.S. Environmental Protection Agency, for example, uses the \$37 average value from three IAMs to evaluate greenhouse gas regulations. Canada, Mexico, the United Kingdom, France, Germany and Norway have also used IAMs to analyze climate and energy policy proposals.



Coal fired power plant on the Ohio River just West of Cincinnati. Credit: Robert S. Donovan

While useful, IAMs have to make numerous simplifying assumptions. One limitation, for example, is that they fail to account for how the damages associated with climate change might persist through time. "For 20 years now, the models have assumed that climate change can't affect the basic growth-rate of the economy," Moore said. "But a number of new studies suggest this may not be true. If climate change affects not only a country's economic output, but also its growth, then that has a permanent effect that accumulates over time, leading to a much higher social cost of carbon."

In the new study, Moore and Diaz took a widely used IAM, called the Dynamic Integrated Climate-Economy (DICE) model, and modified it in three ways: they allowed climate change to affect the growth rate of the economy; they accounted for adaptation to climate change; and they divided the model into two regions to represent high- and low-income countries.

"There have been many studies that suggest rich and poor countries will fare very differently when dealing with future climate change effects, and we wanted to explore that," Diaz said.

One major finding of the new study is that the damages associated with reductions in economic growth rates justify very rapid and very early

mitigation that is sufficient to limit the rise of global temperature to two degrees Celsius above pre-industrial levels. This is the target that some experts say is necessary to avert the worst effects of global warming.

"This effect is not included in the standard IAMs," Moore said, "so until now it's been very difficult to justify aggressive and potentially expensive [mitigation measures](#) because the damages just aren't large enough."

The pair's IAM also shows that developing countries may suffer the most from climate change effects. "If poor countries become less vulnerable to climate change as they become richer, then delaying some emissions reductions until they are more fully developed may in fact be the best policy," Diaz said. "Our model shows that this is a major uncertainty in mitigation policy, and one not explored much in previous work."

The pair notes two important caveats to their work, however. First, the DICE model's representation of mitigation is limited. It doesn't take into account, for example, the fact that low-carbon technologies take time to develop and deploy.

Secondly, while it explores the effects of temperature on economic growth, the model does not factor in the potential for mitigation efforts to also impact growth.

"For these two reasons, the rapid, near-term mitigation level found in our study may not necessarily be economically optimal", Diaz said. "But this does not change the overall result that if temperature affects economic growth-rates, society could face much larger climate damages than previously thought, and this would justify more stringent mitigation policy."

More information: Temperature impacts on economic growth warrant stringent mitigation policy, *Nature Climate Change*, [DOI: 10.1038/nclimate2481](https://doi.org/10.1038/nclimate2481)

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