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Climate Change Economics Environment

What are the economic consequences of climate change?

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Nov 5 2015

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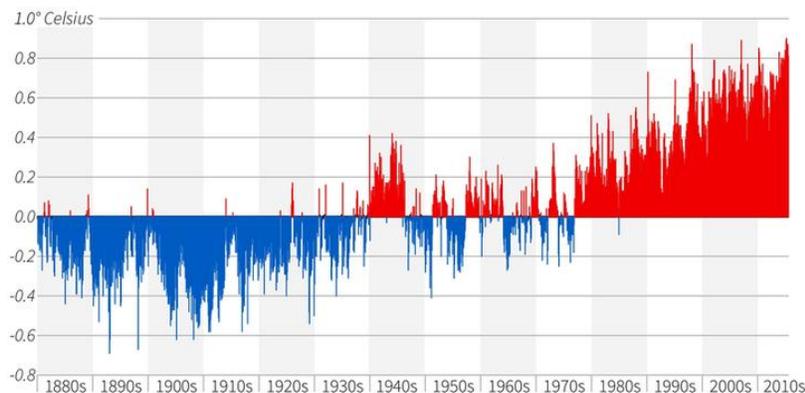
In a paper recently published in *Nature*, Marshall Burke, Solomon Hsiang, and Edward Miguel, economists based at Stanford and the University of California Berkeley, presented a new analysis of the relationship between historic temperature fluctuations and macroeconomic growth.

Their conclusion delivers two blockbusters. First, in contrast to past studies, they argue that 21st century warming could lead to huge global-scale macroeconomic impacts. The best estimate from Burke and colleagues is that business as usual emissions throughout the 21st century will decrease per capita GDP by 23% below what it would otherwise be, with the possibility of a much larger impact.

Secondly, they conclude that both the size and the direction of the temperature effect depend on the starting temperature. Countries with an average yearly temperature greater than 13°C (55°F) will see decreased economic growth as temperatures rise. For cooler countries, warming will be an economic boon. This non-linear response creates a massive redistribution of future growth, away from hot regions and toward cool regions. Based on the analysis, rich and poor countries respond similarly at any temperature, but the impact of warming is nonetheless much greater on poor countries, because they are mostly in regions that are already warm.

Global temperature anomalies

VARIANCE FROM AVERAGE TEMPERATURE OF 1910-2000



Economists have been looking at the relationship between climate change and economic activity for more than 20 years. Why are the results in this new paper so different? And are they likely to be right? We explore both questions in some detail below. The short answer to the first is that almost everything about the new study is different, including its emphasis on observed relationships in countries through time, its focus at the macroeconomic level, and its consideration of non-linear responses. The short answer to the second is that the work of Burke and colleagues deserves a prominent place in future discussions. The new estimate is not definitive, but it effectively pulls the center of gravity toward higher and more unequal levels of damages.

The challenges of estimating economic impacts of future warming are daunting. Leading economists, including Nicholas Stern at the London School of Economics and Political Science, Robert Pindyck at MIT, and Martin Weitzman at Harvard have argued that the architecture of the historic approaches is deeply flawed. Given this skepticism, it is not too surprising that estimates are diverse. Still, Burke and colleagues approach the topic in a powerful new way. The new research is purely observational.

Burke and colleagues looked at the historical response of annual economic growth to annual temperature fluctuations in 166 countries, from 1960 to 2010. While this observational approach limits the ability of the researchers to say much about responses to warming outside the range of historical variation, its strength is in simply describing what happened. Fundamental tipping points like a major change in where agriculture is possible or the long-term commitment to several metres of sea-level rise from the collapse of a major ice sheet are not reflected in the new analysis. Actual damages may be even higher than those based on historical patterns.

A second important difference between the new study and the historical approach is that Burke and colleagues estimate the impact of warming on economic growth rather than on current output. Conceptually, there are several reasons that the impacts might be mostly on current output, especially when infrastructure and productive capacity are not damaged, but there are also reasons that growth might be impacted. Empirical studies are mixed, with several recent studies identifying impacts on growth. The distinction is important, because effects on growth are much more persistent than impacts on current output. A 2015 study by Frances Moore and Delavane Turner at Stanford demonstrated that, with the most widely used of the

historical models, simply swapping a growth impact for the current output impact leads to a several-fold increase in the social cost of carbon or the economic damages per additional ton of CO₂ released to the atmosphere.

Burke, Hsiang, and Miguel are not the first to observe correlations between macroeconomic trends and temperature. Among others, William Nordhaus at Yale and the team of Melissa Dell, Benjamin Jones, and Benjamin Olken (now at Harvard, Northwestern, and MIT) have documented large effects of temperature on growth rates, particularly in poorer countries that also tend to be hot. But when Burke and colleagues looked at the data, they tried a different approach. Building from a large body of empirical data identifying threshold effects, where temperature has little or no effect until a point of rapid collapse, they asked if the basic relationship between temperature and growth is non-linear. Indeed it was, with positive effects at low temperature and negative effects at high temperatures.

This hump-shaped relationship points to the possibility of strong temperature sensitivity across a wide range of temperatures, even if the average response across all temperatures is very small. Of course, it also underscores the unfairness of the economic impacts of warming, with cool countries like those in Scandinavia likely experiencing substantial benefits, while those in hot regions through Asia, Africa, and the Americas, as well as island nations, face potentially huge losses.

Does the high and highly unequal impact of warming observed by Burke and colleagues mean that we have been underestimating the economic impacts of climate change? It might. The new analysis is strongly rooted in evidence, and it builds on a robust and growing body of observations concerning the prevalence of threshold responses to warming. The evidence that at least some of the warming-related impacts affect economic growth and not just current output is also growing. On the other hand, the study by Burke and colleagues looked only at data from 1960 to 2010, and they made no effort to predict how temperature sensitivity might change in the future. One can imagine a future where increasing risk of catastrophes amplifies costs, as Weitzman argues, or where learning and adaptation keep them under control.

The bottom line is that it is too early to know. Burke, Hsiang, and Miguel have brought a breath of fresh air and deep insight to a critically important topic that has been addressed with a too-narrow set of techniques and concepts. Their boldness in looking at other approaches will, as a minimum, inject new life and creativity into future work in the area. It should also increase the emphasis on evaluating a wide range of possibilities, especially prospects of high and disproportionate damages, in estimating the economic costs of climate change. The new estimates warrant serious consideration and substantial weight in future calculations.

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Image: A general view of Argentina's Perito Moreno glacier during sunset near the city of El Calafate, in the Patagonian province of Santa Cruz, December 14, 2009. REUTERS/Marcos Brindicci

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