

Sweeping study claims that rising temperatures will sharply cut economic productivity

By **Chris Mooney** October 21 at 1:10 PM

This story has been updated.

In a [sweeping new study](#) published Wednesday in *Nature*, a team of researchers say there is a strong relationship between a region's average temperature and its economic productivity — adding another potential cost to a warming climate.

Culling together economic and temperature data for over 100 wealthy and poorer countries alike over 50 years, they assert that the optimum temperature for human productivity seems to be around 13 degrees Celsius or roughly 55 degrees Fahrenheit, as an annual average for a particular place. Once things get a lot hotter than that, the researchers add, economic productivity declines “strongly.”

“The relationship is globally generalizable, unchanged since 1960, and apparent for agricultural and non-agricultural activity in both rich and poor countries,” write the authors, led by Marshall Burke of Stanford's Department of Earth System Science, who call their study “the first evidence that economic activity in all regions is coupled to the global climate.” Burke published the study with Solomon Hsiang and Edward Miguel, economists at the University of California, Berkeley.

If the findings are correct, they add, that means that unmitigated global warming could lead to a more than 20 percent decline in incomes around the world, compared with a world that does not feature climate change. And this would also mean growing global inequality, since poorer countries will be hit by worse temperature increases — simply because “hot, poor countries will probably suffer the largest reduction in growth.” Indeed, some already wealthier countries with cold weather, like Canada or Sweden, will benefit greatly based on the study, moving closer to the climatic optimum.

“If you're in a country where the average temperature is cooler than 13 degrees C, a little bit of warming could actually be beneficial,” says Burke. “On the other hand, if you're already at 13 degrees C, a little extra warming is going to hurt you.”

Assuming this relationship between temperature and productivity is correct, that naturally leads to deep questions about its cause. The researchers locate them in two chief places: agriculture and people. In relation to rising

temperature, Burke says, “We see that agricultural productivity declines, labor productivity declines, kids do worse on tests, and we see more violence.”

Indeed, Burke and his two coauthors have previously publishing [research](#) suggesting a [strong relationship between rising temperatures and violence](#), even as Hsiang has [found](#) a [relationship between warmer temperatures and lower math test scores](#). “We find that math performance declines linearly above 21C (70F), with the effect statistically significant beyond 26C (79F),” that previous paper reported.

There is also [recent research](#) suggesting global warming will reduce wheat yields, one of many major projected effects on agriculture. In other words, there is a body of existing research that’s consistent with the new, more sweeping conclusion of the Nature paper.

At the center of the new paper is a historical, economic analysis that culls data from 166 countries over half a century, analyzing GDP per capita against temperature fluctuations that the countries experienced.

Importantly, the researchers did not compare countries with one another — an approach that would have been beset with many confounding factors. Rather, they compared each country “to itself in years when it is exposed to warmer-versus cooler-than-average temperatures due to naturally occurring stochastic atmospheric changes.”

“An economy observed during a cool year is the ‘control’ for that same society observed during a warmer ‘treatment’ year,” the authors write.

The second half of the study then projected the toll of a steadily warming trend, based on these relationships. “In 2100, we estimate that unmitigated climate change will make 77% of countries poorer in per capita terms than they would be without climate change,” the paper says.

However, it is important to note that this is based on a scenario in which the world does nothing to curtail global warming — a scenario that is becoming [increasingly difficult to believe](#).

Some countries fare considerably better in such a future because they are located in currently cold places — reinforcing the idea that northern countries will benefit from climate change. On top of easier shipping, resource exploitation, and tourism, there could be a productivity boost due to more favorable temperatures.

Many tropical countries, in contrast, suffer economic damages in this scenario — getting hotter than they already are. “Warming may amplify global inequality because hot, poor countries will probably suffer the largest reduction in growth,” the study concludes.

“The cross-country implications of the analysis is eye-opening,” said Rick Larrick, a professor at Duke’s Fuqua

School of Business, after reviewing the study for the Washington Post. “Climate change is not just an environmental issue but geopolitical issue.”

“The conclusion that temperature-associated costs will be higher than previously calculated will cause a stir, and should have stark repercussions for policy,” wrote Thomas Sterner, an economist at the University of Gothenburg, Sweden, in a [commentary](#) on the paper, also in Nature.

While the authors appear to have conducted a careful analysis, Robert Stavins, an environmental economist at the Harvard Kennedy School, cautions that there is a lot of uncertainty in calculating the long term economic costs of climate change. Stavins also adds that while the study only examines market impacts of climate change, “many *economic* impacts of climate change will be outside of markets, such as many ecological impacts, which are nevertheless economic.”

Duke’s Larrick also pointed to another possible drawback of the study design — while temperature swings in the short term might cause countries’ economies to swing around, a sustained temperature increase in one direction in the long term might trigger more careful adaptation planning. “Using year-to-year changes is a good proxy for long term temperature changes, but countries may not be prepared to invest in mitigation on such a short cycle (it is unanticipated and temporary); in the presence of ongoing climate change, however, countries might be forward looking in terms of investing in mitigation,” he said by email.

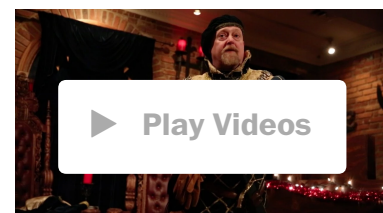
One obvious question is whether air conditioning, which is expected to spread widely around the world in coming decades, can mitigate these effects. And the answer appears to be largely no.


“Air conditioning absolutely can help, but the data suggests that it does not fully insulate you from the effects of temperature,” says Burke.

More generally, the researchers say that “we do not find that technological advances or the accumulation of wealth and experience since 1960 has altered the relationship between productivity and temperature.”

Chris Mooney reports on science and the environment.

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