Testimony by David Barker at the Senate Committee on the Budget hearing on Wednesday, October 25, 2023, entitled "Bottlenecks and Backlogs: How Climate Change Threatens Supply Chains."

Introduction

Thirty-eight trillion dollars is a lot of money. That is the amount the IPCC predicts that climate change will cost the world economy by the year 2100 if nothing is done to reduce greenhouse gas emissions.[1] A careful reader of the IPCC report will notice that this would be a loss of 2.6% of world GDP in 2100.[2] Assuming real growth of 2.1% between now and then, GDP in 2100 will be 5 times higher than it is now.[3] A 2.6% reduction of 2100 GDP would mean that instead of being 5 times higher, GDP per capita would be 4.9 times higher, which is not a catastrophic outcome.[4]

It is reasonable to wonder if this argument is flawed because climate change might affect the rate of growth of GDP through supply chain disruptions or other effects. If, for example, GDP grew at a rate of 1.5% instead of 2.1%, the compounded effect of lower growth would be very large by the year 2100. Robust supply chains are critical to economic growth, and disruption of supply chains might be one way that higher temperatures could affect growth. It is a reasonable hypothesis to test.

The Academic Literature on Climate Change and Economic Growth

Three eminent economists from Harvard, MIT and Northwestern, Melissa Dell, Benjamin Olken and Benjamin Jones, published a paper in 2012 (DJO) claiming to show that higher temperatures reduce the rate of growth of per capita GDP in poor countries.[5] Their work was the basis of many subsequent papers on the economics of climate change. Last month I published a paper in a peer reviewed economics journal, Econ Journal Watch, in which I argued that these results are flawed.[6]

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[1] IPCC. 2018. Global Warming of 1.5°C. Cambridge, UK: Cambridge University Press. p. 256.
[2] Ibid.
[3] See Maddison Project. 2000. Maddison Project Database 2020. Groningen Growth and Development Centre, University of Groningen (Groningen, Netherlands) for data showing the average world growth rate of per capita GDP. An estimate of world economic growth of 2.1% through 2100 can also be found in Christensen P, Gillingham K and Nordhaus W 2018 Uncertainty in forecasts of long-run economic growth Proc. Natl Acad. Sci. 115 5409–14.
[4] These estimates are consistent with the DICE model created by William Nordhaus. See Nordhaus, William. 2018. Projections and Uncertainties About Climate Change in an Era of Minimal Climate Policies. American Economic Journal: Economic Policy 10(3): 333–360 and W. Nordhaus, Revisiting the social cost of carbon, PNAS, 114 (2017), 1518-1523.
[5] Dell, Melissa, Benjamin F. Jones, and Benjamin A. Olken (DJO). 2012. Temperature Shocks and Economic Growth: Evidence from the Last Half Century. American Economic Journal: Macroeconomics 4(3): 66–95.
[6] Barker, David. 2023. Temperature Shocks and Economic Growth: Comment on Dell, Jones, and Olken. Econ Journal Watch 20(2):234–53

The flaws are related to what is often called a crisis of replicability in some areas of scientific research, and more specifically, what is known as p-hacking.[7] The letter P refers to probability. In statistical analysis, a p-value tells us the probability that a result obtained with statistical analysis could have been found because of random chance instead of an actual effect. A common standard is 5%. In other words, if there is less than a one in twenty chance that a result comes from random chance, then the result is taken seriously. But if a researcher runs a model 20 times using different specifications, the odds are that at least one of these specifications will show statistical significance, even if there is no true result. Publishing this result without disclosing that other specifications were tried can be very misleading.

The problem of p-hacking is compounded by publication bias, which means that academic journals are more likely to accept papers that show an effect of something, rather than those that fail to show an effect. As a result, researchers who depend on publications for tenure and post-tenure review are incentivized to produce what appear to be statistically significant results.

Whether it is intentional or not, p-hacking can be overcome through robustness checks, meaning that different specifications and data can be checked to see if they produce similar results. I performed a number of robustness checks on papers claiming to show effects of temperature on economic growth.

In DJO, countries were categorized as rich or poor based on the first year of the sample, which went from 1960 to 2003. In other words, if a country was below the median of all countries in 1960, it was categorized as poor for the entire sample. I discovered that if South Korea, which was very poor in 1960 and very rich in 2003, is classified as poor when it was poor and rich when it was rich, the results nearly disappeared. When I reclassified all countries this way, the results disappeared completely.

There were other arbitrary aspects of their model specification that, when changed, reduced the statistical significance of their results. I also found that, using an alternative data source, there was no effect of temperature on growth. Looking at monthly instead of annual temperatures I also found no evidence supporting their hypothesis.

In DJO and other papers purporting to show a relationship between temperature and growth, all countries are weighted equally. This means that St. Vincent and the Grenadines, one eighth the size of Rhode Island, has the same weight as China. As a result, small countries with unusual circumstances affect the results. For example, 1994 in Rwanda was a year of genocide and economic collapse. It was also a bit warmer than usual, leading the statistical model to conclude that temperature affects GDP. Looking at monthly data, the warmest months of that year in Rwanda occurred after the genocide, and so could not have caused it.

With this method of equal weighting, large countries with varied climates are assigned a single average temperature each year, which can also be misleading.

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[7] For an explanation of p-hacking, see Friese M, Frankenbach J. p-Hacking and publication bias interact to distort meta-analytic effect size estimates. Psychol Methods. 2020 Aug;25(4):456-471.

DJO claimed that temperature might affect economic growth by causing political unrest. Correcting their untenable classification method and removing a few unusual observations was enough to eliminate this result.

Another paper that was first published by the Federal Reserve Bank of Richmond and later in an academic journal, claimed that higher temperatures in the United States have lowered growth of state GDP.[8] Their result came from using an extreme estimate of warming multiplied by a statistically insignificant coefficient that changes sign when estimated with a different source of data. The results are sensitive to removal of a small number of observations and an attempt to deal with non-linear effects shows that if anything, warmer temperatures increase economic growth.[9]

It is interesting to note that the Federal Reserve has devoted considerable attention to climate change. A query of the Fed's listing of recent publications related to climate change returns hundreds of research papers, press releases and policy statements.[10] In May of 2023 twenty-seven Fed economists participated in a conference on climate change hosted by the San Francisco Fed.[11]

Another paper published in 2021 by the Board of Governors of the Federal Reserve System also claimed to find a relationship between temperature and world economic growth.[12] It used complicated statistical techniques, but I showed that its results were not statistically significant, and using simulated data I showed that the paper's model could be easily tricked into showing an effect when no effect existed.[13]

Discussion

Even if these results are valid, none of the papers I examined deny that adaptation could mitigate the effects they claim to find. Robust supply chains exist in a variety of climates around the world, and significant adaptation will certainly occur over the next 80 years The papers find no effect of changes in precipitation on GDP, and the DJO data show no statistically significant increase in the volatility of temperature or rainfall, casting further doubt on the likelihood of significant supply chain disruptions.[14]

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[8] Colacito, Riccardo, Bridget Hoffmann, and Toan Phan (CHP). 2019. Temperature and Growth: A Panel Analysis of the United States. Journal of Money, Credit and Banking 51(2–3): 313–368.

[9] Barker, David. 2022. Temperature and U.S. Economic Growth: Comment on Colacito, Hoffmann, and Phan. Econ Journal Watch 19(2): 176–189.

[10] https://www.fedsearch.org/board_public/search?text=%22Climate%20change%22%20OR%20%22%20global%20warming%22%20OR%20%22CO2%22

[11] https://www.frbsf.org/wp-content/uploads/sites/4/SystemClimate_Final-Agenda.pdf

[12] Kiley, Michael. 2021. Growth at Risk from Climate Change. Finance and Economics Discussion Series 2021-054. Board of Governors of the Federal Reserve System (Washington, D.C.).

[13] Barker, David. 2023. Temperature and Economic Growth: Comment on Kiley. Econ Journal Watch 20(1): 69–84.

[14] The DJO data do not rule out an increase in temperature or precipitation volatility that is more localized than at a national level.

I have examined other papers that are prominently cited, including by the IPCC, and found similar problems, as well as new problems. Estimates of non-linear effects of temperature on growth, for example, are particularly susceptible to being led astray by unusual observations.

The papers failed many other robustness checks that I performed. Research this flimsy should not have passed the peer review process and should not have been published. In my opinion, political and ideological pressure to confirm the importance of climate change has caused the peer review process to break down, allowing questionable results to be published in elite academic journals.

The papers I critiqued were given glowing coverage in the media, and some of them are in the top 1% of the academic economics literature, measured by citation counts. They were published in top journals and the authors are some of the most celebrated economists in the world. Those journals have not acknowledged problems in the articles they have published, and the popular media have no interest in correcting stories they wrote when the research came out. Econ Journal Watch gave all authors of the papers I critiqued the opportunity to respond in print, but none have so far accepted the invitation. I appreciate this opportunity to point out the weaknesses in current research on the economic effects of climate change.

The economists who wrote these papers had a good idea, which was to test whether episodes of high temperatures in the past caused lower GDP growth. The mechanisms that are hypothesized, such as higher temperatures reducing the productivity of outdoor workers or interfering with supply chains as trucks overheat and other equipment is stressed, or higher temperatures leading to more extreme wind or fire, are reasonable things to test. But the evidence from the record of temperature variation and economic growth does not support the hypothesis that climate change will negatively affect economic growth. In fact, some studies show net positive effects of warming for the United States, and by extension for the federal budget, although this conclusion is subject to the same criticisms I have outlined.

A recent paper in Ecological Economics opens by saying: "A large discrepancy exists between the dire impacts that most natural scientists project we could face from climate change and the modest estimates of damages calculated by mainstream economists."[15] Some alarmists have departed from conventional economic views to make extreme predictions. For example, the World Economic Forum claims that without stronger action to reduce greenhouse gas emissions, there will be "runaway climate change that makes the world all but uninhabitable."[16] Some are critical of the work of economists on climate change, believing that tipping points may lurk in the future that are not clear from analysis of past data.

My research does not address possible tipping points that might mean greater effects of climate change on GDP, but other economists have examined this possibility. William Nordhaus, for example, has studied the potential for a melting of the Greenland ice sheet, and has found that it

[15] Rising, James A, Charlotte Taylor, Matthew C. Ives, Robert E.T. Ward. 2022. Challenges and innovations in the economic evaluation of the risks of climate change. Ecological Economics 197: 1-13.
[16] World Economic Forum. 2022. The Global Risks Report 2022 17th Edition. Geneva:World Economic Forum. p. 31.

would have only a minor impact on his estimate of the social cost of carbon.[17] Many mainstream credentialed economists share the view that the effects of climate change on GDP are likely to be far more modest than extreme predictions that receive more media attention. Some have even proposed that the costs of reaching the Paris targets would be greater than the benefits.[18]

Conclusion

The records of temperature and economic growth that I have examined do not support the hypothesis that supply chain disruptions caused by climate change are likely to cause reductions in per capita GDP growth. Because federal revenue is closely tied to GDP, it follows that my results cast doubt on the idea that climate change will have an impact on the United States Budget by reducing federal tax revenue.

Links to my papers:

https://econjwatch.org/articles/temperature-shocks-and-economic-growth-comment-on-dell-jones-and-olken

https://econjwatch.org/articles/temperature-and-economic-growth-comment-on-kiley

https://econjwatch.org/articles/temperature-and-us-economic-growth-comment-on-colacito-hoffmann-and-phan

[17] Nordhaus, W. Economics of the disintegration of the Greenland ice sheet. Proc. Natl. Acad. Sci. USA 2019, 116, 12261–12269.
[18] Tol, Richard (2023). Costs and benefits of the Paris climate targets. Forthcoming, Climate Change Economics.