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ISSUE BRIEF

CLIMATE COSTS IN CONTEXT

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Executive Summary

There is a consensus among climate scientists that human activity is contributing to climate change. However, claims that rising temperatures pose an existential threat to the human race or modern civilization are not well supported by climate science or economics; to the contrary, they are every bit as far from the mainstream as claims that climate change is not occurring or that it will be beneficial. Analyses consistently show that the costs of climate change are real but manageable. For instance, the prosperity that the world might achieve in 2100 without climate change may instead be delayed until 2102.

This view holds across the most recent assessment report by the United Nations Intergovernmental Panel on Climate Change, the "Social Cost of Carbon" estimate by the Obama administration, the "Quadrennial Defense Review" by the U.S. Department of Defense, and the "Stern Review on the Economics of Climate Change" in the United Kingdom.

This issue brief finds that:

- The Obama administration's long-run projection for the cost of climate change is less than one-tenth of one point of economic growth per year.
- Forecasts for the coming century of environmental and social impacts, such as sea-level rise, ecosystem destruction, and geopolitical instability, are likewise substantial but not catastrophic.
- Politicians and activists are especially misleading when they assert a "scientific consensus" for their predictions of damage. Widespread agreement—and, most infamously, the "97% consensus"—extends only to the more mundane assertions that climate change is occurring and that human activity is at least partially responsible.

I. Introduction

The oft-cited "scientific consensus" on climate change[1] supports the claim that human activity is causing changes to the climate—not that this change will be of any specific magnitude or have impacts of any specific magnitude.[2] When President Obama tweeted, "Ninety-seven percent of scientists agree: #climate change is real, man-made and dangerous,"[3] the inclusion of "dangerous" was not correct.[4] None of which means climate change is not dangerous, only that no consensus exists as to the extent of danger.

The chain of causation from greenhouse gas emissions to human impacts is lengthy: economic growth, the energy intensity of economic activity, and the emissions profile of energy use all combine to determine emissions levels. Those emissions then produce a concentration of greenhouse gases in the atmosphere, from which climate models can offer projections of temperature increase. Other models must translate any given temperature increase into estimates of natural-world effects, such as sea-level rise, drought, or ecosystem disruption. And another set of models and qualitative analyses must try to estimate how those changes in the natural world will affect the society that emitted the greenhouse gases in the first place.

Scientific assessments vary widely at each of these steps. However, climate researchers have settled broadly on an expected temperature increase of 3 to 4 degrees Celsius by the year 2100 if efforts are not made to reduce emissions.[5] This forecast derives in part from the "A1B" scenario for future economic growth and emissions created by the UN IPCC,[6] widely recognized as an appropriate baseline[7] and used by both the U.S. government[8] and European researchers[9] as such. The IPCC has estimated a temperature increase by 2100 in the A1B scenario of 3.3°C,[10] while the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC), developed through support of the U.S. Environmental Protection Agency, puts warming in that scenario at 3.4°C.[11] Another scenario, created by the Massachusetts Institute of Technology's Joint Program on the Science and Policy of Climate Change, offers an estimate of 3.9°C.[12] The Climate Action Tracker, which attempts to account for government policies globally, places its estimate for warming by 2100 under "current policy" at 3.3°–3.9°C.[13]

Note that some analyses improperly use a higher estimate of 4.5°–5.0°C as the "business as usual" or base case for warming by 2100.[14] This estimate derives from a UN-created scenario for rising emissions known as "RCP 8.5." This scenario is not intended to be a base case that projects actual emissions, but rather offers an arbitrary and hypothetical high case created by the IPCC to help modelers coordinate their model inputs and compare outputs. The IPCC specifically clarifies: "The RCP 8.5 pathway has higher emissions than all but a few published baseline scenarios."[15]

II. The Economic Cost of Climate Change

To estimate the economic cost of warming, researchers use "Integrated Assessment Models" (IAMs), which translate a given level of warming into estimates of natural-world impacts and then economic costs. Such analysis requires as much art as science,[16] and, especially for larger temperature increases, the results are highly speculative.[17] Still, they offer the best available estimates and should indicate at least the relative magnitude of the threat.

The Obama administration used three such models to develop its estimate of the "social cost of carbon":[18] the Dynamic Integrated Climate-Economy (DICE) model developed by William Nordhaus at Yale University;[19] the Policy Analysis of the Greenhouse Effect (PAGE) model developed by Chris Hope at the University of Cambridge;[20] and the Climate Framework for Uncertainty, Negotiation and Distribution (FUND) model developed by Richard Tol of the University of Sussex.[21]

These models indicate that for 3°–4°C of warming, global GDP in the year 2100 will be 1%–4% lower than in a world with no warming.[22] At the low end, the FUND model estimates a positive impact on GDP for warming of less than 3°C, with the impact turning negative just before the 3°C threshold is crossed. At the high end, the DICE model shows a cost of 2%–3% of GDP at 3°C and just over 4% at 4°C. In the middle, the PAGE model estimates a cost of 1%–3% of GDP and a greater than 90% chance that the value falls between the FUND and DICE estimates.

These are large costs—all three models estimate that global GDP will have grown to at least $500 trillion by 2100 versus a 2015 total of approximately $75 trillion.[23] So if climate change reduces GDP in 2100 by 3%, that would represent $15 trillion—nearly the size of the entire American economy today. But *by the standards of 2100*, the cost is manageable.

The DICE model, which estimates the highest cost in percentage terms, provides a concrete illustration.[24] It estimates that, without climate change, global GDP would grow from $76 trillion in 2015 to $510 trillion in 2100. With climate change of 3.8°C, it estimates that global GDP in 2100 would instead total $490 trillion—a $20 trillion cost but one that still leaves the world 6.5 times wealthier than today.

Nor does that $20 trillion impact strike suddenly. Rather, as temperatures increase and impacts worsen, costs rise as well. Economic growth each year is slightly lower than it would otherwise have been but never is reduced by more than one-tenth of one percentage point. And economic growth continues despite the climate change: the climate-change-impacted world of 2105 is already wealthier than the no-climate-change world of 2100.

This, again, is the *highest*-cost estimate of those considered by the Obama administration. Proponents of aggressive climate policy will sometimes point to the United Kingdom's "Stern Review,"[25] widely recognized as a more extreme estimate of potential costs.[26] But that review actually relies on the same PAGE model used by the Obama administration and arrives at the same estimate of cost—less than 5% of GDP—for warming of 3°–4°C.[27] To find higher estimates of cost, it takes the extraordinary step of attempting to predict costs through the year 2200, by which point its estimate reaches 14% of GDP.[28] Yet even growing at only 1% per year in the 22nd century, and even with that full climate impact realized, the global economy by 2200 would exceed $1 quadrillion in size. Perhaps such a number seems nonsensical and impossible to interpret, but this only underscores the pointlessness of forecasting economic impacts centuries into the future.

Dr. Nicholas Stern, author of the Stern Review, lamented in *Nature* that the best research does not produce the catastrophic results that he had expected. His suggested solution is to create different research: "The next IPCC report needs to be based on a much more robust body of economics literature, which we must create now."[29]

III. Noneconomic Impacts

Such modest economic estimates seem incompatible with the severe disruptions popularly assumed to accompany climate change. However, it is generally the popular assumption rather than the detailed economic research that is in error. For instance, while descriptions of sea-level rise often depict largescale melting in Greenland and Antarctica producing several meters of sea-level rise, such scenarios are forecast to play out only over the course of several centuries or even millennia.

The IPCC's estimate for sea-level increase over the century between the 1986–2005 period and the 2081–2100 period is only 0.52 meters (1.7 feet). The largest contributor to this sea-level rise is not glacial melting at all but rather thermal expansion associated with the warming of ocean water. Melting of the Greenland ice sheet contributes 0.05 meters (2 inches); the Antarctic ice sheet makes no contribution at all.[30] Lest one worry about a worst-case scenario, the IPCC reports: "Only the collapse of the marine-based sectors of the Antarctic ice sheet, if initiated, could cause [Global Mean Sea Level] to rise substantially above the likely range during the 21st century. This potential additional contribution cannot be precisely quantified but there is *medium confidence* that it would not exceed several tenths of a meter of sea level rise."[31] As for "the near-complete loss of the Greenland ice sheet" that could raise sea levels by 7 meters, it "would occur over a millennium or more."[32]

The IPCC itself offered an estimate of what this might cost: "Some low-lying developing countries and small island states are expected to face very high impacts that, in some cases, could have associated damage and adaptation costs of several percentage points of GDP."[33] In other words, even for those poorest and most vulnerable countries, damage still amounts to only the small share of future wealth forecast in the economic models.

The pattern repeats itself across other potential effects of climate change. For instance, researchers call attention to the prospect of widespread ecosystem disruption and species extinction. The IPCC emphasizes: "With 4°C warming, climate change is projected to become an increasingly important driver of impacts on ecosystems." But the actual magnitude of these impacts will only "becom[e] comparable with land-use change"[34]—the disruption the world is already experiencing from human development. That disruption has not been costless—in either economic or less tangible terms—but neither has it produced widespread or insurmountable challenges to continued growth and prosperity.

Similarly, climate change has the potential to contribute to geopolitical instability, especially in regions facing other political and economic stressors. But this is only one of many such challenges. In its 2010 Quadrennial Defense Review, the U.S. Department of Defense observed: "Other powerful trends are likely to add complexity to the security environment. Rising demand for resources, rapid urbanization of littoral regions, the effects of climate change, the emergence of new strains of disease, and profound cultural and demographic tensions in several regions are just some of the trends whose complex interplay may spark or exacerbate future conflicts."[35] In the 2014 review, the DOD observed that "climate change may increase the frequency, scale, and complexity of future missions" and that it "will aggravate stressors abroad such as poverty, environmental degradation, political instability, and social tensions—conditions that can enable terrorist activity and other forms of violence."[36] Nowhere does the DOD single out climate change as an unprecedented or insurmountable threat.

IV. Conclusion

In its own assessment, "The National Security Implications of a Changing Climate," the White House concludes that the nation is fully capable of adapting in the face of climate change and absorbing whatever impacts occur: "While the challenges are vast, the United States is preparing with strong resilience measures that will address these changing dynamics, making the Nation safer at home and strengthening missions abroad."[37]

All these costs—both economic and noneconomic—are substantial and have the potential to cause significant damage and disruption. Policymakers should take them seriously and seek to reduce or prepare for them when the expected benefit of action exceeds the cost. However, none are outside the range of other challenges facing society, and none support the apocalyptic rhetoric of many politicians and activists.

Endnotes

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5 Oren Cass, Testimony Before the House Committee on Science, Space, and Technology, Dec. 1, 2015.

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19 William Nordhaus, "DICE-2013R Model as of November 15, 2013," Yale University William Nordhaus Home Page.

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21 For a list of articles, including by authors Richard Tol and David Anthoff, see the website dedicated to The FUND—Climate Framework for Uncertainty, Negotiation and Distribution. For an article of the same name, which is cited on that list, see "An Institute on the Economics of the Climate Resource," University Corporation for Atmospheric Research, Boulder, CO (1996): 471–96.

22 "Technical Support Document," Feb. 2010. See Figure 1B.

23 "Gross Domestic Product 2015," World DataBank, website of the World Bank.

[24] Nordhaus, "DICE-2013R Model as of November 15, 2013."

[25] U.K. Office of Climate, "Stern Review on the Economics of Climate Change," chap. 6: "Economic Modelling of Climate Change," Oct. 2006.

[26] See, e.g., Martin L. Weitzman, "A Review of the Stern Review on the Economics of Climate Change," *Journal of Economic Literature* 45 (Sept. 2007): 703–24. "Such a strong call to immediate decisive action is at odds with what most other economic analyses of climate change have concluded," according to Weitzman. See also William Nordhaus, "A Review of the Stern Review on the Economics of Climate Change," *Journal of Economic Literature* 45 (Sept. 2007): 686–702. "These results are dramatically different from earlier economic models that use the same basic data and analytical structure," Nordhaus writes.

[27] U.K. Office of Climate, "Stern Review," chap. 6, Figure 6.6.

[28] Ibid., Figure 6.5.

[29] Nicholas Stern, "Economics: Current Climate Models Are Grossly Misleading," *Nature* 530 (Feb. 25, 2016): 407–9.

[30] John A. Church and Peter U. Clark, "Chapter 13: Sea Level Change," in *Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the IPCC* (Cambridge: Cambridge University Press, 2013). See Table 13.5 regarding "median values and likely ranges for projections of global mean sea levels (GMSL) and its contributions in metres in 2081–2100 relative to 1986–2005" (emphasis in the original).

[31] Ibid.

[32] Christopher B. Field et al., "Technical Summary," in *Climate Change 2014: Impacts, Adaptation and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the IPCC* (Cambridge: Cambridge University Press, 2014), pp. 35–94.

[33] Ibid.

[34] Ibid. See Box TS.6, "Consequences of Large Temperature Increase."

[35] DOD, "Quadrennial Defense Review Report," Feb. 2010.

[36] DOD, "Quadrennial Defense Review 2014," Mar. 2014.

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