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United States House Subcommittee on National Security, International Development, and Monetary Policy

Thank you Chairman Cleaver, Ranking Member Stivers, and members of the Committee for inviting me to speak today.

My name is Marshall Burke, and I am a professor of Earth System Science at Stanford University. I have a PhD in economics, and my research focuses on using data and statistics to understand how climate change impacts our economy and our livelihoods.

My job as an academic economist is not to make policy recommendations, but to provide information on the likely costs and benefits of a particular policy choice – or in this case, of failing to take policy action. And we have increasing amounts of evidence on what those costs and benefits might look like with regard to climate change.

Data can now tell us what happens to our economy when temperatures warm or when rainfall patterns change. Just as we use thermometers to tell us whether the temperature is going up or down, we can use data and statistics to tell us what happens to different sectors of the economy, or the economy as a whole, when the temperature changes. Again, my goal as a scientist is to simply make measurements, not political statements. And these measurements are starting to tell a very clear story.

Importantly, this climate story touches directly on all three of the jurisdictional areas of this subcommittee: national security, international development, and monetary policy. I would like to make six points about how a changing climate will affect these important areas.

First, **climate change is likely to have a substantial negative impact on the US economy**. Numerous studies using recent historical data on the US economy show that economic output falls in hot years as compared to cooler years[1]. When combined with projections of future temperature change from climate scientists, these data allow researchers to estimate what the likely loss in future economic output could be if warming continues unimpeded.

Research done by myself and colleagues at Berkeley and Stanford finds that, by 2050, unmitigated climate change will have cost the US economy roughly $5 trillion[2]. By the end of

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the century, these damages could rise to tens of trillions of dollars in present value, just for the US economy alone. In other research, we find that the roughly +1C of temperature increase due to climate change that we've already experienced in the US has already cost the US economy over $1 trillion.[3]

Second, **climate change will affect nearly all sectors of the economy.** For many people, climate impacts are most closely associated with rising seas and declining crop yields. These impacts are certainly important, but in fact are likely to only be a small part of the overall economic consequences in the US. Many other sectors and many other outcomes will be affected by a warming climate.[4] We have strong evidence that workers in all industries are less productive when it's hot.[5] We also have clear evidence that our cognitive function declines when it's hot: people perform office tasks less effectively[6], and kids learn less and score worse on standardized tests[7]. These impacts will have economy-wide effects on economic performance.

Given these widespread economic impacts, it's no surprise that the insurance industry is already labeling climate change *the* top global risk – more worrisome than financial instability, cyber warfare, or terrorism.[8]

The third thing we know is that **climate change will worsen security risks, both domestically and abroad**. Police chiefs in US cities have recognized for decades that crime spikes during heat waves. The statistics bear this out very clearly: violent assault, sexual violence, and homicide all increase on days or months where temperatures are above normal[9]. Hot temperatures also increase suicide risk, and in recent research we calculate that future warming could lead to tens

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potential reduction in economic damages under UN mitigation targets." *Nature* 557 (2018): 549; Deryugina, Tatyana, and Solomon Hsiang. *The marginal product of climate*. No. w24072. National Bureau of Economic Research, 2017. See http://web.stanford.edu/~mburke/climate/ for country data.

[3] Burke, Marshall, and Vincent Tanutama. *Climatic Constraints on Aggregate Economic Output*. No. w25779. National Bureau of Economic Research, 2019.

[4] Hsiang, Solomon, et al. "Estimating economic damage from climate change in the United States." *Science* 356.6345 (2017): 1362-1369.

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[7] Goodman, Joshua, et al. "Heat and learning." (2018), forthcoming *American Economic Journal – Economic Policy;* Graff Zivin, Joshua, Solomon M. Hsiang, and Matthew Neidell. "Temperature and human capital in the short and long run." *Journal of the Association of Environmental and Resource Economists* 5.1 (2018): 77-105.

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of thousands of additional suicides in the US by mid-century[10]. Elsewhere in the world, we have documented large increases in civil conflict and organized crime as temperatures rise[11]. Colleagues from Columbia University have in turn shown that this conflict drives substantial international migration into wealthier countries[12].

Fourth, **climate change is going to exacerbate economic inequality, both domestically and abroad**. Poorer people in this country, and poorer people around the world, tend to live in environments that are already hot. As these regions get even hotter, most economic impacts will be amplified. Country-level estimates that I have published with colleagues at Stanford and Berkeley suggest that poorer countries will suffer two or three times more economic harm than many wealthier countries in coming decades.[13] A recent study in the US also found that economic damages from climate change will be many times higher in poorer counties as compared to wealthier counties.[14]

Fifth, **adaptation is possible, but will be costly**. Adaptation to climate change requires devoting resources to adaptation projects. For instance, we can spend money to build sea walls, to air condition every building, or to treat extra people at the doctor when they get sick. These investments will reduce the damage caused by climate change. But these investments also have a clear "opportunity cost" – they could have been spent on something else, such as on investments that improve future productivity rather than just keeping it from declining.

Similarly, while future innovation will likely reduce the cost of adapting to climate change, it is risky to simply assume these innovations will occur on their own. In many key areas such as agriculture, we don't have clear evidence that farmers – and the public and private entities that support them – are adapting to the substantial climate change that's already occurring.[15] If anything, the negative impact of higher temperatures on crop yields appear to be growing larger[16], likely due to a combination of changing management practices and disincentives

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provided by subsidized crop insurance programs[17]. Similarly, while the widespread adoption of air conditioning in the US reduced many types of mortality[18], it has not reduced suicide- or homicide-related mortality[19], nor has it reduced the impact of hot temperatures on overall economic output in the US[20].

Sixth, **most policies that mitigate climate change will generate immediate benefits**, in the form of improved air quality as we transition away from dirty sources of power in the energy and transportation sectors. Estimates suggest that the health and economic benefits of this improved air quality could be massive. For instance, were the US to adopt clean energy and clean transportation policies consistent with our prior emissions reductions commitments under the Paris Accords, these policies would lead to air quality improvements that would save roughly 300,000 premature deaths by 2030 in the US alone.[21] This reduced mortality would be valued in the trillions of dollars in the US[22], which is roughly on par with the economic benefit of reduced warming by mid-century. Improved air quality would also have positive effects on worker productivity[23] and cognition[24], further amplifying these economic benefits. Crucially, however, unlike the long-run benefits of climate mitigation, these air quality benefits accrue immediately after a polluting power plant is turned off or a polluting car is taken off the road.

Taken together, this evidence helps provide a more robust understanding of how much we should be willing to pay to reduce climate change. Focusing exclusively on the costs of action without considering these very large costs of inaction is terrible economics and bad policy. If we are able to substantially slow the future temperature increases expected under climate change, this will generate tens of trillions of dollars in economic benefits for the US economy and its citizens over the coming decades – and even larger benefits globally. These benefits should be weighed against the costs of proposed climate policies. Policies that can put a big dent in climate change that cost less than tens of trillions of dollars to implement are policies that make economic sense.

Thank you.

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