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CLIMATE ECONOMICS

Valuing climate damages at the country level

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New estimate of the costs of CO_2 emissions at the country level identifies the winners and losers from climate change

Carbon dioxide released from burning fossil fuels affects people and ecosystems around the world, today and in the future. These impacts are not included in market prices, creating an environmental externality whereby consumers of fossil fuel energy do not pay the true costs of their consumption. The Social Cost of Carbon (SCC) is the value of this externality, calculated by tallying-up of all the disparate impacts resulting from emitting a ton of CO_2 and converting them into common units (typically today's dollars). Since CO_2 is a global pollutant, most analysis has focused on the global SCC. But a more geographically disaggregated SCC may be desirable for some applications. Writing in *Nature Climate Change*, Ricke and coauthors provide new estimates of the SCC at the country-level[1].

The country-level SCC tells us how the costs from emitting one additional ton of CO_2 are distributed between countries. In addition to the direct equity implications of climate change, this is also potentially important in understanding how countries strategically negotiate with each other over the provision of greenhouse gas mitigation, a global public good. In a fully cooperative world, countries would internalize the full external costs of their emissions by all pricing CO_2 at the global SCC. In a non-cooperative world however, countries would ignore the international effects of their emissions and internalize only the costs of their own domestic damages, resulting in much lower CO_2 prices and correspondingly higher emissions. We see this playing out currently in the United States, where the federal government, in addition to withdrawing from international cooperation on climate change, has also proposed changing the SCC applied to CO_2 emissions in cost-benefit analysis from a global to a domestic value, a cut of

approximately 90%. Recent work to understand the provision of greenhouse gas mitigation in a strategic setting with limited cooperation has been hampered by sparse information on country-level damages[2].

Ricke and coauthors use recent statistical estimates of the relationship between inter-annual temperature variation and national GDP growth-rates to drive their country-level SCC estimates[3]. Because impacts to GDP growth permanently alter a country's GDP, these growth-rate damages result in a much higher SCC than that derived from existing Integrated Assessment Models (IAMs), which mostly model the effects of temperature fluctuations as temporary, rather than permanent impacts. Ricke et al. therefore estimate global SCC numbers approximately 10 times larger than that produced by the US government using existing IAMs.[3] The questions of whether the effect of temperature on GDP truly persists over many years and, if so, whether the relationship between GDP and short-term fluctuations in weather applies to long-term changes in climate are still open questions with important implications for the SCC.

In order to model the effects of a pulse of CO_2 emissions on country-level temperatures, the authors use an innovative approach combining results from several climate model experiments to capture the magnitude and geographic pattern of warming under different RCPs, and the carbon-cycle and climate system response to a pulse of CO_2 emissions. Incorporating our current knowledge of the climate system, as represented in Earth System Models, into the SCC is an important step forward. Current IAMs use very simple one-region radiative balance models and 2- or 3-box carbon cycle models, which may miss critical dynamics and feedbacks, and do not represent geographic heterogeneity. The loose coupling between the socio-economic and climate systems in Ricke et al's framework mean that it can not be used for certain applications, such as trading off costs and benefits to calculate an optimal CO_2 emissions path. However, the benefits in terms of more closely tying SCC estimates (and uncertainties) to current understanding of the climate system are substantial.

Propagating uncertainty in socio-economic trajectories, the climate system, economic damages, and discounting through the analysis, the authors unsurprisingly find extremely large uncertainties in the global SCC: their 66% confidence intervals alone typically span an order or magnitude. Much of this uncertainty results from statistical and functional form uncertainty in the economic damages, reflecting the importance of better constraining these parameters in the future. Nevertheless, the authors identify several results that are robust across these uncertainties. Cooler, higher-latitude countries are consistently better-off compared to hotter countries, in many cases benefiting from warmer temperatures. In no cases are damages distributed equally around the world, with the magnitude of the inequality dependent on the damage function and discounting assumptions.

The country-level estimates of the marginal damages from CO_2 emissions presented in this paper are important and will be valuable for a range of analytical applications. Nevertheless, they do raise a number of important questions. Firstly, these results call into question the relevance of a country's SCC in determining its negotiating position on climate change. The European Union has been an international leader on climate issues, but seems to stand to benefit from future warming. Conversely, the US and India will be negatively affected by warming and so might be expected to take a leadership role on climate, when in fact the opposite has been the case. Such disparities suggest that domestic damages may play a relatively minor role in determining national climate policies. A second puzzle involves the lack of ambitious climate policy observed to date. The authors show that the *domestic* SCC in several major emitters is close to that required to stabilize temperatures at the Paris Agreement

targets. In other words, based on just their own self-interest, these countries should be acting unilaterally to dramatically cut greenhouse gas emissions. The fact that we do not see this suggests either that damages are overestimated or costs are underestimated, that countries have not yet recognized the risk posed by climate change, or that sub-national political constituencies have been able to effectively block ambitious mitigation policies that would otherwise be in the national interest.

References

1. Ricke et al to be inserted
2. Nordhaus, W. Climate Clubs: Overcoming Free-riding in International Climate Policy. *Am. Econ. Rev.* 105, 1339–1370 (2015).
3. Burke, M., Hsiang, S. M. & Miguel, E. Global non-linear effect of temperature on economic production. *Nature* 527, 235–239 (2015).
4. U.S. Government Inter-Agency Working Group, Technical support document: Technical update of the social cost of carbon for regulatory impact analysis under executive order 12866. 1–22 (2013).