Discussion of Rennert et al. (2021) "The Social Cost of Carbon: Advances in Long-term Probabilistic Projections of Population, GDP, Emissions, and Discount Rates"

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Brookings Papers on Economics Activity

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The climate policy challenge



The Social Cost of Carbon (SCC) enables analysis of policy tradeoffs by quantifying total social costs of an additional ton of CO₂

The 2 Degree Emissions Pathway

The later emissions peak the harder it is to limit warming below 2C



Source: Carbon Brief

History of the SCC in (US) climate policy

The Most Important Number You've Never Heard Of



Source: Interagency Working Group on SCC, 2010

An urgent need to update the US SCC



"[M]uch of the research on which [the SC-IAMs] are based is dated...damage formulations do not in many cases reflect recent advances in the scientific literature."

-National Academies of Sciences, Engineering, and Medicine (2017)

Source: Interagency Working Group on SCC, 2010

\longrightarrow Jan. 2021: Biden Administration reconvenes IWG to comprehensively update the SCC

Challenges with the Integrated Assessment Models

- Pioneering work by Nordhaus and others led to the development of Integrated Assessment Models (IAMs) that link climate and economics that shape how we think about climate change
- 2 IAM Problems
 - Limited set of people with knowledge of what goes on inside the IAMs "black box"
 - Computers were bad and data not readily available so heavy reliance on assumptions
 - Only loose connection to robust climate damages literature
 - Incomplete accounting for uncertainty
 - Highly aggregated
 -

 \longrightarrow "Democracy is the worst form of government – except for all the others that have been tried." (Winston Churchill)

3 Dawn of a New Era?

Updates are needed for each "ingredient" in the SCC calculation



Carleton & Greenstone, Updating the United States Government's Social Cost of Carbon (2021)

The Climate Impact Lab and the Social Cost of Carbon



Climate Impact Lab









Robert Kopp





Ali Hamidi















Daniel Allen

Sam Anderson

Ian Bolliger

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Meredith Fish









Updates are needed for each "ingredient" in the SCC calculation



Carleton & Greenstone, Updating the United States Government's Social Cost of Carbon (2021)

Essential update: New socioeconomic and emissions projections

Shortcomings in the Interim SCC

- $\bullet\,$ Population, economic activity and GHG emissions projections developed ${\sim}2007\,$ through EMF-22
- Does not reflect last decade of work in scenario development

The Rennert et al. (2021) Plan of Action

- Scrap EMF-22 projections for population, economic growth, and GHG emissions trajectories, which were dated and did not reflect uncertainty (i.e., are not probabilistic)
- Projections (RFF-SPs)
 Replace with new probabilistic projections that are a combination of statistical and expert-based approaches, which they refer to as the RFF Socioeconomic Projections (RFF-SPs)
 - Population
 - UN statistical model extended to 2300
 - Expert disagreement with the projected lower bound total fertility rate in 2300 so changed the model
 - 2 Economic Growth
 - Muller, Stock, and Watson (2019) statistical model of economic growth out to 2300
 - Augment MSW (2019) projections with formal expert elicitation about "frontier of growth"
 - 3 Emissions
 - GHG emissions projections from 10 experts
 - Pair with Economic Growth Scenarios

Population growth experts



Juha Alho



Leontine Alkema



Jakub Bijak



Patrick Gerland



Nico Keilman



Ronald Lee



Jim Oeppen



Warren Sanderson



Tomas Sobotka

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Growth experts



Daron Acemoglu



Erik Brynjolfsson



Jean Chateau



Pietro Peretto



Robert Gordon



Mun Ho



Chad Jones



Dominique van der Mensbrugghe



Melissa Dell



Lant Pritchett

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Emissions experts



Sally Benson



Geoff Blanford



Sergey Paltsev



Keywan Riahi



Susan Tierney



Elmar Kriegler



Detlef van Vuuren



Jennifer Morris



Leon Clarke

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→ Substantial Socioeconomic Uncertainty!

Updates are needed for each "ingredient" in the SCC calculation



Carleton & Greenstone, Updating the United States Government's Social Cost of Carbon (2021)

Essential update: New climate model

Shortcomings in the Interim SCC

- IAMs' climate models represent economists' interpretation of climate science
- IPCC and NASEM: last decade of modeling shows peak warming in response to a pulse of CO₂ occurs within a decade and lasts for centuries (not reflected in IAMs)
- IAMs do not resolve local climate

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How these are addressed by Rennert et al (2021)

• Finite Amplitude Impulse Response (FaIR) climate model satisfies NASEM key climate module criteria for SCC calculation, and was highlighted by NASEM

Updates are needed for each "ingredient" in the SCC calculation



Carleton & Greenstone, Updating the United States Government's Social Cost of Carbon (2021)

Empirical publications informing these models



The models should be revised more frequently to accommodate scientific developments... the structure and in some cases the calibration of the damage models is stuck in the 1990s, when the original versions were created...

- Revesz et al (Nature, 2014)

Empirical publications informing these models



 \longrightarrow Updated damage functions should be: **empirical**, globally **representative**, and account for **adaptation** and its costs

Empirical publications informing these models



Shortcomings in the interim SCC:

- Derived from ad-hoc assumptions
- Limited empirical data only from the wealthy
- Ignores distributional impacts (<16 regions)
- Inconsistent assumptions about adaptation



Carleton & Greenstone (2021)

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How these are addressed by CIL:

- Derived directly from empirical analysis
- Based on large-scale, globally-representative data
- Captures local non-linearities (~25,000 regions)
- Inclusive of empirically-based estimates of adaptation and its cost



Re-imagining possibilities w/ distributed computing



Climate Impact Lab (2021)

24,378 regions

Considerable uncertainty about economic damages



Considerable uncertainty about economic damages



Economic and climate uncertainty is substantial in every examined sector



M. Greenstone | University of Chicago, Climate Impact Lab

Impacts and their uncertainty are distributed unequally across the globe



Updates are needed for each "ingredient" in the SCC calculation



Carleton & Greenstone, Updating the United States Government's Social Cost of Carbon (2021)

Essential update: Reassess the discount rate

Discount rate: Rate at which we lower future costs and benefits to make them comparable to the present

Discount Rate Options and Issues

- Descriptive: Constant riskless discount rate of 3% is no longer justified
- **2 Prescriptive**:Ramsey equation, $r_t = \rho + \eta g_t$
 - Weitzman (1998) uncertainty about economic growth and stochastic discount rates $PV(MD_t) = E[e^{-(\rho + \eta g_t)}tMD_t]$
 - Climate Beta

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Rennert et al. (2021)

- Use Ramsey approach, FaIR climate model, and DICE damages
 - Growth uncertainty is important
 - Climate Beta is important

Updates are needed for each "ingredient" in the SCC calculation



Carleton & Greenstone, Updating the United States Government's Social Cost of Carbon (2021)









Updates are needed for each "ingredient" in the SCC calculation



Carleton & Greenstone, Updating the United States Government's Social Cost of Carbon (2021)

Substantial uncertainty in the mortality partial SCC (even without accounting for socioeconomics)

It is apparent that accounting for uncertainty in the SCC (e.g. certainty equivalent calculations) is critical



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Empirically founded SCCs vs. current policy (without accounting for uncertainty)



Scenario: high emissions. Discount rates: 3% (current, IAMs); 3%-7% (Trump Admin.), 2% (CIL)

Concluding Remarks

- A new era of climate damages has arrived
- Empirically founded estimates of climate damages are possible
- Accounting for uncertainty is a critical part of improving the SCC
 - Rennert et al (2021) demonstrates that socioeconomic uncertainty and its correlation with damages are important
 - There are both strengths and weaknesses of expert elicitation
 - Critical to also account for uncertainty in damages and climate