Intragenerational Equity in the Social Cost of Carbon

Naomi Shimberg

A Year-long Senior Thesis in Ethics, Politics, and Economics

April 24, 2023

Yale Women in Economics

Advisor: Ken Gillingham; Second Reader: William Nordhaus

Motivation (1/2)

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The US SCC has influenced:

- US regulations with $>$\$1 trillion in benefits
- Federal/state carbon prices and tax credits
- Analogous metrics in Canada, Germany, India, Australia, New Zealand, and the UK
- A variety of institutional policies (e.g., Yale's internal carbon price)

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VSL varies with income $\Longrightarrow$ statistical lives in rich countries are valued more than statistical lives in poor countries

SHORT WAVE

LISTEN & FOLLOW

EPA's proposal to raise the cost of carbon is a powerful tool and ethics nightmare

February 9, 2023 · 12:10 AM ET

By Rebecca Hersher, Rebecca Ramirez, Aaron Scott, Margaret Cirino

13-Minute Listen

+ PLAYLIST

The tricky business of putting a dollar value on a human life

The EPA's draft "social cost of carbon" analysis opens up a knotty discussion about US lives versus lives abroad.

By Dylan Matthews | dylan@vox.com | Dec 22, 2022, 7:30am EST

The draft proposal translates lost lives into dollars, which is standard practice in government rulemaking. But, according to the report, a lost life in Haiti represents a smaller cost than a lost life in Canada. In fact, a Canadian life saved is worth over 16 times as much as a Haitian life saved in the EPA's calculus. That's because the EPA has chosen to weigh the mortality costs of climate change in proportion to per capita income of the country where someone dies, and **Canada's GDP per capita is more than 16 times that of Haiti**.

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This paper: New evidence on the impact of three approaches to monetizing premature mortality in the estimation of the SCC using the Greenhouse Gas Impact Value Estimator (GIVE) model

NORMATIVE ANALYSIS

Three approaches to benefit-cost analysis

Agencies need to answer two questions:

1. Should premature mortality be valued at a population-wide value (**equal-dollar VSL**) or should it vary with individuals' estimated willingness to pay to avoid mortality risk (**income-elastic VSL**)?
2. Should benefit-cost analysis continue to be **distribution neutral** or should it be **equity weighted**?

	Income-Elastic VSL	**Equal-Dollar VSL**
Distribution Neutral	Pure Kaldor-Hicks	Domestic Status Quo
Equity Weighted	Equity Weighted	-

Notes: Matrix inspired by Hemel (2022).

As of April 6th...

DRAFT FOR PUBLIC REVIEW

Circular A-4

April 6, 2023

TO THE HEADS OF EXECUTIVE AGENCIES AND ESTABLISHMENTS

Subject: Regulatory Analysis

Circular A-4 provides the Office of Management and Budget's (OMB's) guidance to Federal agencies on the development of regulatory analysis as required under Section 6(a)(3)(C) of Executive Order 12866 of September 30, 1993 (Regulatory Planning and Review), as amended; the Regulatory Right-to-Know Act, Pub. L. 106–554, § 624, 114 Stat. 2763, 2763A–161 (2000) (codified as amended at 31 U.S.C. 1105 note); and a variety of related authorities. The Circular also provides guidance to agencies on the regulatory accounting statements that are required under the Regulatory Right-to-Know Act.

This proposed update to Circular A-4, when finalized, will supersede the previous version of OMB Circular No. A-4, issued on September 17, 2003. Until then, that version of OMB Circular No. A-4 remains in effect.

Weights and Benefit-Cost Analysis

A standard assumption in economics, informed by empirical evidence (as discussed below), is that an additional $100 given to a low-income individual increases the welfare of that individual more than an additional $100 given to a wealthy individual. Traditional benefit-cost analysis, which applies unitary weights to measures of willingness to pay, does not usually take into account how distributional effects may affect aggregate welfare because of differences in individuals' marginal utility of income. Related to the topic of distributional analysis is the question of whether agencies should be permitted or encouraged to develop estimates of net benefits using weights that take account of these differences.[26] The proposed revisions to Circular A-4 suggest that agencies may wish to consider weights for each income group affected by a regulation that equal the median income of the group divided by median U.S. income, raised to the power of the elasticity of marginal utility times negative one.

MODEL

Theoretical model (1/2)

Assume an isoelastic utility function and discounted utilitarian social welfare function:

$$U(c) = \frac{c^{1-\eta}}{1-\eta}$$

$$W = \sum_{i=1}^{N} \sum_{t=1}^{T} U(c_{it}) r_t$$

$$r_t = \frac{U'(c_{it})}{U'(c_{i1})} \frac{1}{(1+\rho)^t} = \left(\frac{c_{i1}}{c_{it}}\right)^{\eta} \frac{1}{(1+\rho)^t}$$

The SCC is the marginal change in welfare resulting from a marginal emission today:

$$\mathrm{SCC} = \frac{\partial W}{\partial E} = \sum_{i=1}^{N} \sum_{t=1}^{T} \frac{\partial U(c_{it})}{\partial c_{it}} \frac{\partial c_{it}}{\partial E} r_t = \sum_{i=1}^{N} \sum_{t=1}^{T} \frac{\partial U(c_{it})}{\partial c_{it}} D_{it} r_t$$

Theoretical model (2/2)

Recall the SCC in units of welfare:

$$\mathrm{SCC} = \sum_{i=1}^{N} \sum_{t=1}^{T} \frac{\partial U(c_{it})}{\partial c_{it}} D_{it} r_t$$

Divergence between the three approaches happens during monetization:

$$\mathrm{SCC}_{\mathrm{KH}} = \sum_{i=1}^{N} \sum_{t=1}^{T} \frac{1}{\dfrac{\partial U(c_{it})}{\partial c_{it}}} \frac{\partial U(c_{it})}{\partial c_{it}} D_{it} r_t = \sum_{i=1}^{N} \sum_{t=1}^{T} D_{it} r_t$$

$$\mathrm{SCC}_{\mathrm{EW}} = \sum_{i=1}^{N} \sum_{t=1}^{T} \frac{1}{\dfrac{\partial U(c_{x1})}{\partial c_{x1}}} \frac{\partial U(c_{it})}{\partial c_{it}} D_{it} \frac{1}{(1+\rho)^t} = \sum_{i=1}^{N} \sum_{t=1}^{T} \left(\frac{c_{x1}}{c_{it}} \right)^{\eta} D_{it} \frac{1}{(1+\rho)^t}$$

$$\mathrm{SCC}_{\mathrm{SQ}} = \sum_{i=1}^{N} \sum_{t=1}^{T} D_{it}^{\mathrm{NM}} r_t + \left(\frac{c_{x1}}{c_{it}} \right)^{\eta} D_{it}^{\mathrm{M}} \frac{1}{(1+\rho)^t}$$

Numerical model

Greenhouse Gas Impact Value Estimator (GIVE) model: calculates climate damages given temperature and socioeconomic projections (Rennert et al. 2022)

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Estimation strategy:

1. Run the GIVE model to 2300 for a 'baseline' case and a 'perturbed case'
2. Calculate the marginal climate damages in year t as the difference between the two cases
3. Aggregate marginal damages into a single present value using a discount factor

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Calculate 10,000 unique SCC estimates using a Monte-Carlo approach to account for uncertainty in emissions and socioeconomic projections

Modifications to the GIVE model

This project makes three modifications to the GIVE model:

1. **VSL flexibility**: calculate mortality damages using an equal-dollar or income-elastic VSL
2. **Equity weighting**: account for diminishing marginal utility of income across *all* damage sectors
3. **Alternative mortality damage function**: replace Cromar et al. (2022) with Bressler et al. (2021)

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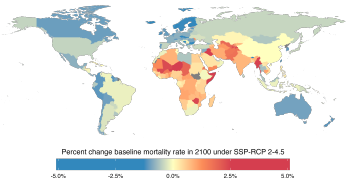
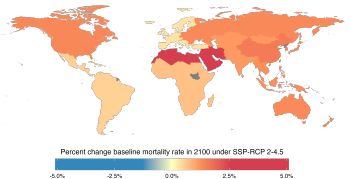
Why replace the existing mortality damage function?
$\longrightarrow$ Cromar et al. (2022) finds that people in hotter and poorer places will be less severely impacted than people in richer and cooler places

Comparing mortality modules

Bressler et al. (2021)



Cromar et al. (2022)



RESULTS

SCC increases when accounting for accurate distribution

Figure 1: Country-level VSL (EPA's approach)

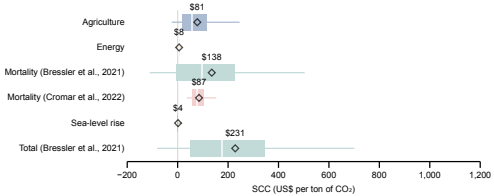


Figure 2: Global average VSL (preferred) (Status quo)

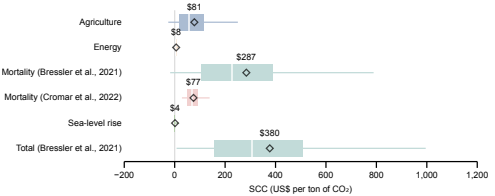
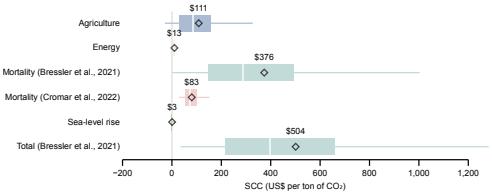


Figure 3: Equity weighting



Equity weighted estimates highly sensitive to reference region

Figure 4: Bressler et al. (2021) damage function

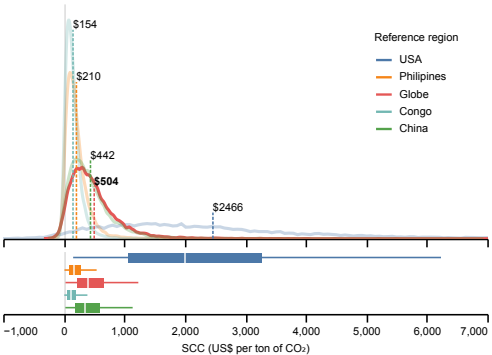
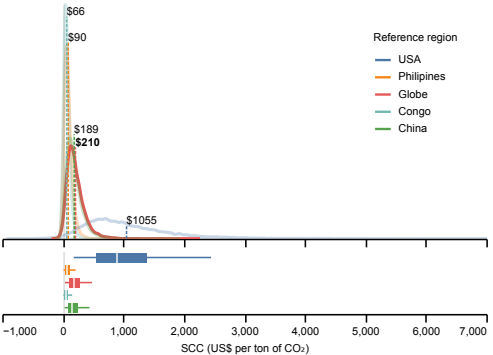


Figure 5: Cromar et al. (2022) damage function



Intratemporal spatial inequality aversion matters more than intertemporal inequality aversion in the Bressler et al. (2021) damage function

Figure 6: Bressler et al. (2021) damage function

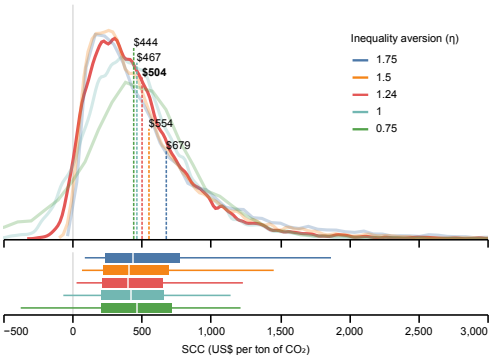
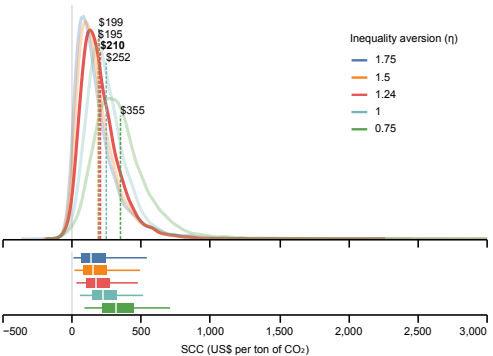


Figure 7: Cromar et al. (2022) damage function



Thank You

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A Modular Approach to the Estimation of the SCC

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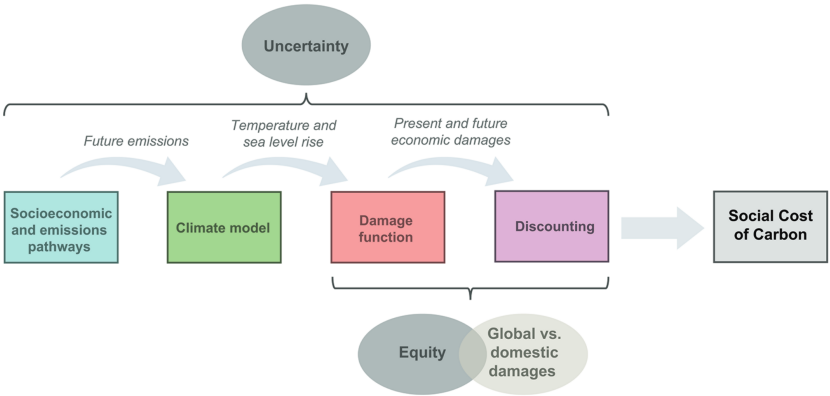
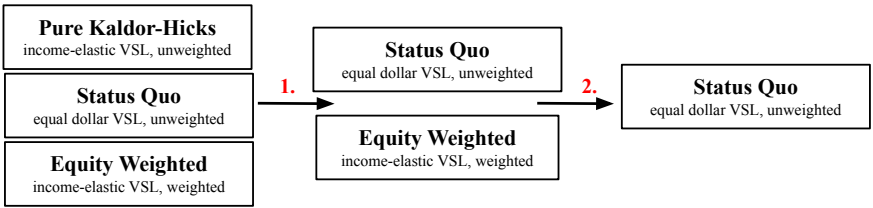


Source: Carleton and Greenstone (2022)

A defense of the status quo approach



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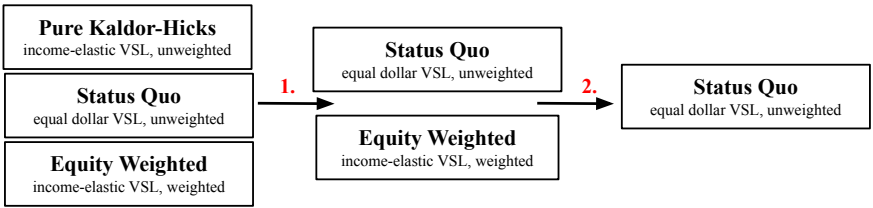

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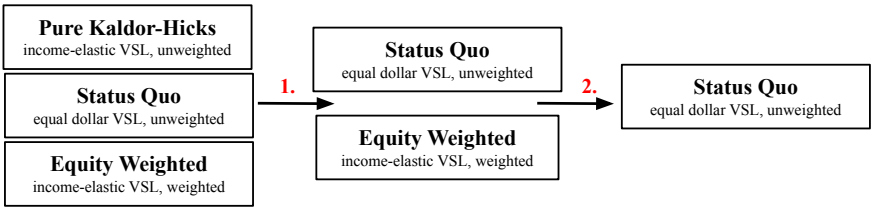

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2. Equity weighting is far more legally vulnerable

Bottom line: The status quo approach offers somewhat of a middle ground: avoids the expressive consequences associated with different-dollar VSLs without necessitating an overhaul of the process of estimating the social cost of carbon.