



Federal Interagency Estimates of the Social Cost of Carbon

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Outline

- Background
- Overview of 2009-2010 Interagency SCC Process
- Updated SCC values (NEW!)
- Discussion

Background

What is the Social Cost of Carbon?

- The SCC is the monetized value of future worldwide economic damages associated with a one-ton increase in CO₂ emissions in a particular year discounted to the present.
 - This is identical to the avoided damages associated with a one-ton decrease.
- It is intended to be a comprehensive measure of climate change damages, including (but not limited to):
 - changes in net agricultural productivity
 - net energy demand
 - human health
 - property damages from increased flood risk
 - the value of ecosystem services
- The SCC is not the price on carbon implied by a GHG abatement policy such as cap-and-trade



How is the SCC Used to Evaluate the Effects of Domestic Regulation?

- Executive Order 12866 directs agencies “to assess both the costs and benefits of the intended regulation....”
 - The SCC is an estimate of the benefits of reducing emissions of CO₂, which allows those benefits to be considered in benefit-cost analysis.
 - Without a SCC, the benefit to society of reducing CO₂ emissions would be treated as zero – effectively ignoring climate change damages
- The 2009–2010 interagency process was the first effort to promote consistency in the SCC values used by federal agencies
 - Prior to 2008, reductions CO₂ emissions impacts were not valued
 - From 2008 to 2009, SCC estimates varied substantially among agencies
 - The 2010 Interagency SCC values have been used in 17+ regulations to date (EPA, DOT, DOE)



Overview of 2009-2010 Interagency SCC Process

SCC Interagency Working Group



- Leads: CEA and OMB
- Other EOP: CEQ, NEC, OECC, OSTP



- Actively participating departments and agencies:
 - EPA
 - DOT
 - DOE
 - Treasury
 - USDA
 - Commerce



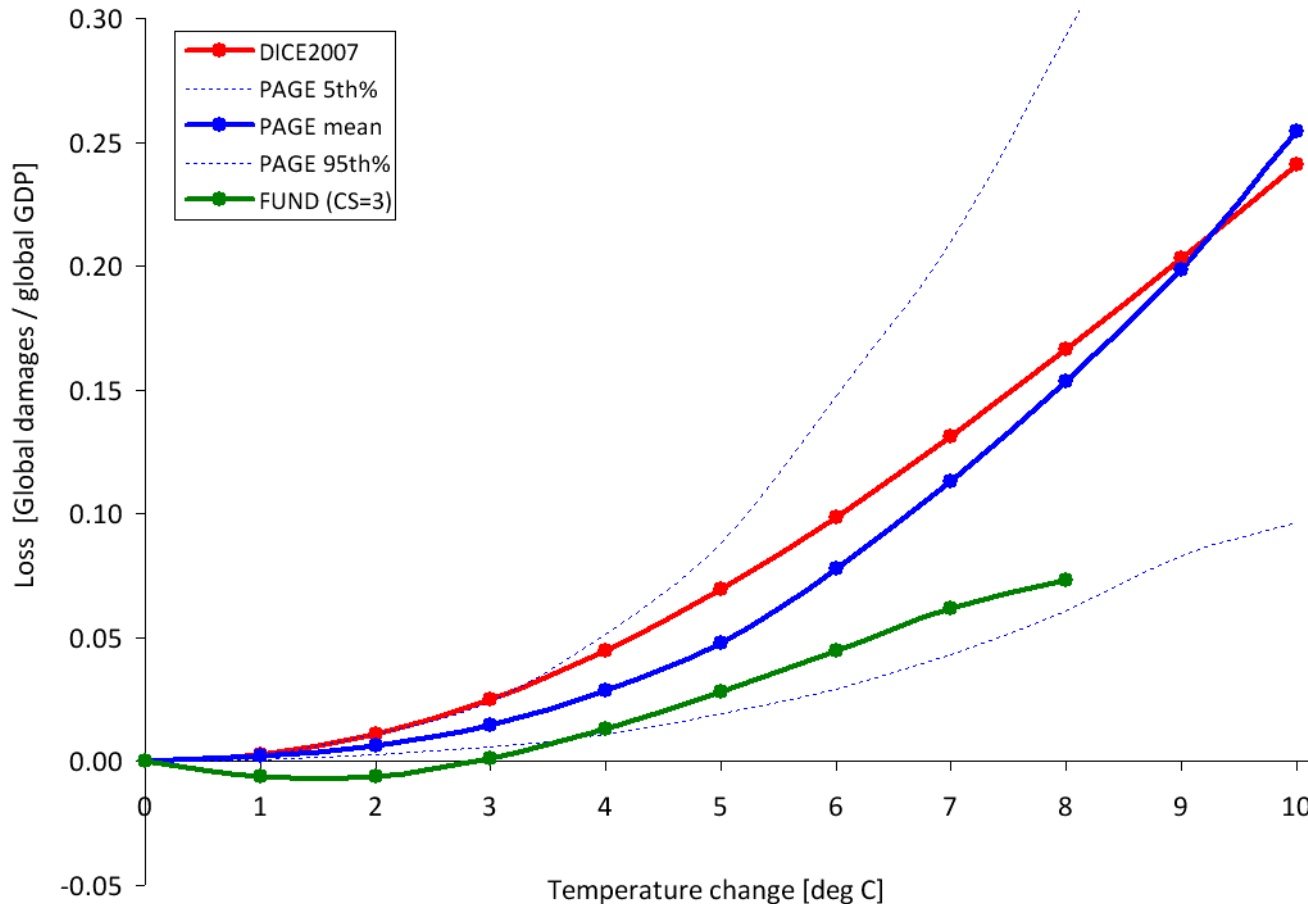
Overview of SCC Analytic Process

- Used 3 “integrated assessment models” (IAMs) that combine climate processes, economic growth, and feedbacks between the two in a single modeling framework
 - PAGE, DICE, and FUND models, each given equal weight
 - IAMs are highly simplified representations of the potential economic damages from climate change and limited by the current state of research
 - Despite their inherent uncertainties and limitations, they are the best tools currently available for estimating the SCC
- Used a common set of assumptions for reference socioeconomic and emissions trajectories, climate sensitivity, and discount rates in each model
- Other features of the IAMs were left unchanged, relying on the model developers’ own best estimates

Illustrative Climate Damages in 2100*



Annual Consumption Loss as a Fraction of Global GDP in 2100 Due to an Increase in Annual Global Temperature in the DICE, FUND, and PAGE models



*Based on modelers default inputs. For general illustrative purposes only. Values are model run specific. See 2010 TSD for discussion.

For Each Model, the Steps for Calculating the SCC are:



1. Input the path of emissions, GDP, population and calculate the resulting path of temperature effects and per capita consumption in each year.
2. Add an additional unit of carbon emissions in year t and recalculate the paths of temperature and per capita consumption in all years beyond t resulting from this adjusted path of emissions.
3. Compute the marginal damages in each year as the difference between the per capita consumption computed in step 1 from those in step 2.
4. Discount the resulting path of marginal damages back to the year of emissions using the agreed upon fixed discount rates and calculate the SCC as the net present value of the discounted path of marginal damages.

Putting It All Together

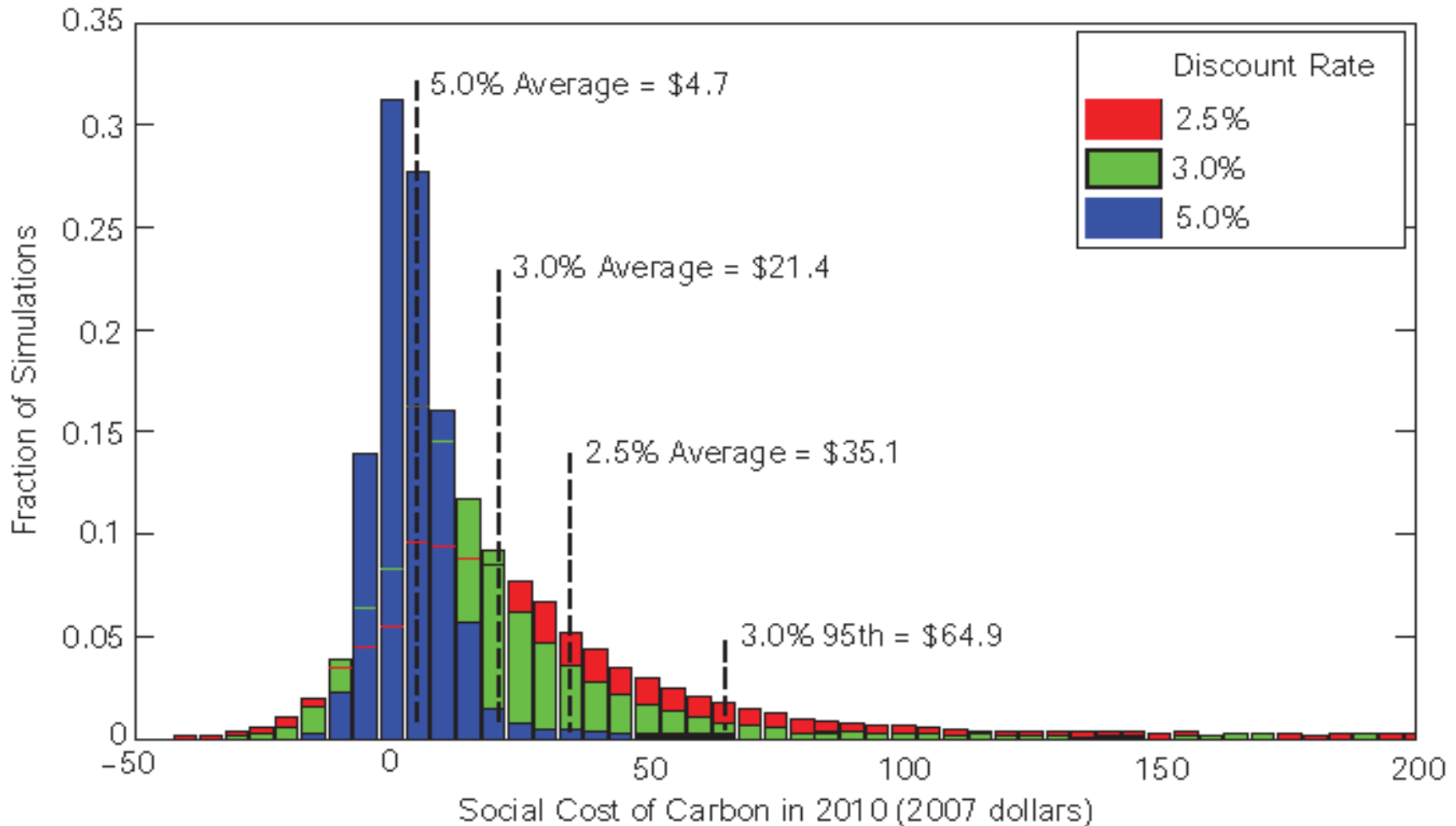


- The model runs produced 45 separate SCC distributions for a given year
 - (3 models) x (5 socioeconomic scenarios) x (1 climate sensitivity distribution) x (3 discount rates)
- The distributions from each model and scenario were equally weighted and combined to produce three separate probability distributions for SCC in a given emissions year, one for each of the three discount rates.
- From the 3 distributions, the interagency group selected 4 values:
 - The average SCC at each discount rate: 2.5%, 3%, and 5%
 - The 95th percentile at a 3% discount rate, representing higher than expected economic impacts further out in the tails of the distribution.

Interagency SCC Estimates (2010 TSD)



Distribution of 2010 Social Cost of Carbon Values at Each Discount Rate



Discussion

- Higher discount rates result in lower SCC values, and vice versa
- There are clear differences in the SCC estimated across the three main models
 - FUND produces the lowest estimates
 - PAGE produces the highest estimates
- Results match up fairly well with estimates in the existing literature
- However, any SCC estimate must be taken as provisional and subject to further refinement in accordance with evolving scientific, economic, and ethical understandings.
 - Limitations of the analysis include, e.g., incomplete treatment of non-catastrophic and “catastrophic” damages, uncertainty in extrapolation of damages to high temperatures, incomplete treatment of adaptation, technological change, and inter-sectoral and inter-regional interactions.

Updated SCC Values

Why Were the SCC Values Updated?



- Executive Order 13563 declares that our regulatory system must be based on “the best available science.”
 - Most models that EPA and other agencies rely on are updated regularly (often annually) as new information becomes available.
 - Current SCC estimates are based on model versions that were developed up to 10 years ago in a rapidly evolving field.
 - Significantly updated models are available that correct some shortcomings in earlier versions, especially in treatment of sea level rise.
- The 2010 interagency report committed to an update “within 2 years” and when “substantially updated models become available.”
- A technical update based only on updated versions of the models allows for significant improvements while science progresses on other aspects of the models.

New Versions of Each Model Are Available

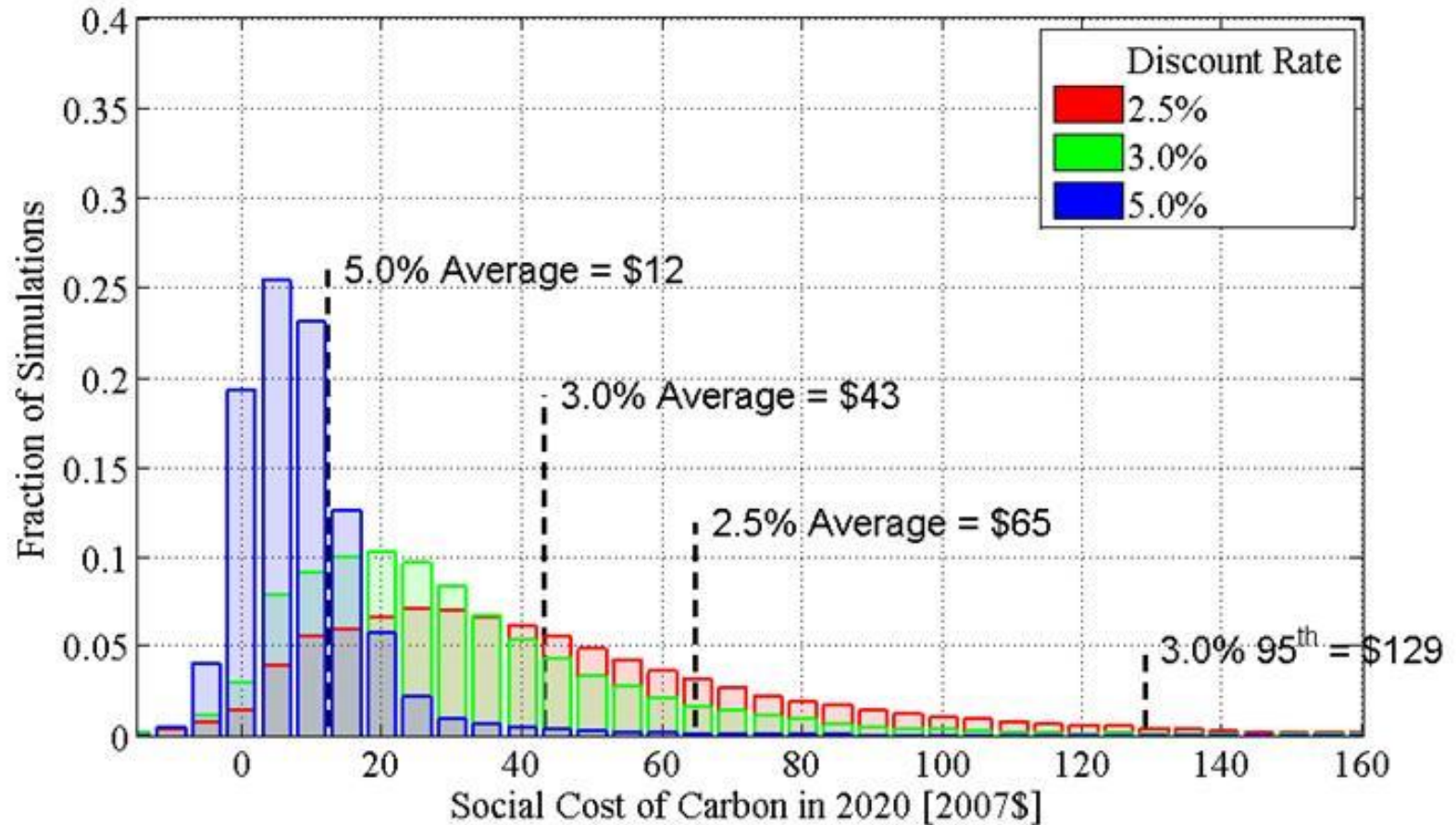


Model	2010 TSD Version	New Version	Key changes in new version
DICE	2007	2010	Updated calibration of the carbon cycle model and explicit representation of sea level rise (SLR) and associated damages.
PAGE	2002	2009	Updated adaptation assumptions, explicit representation of SLR damages, change in regional scaling of damages, revised treatment of potential abrupt damages, revisions to damage function to ensure damages do not exceed 100% of GDP.
FUND	3.5 (2009)	3.8 (2012)	Updated damage functions for SLR, agricultural impacts, and space heating, inclusion of indirect climate effects of methane, and changes to response of temperature to buildup of GHG concentrations.

Updated SCC Estimates

- For 2020, the revised SCC values are: \$12, \$43, \$65, & \$129 (2007\$).

Distribution of SCC Estimates for 2020 (2007\$/ton CO₂)



Updated SCC Estimates, 2010-2050



- As before, the values increase over time, as determined within each model, because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change.

Revised Social Cost of CO₂ (2007\$/ton), based on year of emission reductions

Discount Rate	5.0%	3.0%	2.5%	3.0%
Year	Avg	Avg	Avg	95th
2010	11	33	52	90
2015	12	38	58	109
2020	12	43	65	129
2025	14	48	70	144
2030	16	52	76	159
2035	19	57	81	176
2040	21	62	87	192
2045	24	66	92	206
2050	27	71	98	221

SCC Estimates Remain Conservative in a Number of Regards



For example,

- SCC estimates do not include damages from ocean acidification
- Damages from most large scale earth system feedback effects (e.g., Arctic sea ice loss, melting permafrost, large scale forest dieback, changing ocean circulation patterns) are not included at all in one model, and at best imperfectly captured in others.
- Many categories of direct impacts remain incomplete and rely on science lagging behind the most recent research (e.g., agriculture).
- A number of potentially significant damage categories remain exceedingly difficult to monetize (e.g., species and wildlife loss).

Discussion

- The SCC provides a measure of the marginal damage from CO₂ emissions – and thus the *marginal benefit of abatement*
 - As such it could be used, e.g., to monetize the climate benefits of a power plan scenario that reduces CO₂ emissions.
- The SCC is not the carbon price derived from various policies (e.g., cap-and-trade program)
 - The carbon price associated with a policy that specifies an environmental target provides a measure of the *marginal cost of abatement*.
 - This is useful in evaluating policy cost-effectiveness.
 - Economists would regard a policy as “economically efficient” if the emissions target is set to that the marginal cost of abatement is equal to the marginal benefit of abatement (i.e., the true value of the SCC).

References

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