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The Development and Use of the Social Cost of Carbon

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Outline

- Understanding the SCC
- Estimating the SCC
- History of the SCC in US regulatory analysis
- Communication of the SCC
- Research to improve the SCC

Understanding the Social Cost of Carbon

- What *is* the SCC?
  - SCC is an estimate of the damages of a marginal increase in CO_2 emissions (avoided damages = benefits)
    - It is the net present value of the monetized damages due to a *one-tonne increase* in CO_2 emissions in a specific year
    - SCC reflects consumption damages
- What is the SCC *not*?
  - The SCC is *not* the price of carbon required to achieve any specific greenhouse gas mitigation policy
  - The SCC does not necessarily represent the value at which the costs of a climate change mitigation policy equal the benefits
    - It is a *marginal* value off a business as usual emissions pathway
    - Benefits due to large changes in emissions may not scale linearly
  - The SCC does not represent the change in utility due to changes in CO_2 emissions

Understanding the Social Cost of Carbon

- Ideally a comprehensive measure of climate change damages
  - Specification of damage functions vary across models, but typically include:
    - Changes in net agricultural productivity
    - Net energy demand
    - Mortality due to heat, cold, disease
    - Property damages sea level rise and tropical storms
    - Value of ecosystems
    - Risk of catastrophic impacts
    - Some types of adaptation
  - Net damages generally do not include:
    - Indirect effects (e.g. impacts of ozone due to CH_4 emissions on agriculture and human health)
    - Drought and flooding
    - Ocean acidification
    - Lost labor productivity
    - Utility losses
- Challenges to estimation of damage functions
  - Extrapolation of damage estimates to high levels of warming
  - Inter-sectoral and inter-regional interactions
  - Potential climate tipping points
  - Cost and effectiveness of adaptation

Estimating the SCC

- Basic methodology
  - Calculate the temperature effects and consumption under a business as usual socio-economic and emissions pathway over a given time horizon
  - Repeat this calculation under a carbon dioxide “shock” scenario—baseline emissions plus additional unit of carbon dioxide in year *t*
  - Compute the marginal damages in each year as the difference between the per capita consumption in the baseline and emissions “shock” scenarios
  - Calculate the net present value (discounted to the year of emission) of future damages from the marginal shock of carbon dioxide
- Estimates of the SCC are very sensitive to a number of parameters
  - Future socio-economic and emissions scenario
  - Climate response
  - Specification of damage functions
  - Spatial and temporal scope
  - Discount rate

History of the SCC in US regulatory analyses

- EPA and other federal agencies use SCC to estimate benefits of CO_2 reductions from rulemakings
  - Executive Order 12866 directs agencies "to assess both the costs and benefits of the intended regulation…."
    - Ninth Circuit Court (2007): Omission of a valuation on changes in CO_2 emissions from the cost-benefit analysis implicitly treats the value as zero
  - Created a need for a metric to incorporate the value of changes in CO_2 emissions
    - The SCC is an estimate of the benefits of reducing emissions of CO_2, enabling the benefits to be considered in benefit-cost analyses
- An interagency working group convened in 2009 to promote consistency in the SCC values used by federal agencies
  - Prior to 2008: Changes in CO_2 emissions were not valued in RIAs
  - 2008-2009: SCC estimates varied across agencies
  - 2009: Interim government-wide SCC values, based on existing literature, developed
  - 2009-2010: An interagency working group developed new estimates of the SCC (used in 17+ rules to date)
  - 2013: Updated SCC values

History of the SCC in US regulatory analyses

- 2009-2010 Interagency working group SCC methodology
  - Global value
  - DICE, FUND, and PAGE
    - Each model given equal weight
    - Monte Carlo analysis with 10,000 runs for each scenario to capture uncertainties
  - Common assumptions across all models
    - Five socio-economic and emissions scenarios given equal weight (IMAGE, MERGE, MESSAGE, and MiniCAM EMF 22 reference scenarios plus the average of the four models' 550 CO_2e)
    - Distribution over climate sensitivity based on Roe and Baker (2007)
    - Discount rates of 2.5%, 3.0%, and 5.0%

Current US SCC estimates:

Social Cost of CO_2, 2015-2050 [a] (in 2011 Dollars)

Year	Discount Rate and Statistic			
	5% Average	3% Average	2.5% Average	3% 95th percentile
2015	$12	$39	$61	$116
2020	$13	$46	$68	$137
2025	$15	$50	$74	$153
2030	$17	$55	$80	$170
2035	$20	$60	$85	$187
2040	$22	$65	$92	$204
2045	$26	$70	$98	$220
2050	$28	$76	$104	$235

[a] The SCC values are dollar-year and emissions-year specific.
http://www.epa.gov/climatechange/EPAactivities/economics/scc.

Communication of the SCC

- Communicating what the SCC is designed to be, how it is developed, and the challenges of estimation can be very challenging
- Purpose of the SCC
  - Intended for regulatory analysis – marginal nature of the estimate
  - Not designed to be used to estimate the benefits of
- Large range in estimates resulting from many types of uncertainty: scenarios, climate, damages, discounting
- Reflecting these uncertainties in the USG SCC estimate
  - Models, damages, and scenarios
    - Without objective evidence to prefer one SCC model, or one reference socioeconomic and emissions scenario, over another
    - Treated as equally likely
  - Climate sensitivity
    - Peer reviewed estimates provide PDFs for climate sensitivity
    - Appropriate to weight different levels of CS
  - Discounting
    - A social discount rate reflects societal preferences about damages to future generations
    - Multiple rates (2.5%, 3.0%, and 5.0%) reflect different preferences and are presented separately
  - Shape of the distribution (long tails)
    - SCC estimates have long-tailed distributions
    - Limited presentation of this (only the 95th percentile estimate at a 3% discount rate)
    - Risk neutral treatment

Research to Improve the SCC

- Appropriate scale for SCC estimation
  - SCC models have a need for simplicity
    - Regional disaggregation ~ 8-14 regions
    - Global average temperature change
  - Damage estimates could be improved through the use of regional temperature and the inclusion of precipitation changes
  - Design and scale of SCC models is unlikely to be useful for adaptation decision-making
- Sharing information across research communities
  - Need for increased communication between communities to understand the needs of each and how best to share information
    - Joint workshops can improve communication between research communities
    - Relatively few workshops of this nature (EPA & DOE; NBER)
  - Incorporation of the impacts of catastrophic/extreme events into SCC models requires estimates of these from the IAV literature
    - Some models currently include some representation of catastrophic damages
  - Joint workshops can improve communication between research communities