ENVIRONMENTAL ECONOMICS

Using and improving the social cost of carbon

Regular, institutionalized updating and review are essential

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The social cost of carbon (SCC) is a crucial tool for economic analysis of climate policies. The SCC estimates the dollar value of reduced climate change damages associated with a one-metric-ton reduction in carbon dioxide (CO_2) emissions. Although the conceptual basis, challenges, and merits of the SCC are well established, its use in government cost-benefit analysis (CBA) is relatively new. In light of challenges in constructing the SCC, its newness in government regulation, and the importance of updating, we propose an institutional process for regular SCC review and revision when used in government policy-making and suggest how scientists might contribute to improved SCC estimates.

POLICY

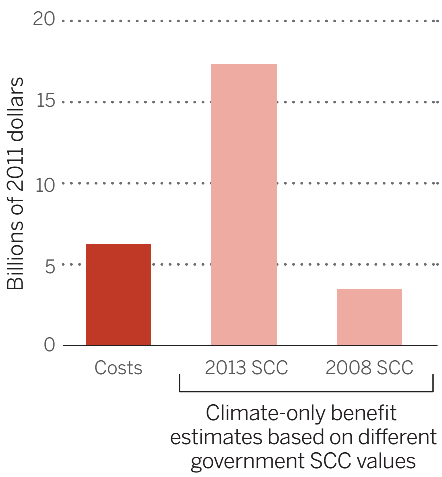
Although regulations issued by U.S. federal agencies have been subject to CBA for four decades, those analyses largely ignored economic benefits of carbon reduction until a federal court held in 2008 that carbon emission reductions have nonzero value. After a brief period during which different U.S. agencies used different SCC numbers, an interagency working group established a single set of government-wide values in 2009 and 2010, with an update in 2013 (*1*).

Such updates arise because the science, impact estimates, and socioeconomic models used to develop the SCC continue to evolve, as do expert opinions about how it should be synthesized. The results for CBA are consequential (see the graph). Using the most recent central value of interagency SCC estimates, a proposed U.S. rule on emissions from existing power plants would pass a CBA on climate benefits alone (*2*); using the central value SCC from a single agency in 2008 (*3*), it would not.

Estimating the SCC in a particular year, say 2015, involves four steps: (i) projecting a future path of global greenhouse gas (GHG) emissions; (ii) translating this emissions path, along with an alternative that adds 1 ton in 2015, into alternate scenarios of climate change; (iii) estimating physical impacts of these climate changes on humans and ecosystems; and (iv) monetizing these impacts and discounting future monetary damages back to 2015. The SCC is the difference in damage valuations with and without the extra ton of CO_2 in 2015.

Integrated assessment models [IAMs; e.g., DICE (*4*), FUND (*5*), and PAGE (*6*)], perform all four steps. Underlying step (i) are assumptions about future climate change policies and their effects on GHG emissions and about population, GDP growth, and technology. In step (ii), a simplified representation of the climate system translates emissions to metrics of climate change (e.g., change in global average temperature). Steps (iii) and (iv) require a damage function that relates climate change metrics to climate impacts and to valuations. Valuation of impacts often aggregates and/or extrapolates detailed climate impact studies and relies on population and economic assumptions from step (i) to project the level of human and economic activity exposed to these impacts in the future.

Costs and benefits of emissions reductions



Benefits of regulations vary. Estimated costs and climate change benefits of emission reductions in 2020 from proposed U.S. power plant regulations using 2008 (*3*) and 2013 (*2*) government SCC estimates. Estimates from table 18 in (*2*) using a 3% discount rate averaged over state and regional approaches. SCC estimate from table V-3 in (*3*), rising 2.4% per year to $8.67 in 2020, multiplied by avoided emissions estimates averaged over state and regional approaches from table 10 in (*2*), and inflation adjusted using the implicit GDP price index from the U.S. Bureau of Economic Analysis.

DIFFICULT CHOICES. Constructing an SCC for government CBA requires specific choices, beginning with the selection of which IAMs to include. Models vary in terms of breadth of use, degree of public access and available peer review, and incorporation of latest scientific results. New IAMs may emerge. How should a government select among models? Should selection evolve over time? Should models be weighted? If so, how?

Next, one must choose what, if any, assumptions to harmonize across models. Such assumptions may be important for consistency between the SCC and other elements of a government CBA, to reflect important uncertainties, or to address possibly outdated assumptions.

This harmonization requires more tough choices. For example, the SCC will measure incremental policy benefits relative to a baseline or range of baselines, which must be explicitly selected. One must decide whether emissions are forecast on the basis of an ambitious climate policy (such as the scenario in which polluters are already forced to pay the estimated SCC), a scenario where only policies already on the books remain in place, or something in between.

There are also credible differences on analytic and ethical grounds regarding the appropriate discount rate. Previous government guidance for CBA suggested discount rates of 3 and 7% for most projects, with possibly lower rates for phenomena (like climate change) with important intergenerational effects (*7*). Such differences have enormous implications; federal SCC estimates tripled as the discount rate changes from 5 to 3% (*1*). For practical CBA, it is important to have distinct SCC estimates for different discount rates that can be paired with cost estimates based on a particular discount rate(s).

Each IAM will have its own internal discount rate determined by model parameters and socioeconomic forecasts. Low discount rates typically follow from low economic growth (*8*), and economic growth is tied to climate impacts. Given this connection, how problematic is it to impose a discount rate in the SCC that is different from the rate used within the IAM itself?

Should socioeconomic scenarios in the IAM be made consistent with the selected SCC discount rate, or vice-versa?

Finally, one must choose how much weight to give to climate change impacts outside the jurisdiction considering the SCC. In the United States, some have questioned the legality of using global SCC estimates (*9*). Unless a relevant statute clearly requires otherwise, the President and agencies have latitude to choose between domestic and global SCC values for regulatory analysis [including the authority to interpret silent or ambiguous statutes under the Chevron doctrine (*10*)]. Key U.S. statutes (e.g., Clean Air Act and National Environmental Policy Act) refer to global impacts in some sections and do not preclude a Presidential judgment that U.S. interests are best served via a global SCC.

Traditionally, regulatory CBA has used domestic impacts. However, unlike virtually all other regulated pollutants and risks, GHG emissions are overwhelmingly a problem of the global commons. A global SCC, used worldwide to determine policy, would maximize global net benefits. U.S. emissions cause the bulk of their damages beyond U.S. borders, and U.S. damages will largely depend on mitigation choices in other countries where emissions are larger and growing (*11*).

Beyond the moral, ethical, and security issues this raises, there is a strategic foreign relations question. The United States is engaged in international negotiations in which U.S. emission reductions are part of a deal for abatement by other countries. Benefits to each country are determined by the global effort. Even if the U.S. government cares only about domestic impacts, this potential to leverage foreign mitigation supports a domestic SCC estimate augmented by the expected foreign leverage. Our view is that these are compelling reasons to focus on a global SCC but, more important, to make a strategic choice and to conduct periodic review.

A PROCESS TO UPDATE THE SCC. Current U.S. government practice is vague regarding when and how a process of reviewing and updating the SCC might occur, which makes it difficult for stakeholders and researchers to anticipate future reviews and to plan for useful engagement in the process. A regularized and institutionalized process would allow both groups to align their activities more sensibly.

We see four components to an improved institutional process. First, revisions to the SCC should follow a regular schedule. A 5-year cycle would balance the need to respond to evolving research with the need for a thorough process.

Second, SCC revisions should continue to be an interagency process, led by an appropriate group within the Executive Office of the President. This emphasizes the need for consistent values across the whole of government and allows the process to draw on expertise from multiple agencies, as well as reflecting the strategic considerations noted above. The process should include public notice and comment.

"Current U.S. ... practice is vague regarding when and how ... reviewing and updating the SCC might occur."

Third, government SCC estimates should be regularly reviewed by the National Academy of Science's National Research Council (NRC). This would enhance the scientific credibility of the SCC and provide an avenue for experts to suggest changes for the next iteration. Such review could begin with the current estimates.

Finally, the entire process should be institutionalized through an executive order or an Office of Management and Budget (OMB) memorandum or circular. This would communicate the aforementioned components and achieve reasonably stable expectations about future practice. Moreover, a regular procedure with high-quality external review would help reduce any potential politicization of the SCC.

A regularized process for updating the SCC allows researchers to direct efforts toward policy-relevant issues. First, there is research on socioeconomic and emissions scenarios, climate science, and physical impacts, which are necessary inputs to IAMs and SCC estimates. Second, there is translation of physical impacts into human and ecosystem consequences, monetization of those consequences, and synthesis of this information into a consistent modeling framework to estimate the SCC. We believe there are especially appealing opportunities in the second area, which has not been as strongly supported as the physical science research.

Currently, estimates of human and ecosystem consequences of climate change, particularly in less-studied regions and impact categories, come from a small number of studies. Recent work suggests that temperature change may have different—and larger—impacts in poorer countries (*12*). Estimating damage from extreme climate change is a research area with particularly high value (*13*). Increased efforts to synthesize such studies for use in IAMs can facilitate their incorporation into SCC estimates.

SCC estimates could be improved by increasing opportunities for peer review of IAM development. This could be through model intercomparison projects focused specifically on the SCC, special journal issues to compare sector-by-sector impact valuations, and the NRC review process proposed earlier. This will require redirection of research time and funding, adjustments more easily planned in conjunction with a regularized updating schedule.

As the world makes progress in GHG mitigation, governments will need decision-making processes and information tools that reflect important trade-offs. That requires a regularized, transparent, and credible process that ensures that the SCC is reliable, well-supported, and up to date.

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