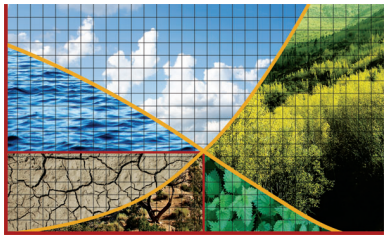
Harvard Environmental Economics Program



Harvard Project on Climate Agreements

Summary of Discussion Paper 68

JULY 2015

THE ROLE OF INTEGRATED ASSESSMENT MODELS IN CLIMATE POLICY: A USER'S GUIDE AND ASSESSMENT

Authors:

Gilbert Metcalf, Tufts University
James Stock, Harvard University

Overview

Emitting carbon dioxide (CO_2)—and other greenhouse gases—imposes a cost on society because it contributes to damages from climate change. This "social cost" is also known as an "externality," in that the emitter does not bear this cost. The "Social Cost of Carbon" (SCC), then, is the "marginal monetized externality value" of damages from CO_2 emissions, where "marginal" refers to the next incremental unit of emissions. As damages from climate change become more evident, it becomes increasingly useful in formulating public policy (especially in connection with attendant benefit-cost analysis of that policy) to employ an SCC—that is, a numerical, non-zero value for climate damages. This paper examines the process in the U.S. government of specifying an SCC.

Background

The SCC has usually been estimated using integrated assessment models (IAMs). IAMs combine models of the economy, atmosphere, ocean, and other social and physical systems to examine how changes in geophysical variables affect economic variables. In this case, IAMs are used to study the relationships among CO_2 emissions, CO_2 concentrations in the atmosphere, global average surface temperature, and economic variables, notably per capita consumption and GDP. By estimating the impact of changes in CO_2 emissions on consumption, IAMs allow economists to specify an SCC. Because of scientific uncertainty about climate change and its impacts (that is, the inputs to the models), however, there is significant uncertainty in the results generated by IAMs. This uncertainty has led observers to ask whether alternative approaches to estimating the SCC might be preferable to IAMs.

The authors attempt to answer this question by proposing five criteria by which an SCC-estimation method might be evaluated—that it: (i) is based on the best available science and accompanied by quantified measures reflecting the uncertainty in the existing science, (ii) is derived in a transparent and readily understandable manner, (iii) is subject to expert review and updated regularly, (iv) provides guidance to researchers on key sensitivities of the SCC to identified variables, and on areas where future research would be most productive for improving SCC estimates, and (v) is not viewed (especially by the courts that will review challenges to a public policy using an SCC) as "arbitrary and capricious" or politically motivated.

The authors evaluate five alternative approaches to IAMs (for example, expert judgment) and find that IAMs are the best currently available tool for specifying an SCC. Each alternative fails to meet several of the five criteria listed above.

Key Findings

1. **IAMs have helped focus the attention of researchers on four key areas of scientific uncertainty that drive many of the results in SCC calculations: climate sensitivity, damage functions, treatment of catastrophic events, and the discount rate.** Equilibrium climate sensitivity is the change in global average temperature that results from a specified increase in CO_2 concentrations. The damage function relates changes in surface temperature to changes in per capita consumption. IAM-generated SCCs do not currently include the monetary impact of catastrophic events (such as the rapid melting of ice sheets); there are significant methodological as well as scientific issues to be resolved before they can. Finally, the choice of discount rate strongly affects how damages that occur in the future are converted into a dollar value today.

2. **Uncertainties in each of these four parameters are unlikely to be resolved in the near future.** While much progress has been made in better understanding damages from climate change, much work remains to be done. Meanwhile, research progress in other areas has been slow. For example, 35 years of research have failed to substantially reduce the uncertainty in climate-sensitivity estimates. Disagreements over the appropriate discount rate, on the other hand, often reflect differences in values that cannot be resolved with more research.

3. **Persistent uncertainty in key parameters argues for continued use of IAMs, when compared with alternative approaches.** For the most part, uncertainty about climate sensitivity, damage functions, and catastrophic events is a feature of the current scientific understanding of climate change—not a function of IAMs. In the meantime, IAMs are helpful at identifying where uncertainty exists and characterizing and quantifying certain types of uncertainty, relative to alternative approaches.

4. **There is room for improvement in the U.S. government's approach to estimating the SCC.** The process currently used by federal agencies (considered more broadly than the technical performance of IAMs) does well by most of authors' five criteria. However, this method should be updated on a regular schedule, should be subject to expert review, and should be codified through an Office of Management and Budget (OMB) circular or memo that coordinates the expert review process with the updating exercise.

Conclusions

A numeric, non-zero value for the SCC is necessary to evaluate policy to address climate change and in areas affected by climate change. The evolving nature of the science and the ultimate goal of informing first-best policy suggests that the official SCC—the SCC used for regulatory analysis by the U.S. Government—should not be thought of as a single number or even a range of numbers, but more broadly as a process that yields updated estimates of those numbers and ranges. Viewed in this way, the ultimate goal of the process is scientific credibility, public acceptance, and political and legal viability.

Full paper available at: http://belfercenter.ksg.harvard.edu/publication/25132

About the Project

Established in 2007, the goal of the Harvard Project on Climate Agreements is to help identify and advance scientifically sound, economically rational, and politically pragmatic public policy options for addressing global climate change. Drawing upon leading thinkers in Argentina, Australia, China, Europe, India, Japan, and the United States, the Project conducts research on policy architecture, key design elements, and institutional dimensions of international and domestic climate policy.

HEEP: http://heep.hks.harvard.edu

HPCA: www.belfercenter.org/climate