Agricultural and Resource Economics
ARE UPDATE

Giannini Foundation of Agricultural Economics, University of California Vol. 22, No. 2 Nov/Dec 2018

ALSO IN THIS ISSUE

The New Social Cost of Carbon

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The Social Cost of Carbon is a dollar figure, which measures the damage caused from one more ton of the greenhouse gas CO_2 emitted. The federal government uses this number in benefit cost analysis to evaluate new regulations. The current administration has dropped this number from $42 to a range of $1–$7. This has significant consequences for environmental policy.

Economics has been influential in the policy arena over the past century, but maybe our biggest impact has been through the insertion of benefit cost analysis into the regulatory process. When the federal government designs new policies, or contemplates the tightening or loosening of existing regulations, the implementing agencies are required to compare the benefits of the policy (change) to its cost.

This is often not straightforward to do, as putting a number on the benefits of, say, better air quality, requires knowledge of how many fewer people die from bad air, changes in soil acidity and consequential agricultural production, changes in the acidity of lakes for recreational fishing, and what the dollar value of these changes is.

On the cost side, the regulator needs to learn how much it would cost firms, who have no incentive to truthfully report this number, to reduce their emissions of air pollutants. But over the years, the government, with the help of academics, has established a number of guidelines to help us come up with estimates of costs and benefits in all types of settings.

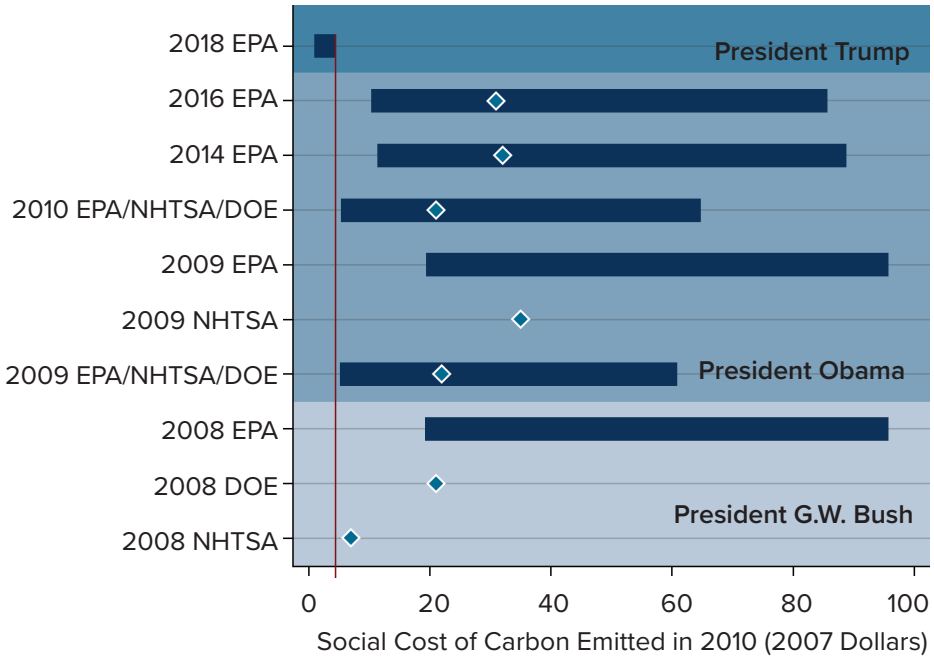
Climate change historically posed one of the toughest challenges in benefit cost analysis due to the scale of time, space and economic sectors involved. First off, carbon dioxide, the main greenhouse gas, once emitted, affects the global climate for hundreds of years. Projected changes will include changed temperature, precipitation and cloud patterns, sea-level rise, as well as the increased intensity and possibly frequency of extreme events worldwide. Second, each ton of CO_2 emitted (roughly what your car emits if you drove it from San Francisco to Chicago) will cause changes in climate everywhere on earth, hence the origin of emissions does not matter. Finally, the number of economic sectors affected by the changed climate is significant.

Extreme heat has been shown to lead to higher mortality, lower crop yields, higher electricity consumption, and increased conflict to name but a few. Hence, if you want to calculate the benefits from reducing emissions of CO_2 by one ton, you would have to calculate the damages this ton would cause over the next 300 or so years. Globally. For all economic sectors. This number is called the Social Cost of Carbon (SCC) and it is hard to calculate.

What Is the Social Cost of Carbon and How Do You Calculate It?

In order to calculate the SCC, economists have employed so called Integrated Assessment Models, which integrate simple models of the economic and climate system. These models start with assumptions about the evolution of global, and in some cases regional, income and population over the next 300 years. The models then translate economic activity into emissions of greenhouse gases (GHG), most notably CO_2, but in some cases other GHG such as methane.

Figure 1. Sample of SCC Estimates Used in Federal Rulemakings for Three Administrations



Notes:
The blue diamond indicates the "central estimate."
The blue bars indicate selected upper and lower bounds used in regulatory analyses.
Measured in 2007 dollars for a ton of emissions in 2010.
NHTSA—National Highway and Traffic Safety Administration; IWG—Interagency Working Group; EPA—Environmental Protection Agency; DOE—Department of Energy.

Source: Auffhammer (2018)

These 300-year time paths of emissions are then fed into a climate model, which translates emissions into surface temperature, precipitation, and sea level rise. These outputs are then fed to a set of so-called damage functions, which map the emissions path into economic damages.

In order to calculate the effect higher emissions have on outcomes of interest across the many sectors of the economy, the Integrated Assessment Model is run with and without one additional ton of CO_2. The difference in damages relative to the baseline path represents the damages from that one ton for each year over the next 300 years. The stream of damages is then discounted into a present value, as future dollars are worth less than current dollars. This dollar amount is called the Social Cost of Carbon and is measured in US$.

This number represents the damages caused globally over time by one additional ton of CO_2 emissions. The SCC is higher for emissions made later in time, as they are generally understood to be more damaging due to the elevated stock of greenhouse gases in the atmosphere, and because gross domestic product (GDP) grows over time and some damage categories are modeled as proportional to GDP.

How Do We Use the SCC and How Big Is It?

The federal government has employed the Social Cost of Carbon in rulemakings since the Bush administration in 2008. Figure 1 shows a set of values used by the three last administrations. For comparability, the graphic shows values for one ton of CO_2 emitted in the year 2010 valued in 2007 US$.

Towards the end of the Bush administration, EPA used a range of $19–$96 per ton, when it examined regulating greenhouse gas emissions under the Clean Air Act. In the early years of the Obama administration, an Interagency working group (IWG) embarked on an effort to calculate an official Social Cost of Carbon, which could be used across agencies in all federal rulemaking. The approach adopted, which is described in detail in Greenstone, Kopits, and Wolverton (2013), was to feed three integrated assessment models with a set of harmonized assumptions.

The number emerging from this effort, which has since been employed in the majority of economic studies on the external costs of climate change, was $42 per ton emitted in 2020 as measured in 2007 dollars. This means that one ton of CO_2 emitted in 2020 is thought to cause $42 of damages globally. The IWG provided detailed information on the evolution of the SCC over time and for a variety of assumptions about how much value is placed on future generations as reflected by the approach used to discount future dollars.

The New "Trumpian" SCC

Under the current administration, several policy proposals have been made in the environmental arena. The most significant is the proposed rollback of President Obama's tightened fuel efficiency standards. If you read through the thousands of pages underlying the proposed rule, you will note that the Social Cost of Carbon has been slashed from $42 to $1 or $7, suggesting a massive decrease in the damages caused by the same ton of CO_2 that was modeled by the Obama team. So how did that happen? Is CO_2 not as bad as we thought? No.

The National Highway Traffic Safety Administration (NHTSA), the agency in charge of this policy proposal, did two things to arrive at this new, lower number. First, they significantly decreased the value we place on future generations by increasing the discount rates used to between 3%–7% from the 2.5%–5% the Obama administration used.

A forthcoming paper in a top economics journal surveyed experts on the subject and they arrive at a median social discount rate of 2%. The share of experts that stated that the preferred rate is lower than 3% is 67%. Meaning two-thirds of experts on the topic surveyed think the lowest rate used by the administration is too high. By increasing the discount rate, you decrease the implied damage numbers significantly.

The much bigger change is that NHTSA is using a domestic Social Cost of Carbon. This means they used the above-mentioned integrated assessment models to calculate a number for damages occurring on U.S. soil only. There are at least three reasons why the domestic number may not be fit for rulemaking.

The economically correct number is global, as the Interagency Working Group argued, since the underlying externality (think damages imposed on humans, animals, and plants) is global. Carbon dioxide does not stop causing damages at the U.S. borders. The issue here is that if each country uses only domestic damages—which are much lower—to design its optimal regulations, each country will emit an inefficiently large amount of greenhouse gases and the world gets inefficiently hot! If the U.S. starts using a domestic number, this is likely to lead other countries to do the same, which might have a domino effect.

The simplistic way in which the domestic Social Cost of Carbon was calculated is a crude approximation and leaves out important spillover effects on the United States. For example, U.S. firms own capital and rely on suppliers located abroad. The analysis ignores this. If a climate change-fueled storm takes out all of Apple's suppliers' manufacturing facilities in China, this is free to the U.S. according to this analysis. If a heatwave affects major wheat producers outside of the U.S., this has no consequences for U.S. producers in this setting. The way the number was calculated also does not take into account national security implications and important effects on trade flows and global commodity markets.

By using a domestic SCC, the analysis places zero weight on the welfare of U.S. citizens living abroad. This includes the men and women serving in the U.S. armed forces (~450,000) abroad as well as U.S. citizens (~9,000,000) living abroad. If members of the armed forces are exposed to climate change-induced events elsewhere, according to this analysis, we do not care as a society. Also, if climate change leads to more conflict, resulting in more troop deployments, this is not accounted for.

Figure 1 shows the consequences of these modeling decisions quite clearly. The range of estimates used since the Bush and throughout the Obama administration ranged between $20 and $100. The number adopted under the Trump administration is $1–$7. Is this based on good science? The answer is no.

The non-partisan National Academies of Sciences reviewed the approach taken by the Interagency Working Group and made a set of concrete suggestions to improve how the SCC is determined. NHTSA did not implement any of these updates, although many of the suggestions have already been implemented in the peer-reviewed literature and are hence readily available. The most glaring omission is the lack of updates to the antiquated damage functions, which are mathematical functions translating changes in climate into economic damages, in the integrated assessments used to calculate the SCC.

This lack of scientific rigor used in the calculation of the SCC makes policy which increases emissions look much less damaging than it actually is. Further, the administration has disbanded the Interagency Working Group and ordered all innovation on modeling the SCC to stop.

Fortunately, there are two major research efforts underway pushing the frontier of this literature. Resources for the Future (rff.org) is working on implementing the suggestions made by the National Academies of Sciences. Another joint effort between the University of Chicago, UC Berkeley, and Rutgers University (impactlab.org) is focusing on providing cutting edge, empirically based damage functions. Initial results indicate that the SCC is likely much larger than previously thought, which does not surprise this economist.

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Suggested Citation:
Auffhammer, Maximilian."The New Social Cost of Carbon."*ARE Update* 22(2) (2018): 1–4. University of California Giannini Foundation of Agricultural Economics.

For additional information, the author recommends:

Auffhammer, Maximilian. 2018. Quantifying Economic Damages From Climate Change. *Journal of Economic Perspectives*. 32(4): 33-52

Greenstone, M., et al., 2013. Developing a Social Cost of Carbon for U.S. Regulatory Analysis: A Methodology and Interpretation. *Review of Environmental Economics and Policy*, 7(1): 23-46.

U.S. Environmental Protection Agency / Interagency Working Group. 2016. Current Technical Support Document (2016): Technical Update to the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866.