




A Policymaker's Guide to Climate Economics

Questions to Ask

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Although major U.S. scientific bodies agree that human activity is contributing to climate change, debate about how to best mitigate the environmental and economic impacts continues. Regardless of the cause, climatologists are forecasting an increase in severe weather, flooding, droughts, warmer temperatures, rising sea levels and diminishing air quality as a result of climate change.[1] The nation's ability to adapt to these changes may affect the U.S. economy for decades to come.

Climate change economics is unique; its long time scale, uncertainties and varied effects across regions and generations make it a challenge to assess costs and benefits. Economists aim to determine how much and how fast policymakers should react by estimating economic and environmental effects.

Many are concerned about the high initial costs of mitigation policies, but actual costs and benefits (avoided damages) remain uncertain. Scientific projections of temperature increases vary, as do economic determinants such as population growth and industry development. Lawmakers face diverse recommendations for climate change policies and will want to understand how different assumptions can influence the forecasts that inherently drive policy proposals.

This brief guideline describes how assumptions can dramatically influence climate change policy and outlines questions lawmakers can ask to better understand the implications of climate change mitigation modeling.

Background—Assuming the Uncertain

In October 2006, the British government released what would soon become one of the most contentious and widely discussed climate change economics studies of its kind: *The Stern Review on the Economics of Climate Change*. This 700-page report by a team of economists led by Sir Nicholas Stern presents bold arguments favoring strong, early action to mitigate climate change effects, concluding that the benefits far outweigh the costs of continuing business as usual. Without action, the *Stern Review* estimates, overall costs and risks will be equivalent to losing at least 5 percent (and up to 20 percent) of global gross domestic product (GDP) annually.[2]

Stern's historically radical estimates remain in the spotlight. While some economists support *The Stern Review,* others attest that the study is deeply flawed, claiming that the present value of climate change costs are overestimated and emissions reduction costs are underestimated.[3] Most climate scientists agree that global greenhouse gas emissions reductions are critical to avoid potentially catastrophic consequences,[4] but economists debate the pace at which, and at what costs, lawmakers should implement abatement policies.[5]

American economist William Nordhaus suggests a slow and steady change in the energy supply system. [6] Both authors make many of the same assumptions about climate change effects and parameters, yet they formulate very different policy recommendations. The difference lies in how they choose to allocate resources across time (i.e., how much money should be spent now versus later to prevent future costs resulting from climate change damages).[7] Economists place a numerical value on this choice—the "discount rate"—that is the rate of return on investing in greenhouse gas emissions reductions (discussion follows). Typically, "optimal" policies use a dynamic discount rate. They involve modest but immediate emissions

reductions followed by an increasing rate of emission reductions.[8] Differing discount rates largely account for Nordhaus' and Stern's contrasting results.

Analysts commonly use integrated assessment modeling, which incorporates knowledge from various disciplines into a single analysis to determine the best climate change policies. Optimization aims to calculate the "best" trajectory for future emission reductions based on a specific performance measure. The policy optimization framework and applicability have been heavily critiqued in the areas of discounting across generations, determining values for damages on resources that do not have a specified price (such as the environment), and proposing solutions that are based on many uncertainties.[9]

Benefits of action, in the case of climate change, are the avoided climate impacts that otherwise would have caused damages in the future. If the damages associated with a specified temperature increase are significant, then the benefits of efforts to reduce emissions will be high. On the other hand, the costs of climate change can include lost resources from a decline in agricultural crops or infrastructure damage from extreme weather.

Projections (and policy recommendations) are sensitive to uncertainties, which are accounted for by the analyst's assumptions. It is essential for policymakers to understand what lies behind these assumptions, which vary dramatically.

What Policymakers Need to Ask

Is it really an economic analysis?

It is difficult to assess options without alternatives. Consider, for example, comparing prices of an unfamiliar item such as a "widget." If a widget costs $3 in Denver, is it expensive or cheap? Without a comparison, it is not possible to make this judgment. If it costs $8 in New York City, the Denver price is cheap; if it costs only $1.50 in Seattle, however, the Denver price is expensive.

Since all economic analyses must consider alternatives, policy choices need to be assessed relative to other choices. In the case of climate change, the alternative to mitigation efforts often is to do nothing. The solution must be an economic analysis of trade-offs between abatement costs and climate damages.

An economically efficient solution to climate change minimizes total costs over time.[10]

What discount rate did the analyst choose?

If nothing is done to prevent climate warming, future generations may suffer both economically and environmentally. Using resources to take action now, however, may avoid future losses caused by warming. In other words, investing in climate change policies now can benefit future generations.[11] One of the most controversial debates in climate change economics is not about whether emissions should be cut, but how aggressively to do so.

In economics, acting now versus later is reflected in the "discount rate." This refers to the rate of return on investing in greenhouse gas emission reductions, based on the notion that emissions today may create monetary losses tomorrow. Discounting is a critical reflection of how economists assess the trade-off between current costs and long-term losses to account for how climate damages are valued over time. Mathematically, discounting is the opposite of compounding, a term that is commonly associated with interest rates.[12]

Economists choose various discount rates, since observed market interest rates reflect private rates of return and do not account for the benefits to society of mitigating potential warming effects. Complications arise when taking into consideration such factors as wealthier future generations that may place higher value on the environment than today's generation. In addition, technology advancements may decrease mitigation costs and better reduce greenhouse gas emissions.

Generally, economists calculate environmental policy returns with declining discount rates because of the unknown risk of future events. A larger discount rate gives greater weight to present benefits. As a result, lower benefits may be attributed to climate policy, since future climate damages are discounted more heavily.[13]

The lower the discount rate, the higher the calculated benefits of climate mitigation policy. Studies that use lower discount rates generally justify investing in greater greenhouse gas reduction efforts.

For example, the *Stern Review* used an historically low 0.1 percent discount rate, concluding that 1 percent of global gross domestic product should immediately be invested to reduce the effects of global warming.[14] This

recommended investment, which is much higher than most earlier estimates, has drawn considerable attention. Other credited economists use initial rates as high as 3 percent,[15] which give less weight to the welfare of future generations. Nordhaus concludes that preventative measures are necessary, but the recommendations are not as extreme as Stern's.[16] Others, such as Thomas Sterner and U. Martin Persson, justify the *Stern Review*'s conclusions even if a low discount rate is not used.[17]

What time horizon did the analyst choose?

Climate change is a long-term problem, but uncertainty exists as to exactly how long. When choosing to discount, the length of time economists assume it will take to feel the effects of global warming is a significant factor. An event can have vastly different present value impacts, depending upon how many years into the future the economist considers, and the longer the time, the greater the uncertainty.

Long time horizons furnish results that are sensitive to the discount rate; the longer the time horizon, the more the discount rate matters. As the time horizon increases, so do the benefits of climate policy.

Cass R. Sunstein of Harvard Law School and David A. Weisbach of the University of Chicago Law School provide an example that clearly illustrates this concept. If society faces the loss of $1 trillion dollars in 100 years, using a 7 percent discount rate, a little over $1 billion would be spent to prevent this harm. On the other hand, given a 200-year time horizon and the same discount rate, only $1.3 million would be spent.[18] Given a 100-year time horizon, Stern's predicted costs would be about 53 times Nordhaus' due to their differing discount rates; Stern's costs are valued at about 2,800 times Nordhaus' over a 200-year time horizon.[19]

How fast does the analyst assume the earth is warming?

Two key assumptions that affect the calculations of climate change policy benefits include the actual long-term temperature increase associated with carbon dioxide concentrations and the rate at which the temperature changes.[20]

The greater the temperature increases and the faster it happens, the higher the calculated benefits of climate policy.

What value does the analyst place on the environment?

Economic valuation involves measuring tradeoffs among people and resources, over time.[21] For example, when valuing nonrenewable resources, the trade-off requires balancing the benefits of using the resource completely against preserving a portion for later use. When public goods—clean air or water, for instance—are involved, markets are imperfect and it is difficult to place quantitative values on the resource. These are considered "non-marketed" goods. People do not necessarily pay for the benefits of using a public good, yet it is nearly impossible to exclude anyone from such benefits.

Economists measure an individual's willingness to pay for the benefits of a resource that does not require direct payment to determine a price for that good or resource. Even if analysts accept a given temperature increase, the economic impacts (such as economic losses, or benefits in some regions) remain uncertain.

Because assumptions made when valuing the environment greatly influence the discount rate and time horizon, they therefore also influence the policy recommendations.

Key Points

The long time scale, uncertainties and varied effects (across regions and generations) of climate change introduce challenges when designing mitigation policies. As economists seek to determine how aggressively lawmakers should implement policies that reduce greenhouse gas emissions, it is key for policymakers to remember:

- The lower the discount rate, the higher the calculated benefits of climate mitigation policy.
- The longer the time horizon, the more the discount rate matters. As the time horizon increases, the benefits of climate policy increase.
- The greater the temperature increase and the faster it happens, the higher the calculated benefits of climate policy.

Notes

1. Committee on America's Climate Choices, National Research Council of the National Academies of Sciences, *America's Climate Choices* (Washington, D.C.: National Academies Press, 2011); http://dels.nas.edu/Report/Americas-Climate-Choices/12781; National Air and Space Administration, *The current and future consequences of global change* (Washington, D.C.: NASA, 2011); http://climate.nasa.gov/effects/; Intergovernmental Panel on Climate Change, *Summary For Policy Makers, Climate Change 2007: Synthesis Report* (Geneva: IPCC, 2007); www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

2. Nicholas Stern, *The Stern Review on the Economics of Climate Change* (Cambridge, U.K.: Cambridge University Press, 2007); http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm.

3. Ian Byatt et al., "The Stern Review: A Dual Critique, Part II. Economic Aspects," *World Economics* 7, no. 4 (October-December 2006): 199–232.

4. Intergovernmental Panel on Climate Change (IPCC), *Summary For Policy Makers. Climate Change 2007: Synthesis Report* (Geneva: IPCC, 2007); www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

5. Martin L. Weitzman, "A Review of *The Stern Review on the Economics of Climate Change," Journal of Economic Literature* XLV, (September 2007): 703-724; William D. Nordhaus, "A Review of the *Stern Review on the Economics of Climate Change," Journal of Economic Literature* 45, no. 3 (September 2007): 686-702.

6. Cass R. Sunstein and David A. Weisbach, *Climate Change and Discounting the Future: A Guide for the Perplexed* (Cambridge: AEI Center for Regulatory and Market Studies, August 2008); http://www.hks.harvard.edu/m-rcbg/cepr/Online%20Library/Papers/Weisbach_Sunstein_Climate_Future.pdf.

7. Ibid.

8. William D. Nordhaus, "A Review of the *Stern Review on the Economics of Climate Change," Journal of Economic Literature* 45, no. 3 (September 2007): 686-702.

9. Michael D. Mastrandrea, *Calculating the Benefits of Climate Policy: Examining the Assumptions of Integrated Assessment Models* (Palo Alto: Stanford University, 2009); http://www.pewclimate.org/docUploads/mastrandrea-calculating-benefits-climate-policy-12-22-09.pdf.

10. This is oversimplified for the lay reader. An economically efficient solution minimizes the "present value," the value today of an amount of money in the future, of total costs over time.

11. Pedro Conceição, Yanchun Zhang and Romina Bandura, "Brief on Discounting in the Context of Climate Change Economics,"Human Development Report 2007/2008, *Fighting climate change: Human Solidarity in a divided world*; http://www.undp.org/developmentstudies/docs/Fighting_climate_change.pdf

12. Michael D. Mastrandrea, *Calculating the Benefits of Climate Policy: Examining the Assumptions of Integrated Assessment Models* (Palo Alto: Stanford University, 2009); http://www.pewclimate.org/docUploads/mastrandrea-calculating-benefits-climate-policy-12-22-09.pdf.

13. Ibid.

14. Nicholas Stern, *Stern Review on the Economics of Climate Change* (Cambridge, U.K.: Cambridge University Press, 2007); http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm.

15. Simon Dietz, *A long-run target for climate policy: the Stern Review and its critics* (London, U.K.: London School of Economics, May 2008); http://personal.lse.ac.uk/dietzs/A%20long-run%20target%20for%20climate%20policy%20-%20the%20Stern%20Review%20and%20its%20critics.pdf.

16. William D. Nordhaus, *The Challenge of Global Warming: Economic Models and Environmental Policy* (New Haven, CT: July 24, 2007); http://nordhaus.econ.yale.edu/dice_mss_072407_all.pdf.

17. Thomas Sterner and U. Martin Persson, *An Even Sterner Review: Introducing Relative Prices into the Discounting Debate* (Oxford: Oxford University Press, 2008); http://reep.oxfordjournals.org/content/2/1/61.short.

18. Cass R. Sunstein and David A. Weisbach, *Climate Change and Discounting the Future: A Guide for the Perplexed* (Cambridge: AEI Center for Regulatory and Market Studies, August 2008); http://www.hks.harvard.edu/m-rcbg/cepr/Online%20Library/Papers/Weisbach_Sunstein_Climate_Future.pdf.

19.Ibid.

20. Michael D. Mastrandrea, *Calculating the Benefits of Climate Policy: Examining the Assumptions of Integrated Assessment Models* (Palo Alto: Stanford University, 2009); http://www.pewclimate.org/docUploads/mastrandrea-calculating-benefits-climate-policy-12-22-09.pdf.

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