

R E P L Y T O R E S P O N S E S

A Reply

by Jody Freeman and Andrew Guzman

We wish to begin with a note of thanks to Richard Morgenstern, Jeffrey Hopkins, Laurie Johnson, Daniel Lashof, and Kristen Sheeran for their comments on our article, *Climate Change and U.S. Interests*. The comments have helped our own thinking on the subject, and it is gratifying to know that our paper stimulated such thoughtful responses. In the few pages we have for our reply, we focus on the claims that are most important and in the greatest tension with our article.

The most critical of the comments is from Morgenstern, who advances two main objections. First, he dismisses the entire exercise of estimating the likely harms from climate change as relatively unimportant to the climate policy debate.¹ Second, he asserts that our critique is poorly done—we have mishandled the uncertainty inherent in calculating damages, “unfairly attacked” the relevant economic models, and “overinterpreted” their results.²

Morgenstern’s first objection rests on the claim that cost-effectiveness analysis, rather than cost-benefit analysis, is the appropriate tool for addressing climate change, a point on which, he claims, the policy community agrees. Cost-effectiveness analysis, he explains, “assumes that policymakers have in mind a long run target for limiting the amount of projected climate change” and focuses on choosing among alternative implementation strategies. Cost-benefit analysis, which is the focus of our article, seeks to estimate the future economic harms from climate change and assess the benefits of alternative mitigation or adaptation strategies. By way of evidence that cost-benefit analysis is an inappropriate climate policy tool, Morgenstern notes that every legislative proposal advanced in Congress in recent years has stated its goals in terms of target greenhouse gas (GHG) concentration or emission levels, “with policies neither conceived nor framed in terms of monetized benefits.”³

We see both cost-benefit and cost-effectiveness analysis as unavoidably necessary and important to climate policy debates. The legislative targets that Morgenstern says policymakers “have in mind” must come from somewhere. We take his point to be that legislators choose these targets through a political process rather than by conducting a formal economic analysis. While this may be true, that political process necessarily depends on an implicit or explicit

evaluation of the relevant costs and benefits of alternative approaches. After all, one would only support legislation addressing climate change if one were persuaded that the anticipated harms from unmitigated emissions outweigh the costs of trying to curtail them.⁴ In other words, policymakers somehow must conclude that the endeavor is worthwhile, which means comparing costs and benefits, however crudely.⁵ In addition, choosing one emissions level over another inevitably requires policymakers to balance the harms associated with increased global GHG concentrations against the costs of trying to avoid them. Morgenstern elides this reality by simply positing that legislators have certain levels in mind, without explaining how they are chosen. We have no quarrel with the value of cost-effectiveness analysis as a useful mechanism for assessing alternative implementation strategies once a target is chosen. But our article focuses on the necessary prior step, which is the methodology for choosing the target. Because he cannot mean that legislative targets simply fall from the sky, we assume Morgenstern would agree that policymakers must go through a rough calculus to determine them. Our central point is that the costs of any given level of GHG emissions are likely to be much higher than suggested by most current estimates.

In any event, it seems peculiar for Morgenstern to claim that cost-benefit analysis “is not ready for prime time in the policy world,” when it is actually being used in the policy world. Indeed, the Obama Administration’s interagency working group (IWG) on the social cost of carbon (which Morgenstern invokes and whose methodology he praises) explicitly monetized the social cost of carbon by relying on the very same models that we use as a starting point in our analysis.⁶ The output from the IWG process has con-

1. Richard D. Morgenstern, *Critiquing the Critique of the Climate Change Winner Argument*, 41 ELR 10720 (Aug. 2011).

2. *Id.*

3. *Id.* at 10721.

4. Clearly, Congress has thus far not been persuaded. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009).

5. One might argue that legislative targets can be determined without resort to cost-benefit analysis—that they are dictated by science, for example. But scientifically grounded recommendations about appropriate emissions targets are themselves necessarily based on an assessment of the relevant tradeoffs. If cost were irrelevant, surely the goal of climate policy would be to minimize risk to the greatest extent possible by selecting a target of zero increase in atmospheric GHG concentrations over today’s levels. But of course cost does matter, and the choice of target (whether expressed as concentrations such as 450 or 550 ppm, goals such as 80 percent below 2005 levels by 2050, or as a commitment to no greater than 2 degrees Celsius rise in average global temperature by 2050) reflects that. We cannot decide what the target should be unless we have some understanding of the costs and benefits.

6. INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, APPENDIX 15A. SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866, in U.S. DEPARTMENT OF ENERGY, FINAL RULE

crete implications for policy. The estimates for the social cost of carbon it produced—including the central point estimate of \$21 per ton—will now be reflected in executive agencies' cost-benefit calculations of the net social impact of their significant regulations, including for example, the Department of Energy's appliance efficiency standards, the Department of Transportation's fuel economy standards, and a host of air pollution regulations issued by the Environmental Protection Agency. If our critique of the prevailing economic models is right, it applies equally to the IWG's results. The upshot is that the estimated benefits of many government regulations will be too low because of a systematic downward bias. As a result, in some cases, agencies may ultimately set—or be asked by the Office of Information and Regulatory Affairs (OIRA) to set—lower regulatory standards than are otherwise justified.⁷

Moreover, in the face of ongoing disputes over the merits and demerits of Congress doing *anything* to address climate change, it seems plainly wrong to criticize our project by asserting the “relative unimportance” of cost-benefit analysis to climate policy. The debate over domestic climate legislation continues to turn on arguments about the relative costs and benefits to the United States of taking action.⁸ Those who oppose domestic legislation may find it convenient to cite leading economic models showing limited negative impact on U.S. GDP from global climate change, or projections about increased agricultural productivity in the United States, to claim, essentially, that the United States will fare relatively well in a warming world,

and that mitigation is not worth the costs. Although the argument against addressing GHG emissions comes in many forms—it would impose an energy tax⁹; it would kill jobs;¹⁰ carbon is not a problem in need of regulation¹¹—such claims, at bottom, must rest on a conclusion that the costs of climate change to the United States are insufficiently great to warrant Congress addressing it now.¹² It is thus important to debunk the intellectual and academic basis for such claims, which includes the damage estimates from the dominant economic models, which can easily be taken out of context.¹³

This leads us to Morgenstern's second critique, which engages our claims about the economic models of climate change, known as integrated assessment models or IAMs. As we explain in our article, and as scholars including Morgenstern generally acknowledge, these models make certain simplifying assumptions about how the world's climate system will affect the global economy, and those assumptions limit their ability to predict accurately the true social cost of greenhouse gas emissions.¹⁴ The models

TECHNICAL SUPPORT DOCUMENT (TSD): ENERGY EFFICIENCY PROGRAM FOR COMMERCIAL AND INDUSTRIAL EQUIPMENT: SMALL ELECTRIC MOTORS (2010), available at http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/smallmotors_tsd/sem_finalrule_appendix15a.pdf [hereinafter IWG SCC Report]. Led in 2009 by the Council of Economic Advisors and the Office of Regulatory Affairs within the Office of Management and Budget in the White House, this effort sought to develop a government-wide social cost of carbon to be incorporated by the agencies into their regulatory impact analyses (RIA). Exec. Order No. 12866, 3 C.F.R. 638 (1993), reprinted as amended in 5 U.S.C. §601 (2006). RIAs consist of a detailed cost-benefit analysis, which are required for all significant rules pursuant to Executive Order No. 12866. See *id.* §1(b)(6) at 639. The Executive Order requires that agency rules be cost justified. See *id.* §6(a)(3)(C), at 645. Although the Order does not specify that cost-benefit analysis be used as a decision rule for agency standard-setting (that is, it does not require agencies to use marginal cost analysis to set levels of stringency), the cost justification requirement in the Order would appear to allow OIRA to request that agencies do so unless a statute or court ruling specifies otherwise.

7. Even if many regulations will be affected by the social cost of carbon only on the margins, the potential for some regulations to come out differently remains.

8. And to the extent it does not, it is only because the debate has regressed to one over the validity of the climate science. See John M. Broder, *Waxman Angrily Assails G.O.P. "Science Deniers,"* N.Y. TIMES, Mar. 7, 2011, available at <http://green.blogs.nytimes.com/2011/03/07/waxman-angrily-assails-g-o-p-science-deniers> (quoting Rep. Henry Waxman's complaint of an “overwhelming disconnect between science and policy” in the Congress and his critique of Republican efforts to repeal the EPA's scientific finding that greenhouse gases endanger health and welfare); see also Wash. Post Staff, *Climate Change Skeptics Who Won the Senate*, WASH. POST, Nov. 3, 2010, available at <http://www.washingtonpost.com/wp-srv/special/nation/senators-skeptic-climate-change/index.html>.

9. See, e.g., SUSAN ECKERLY, NAT'L FED. OF SMALL BUSINESSES, NATIONAL FEDERATION OF SMALL BUSINESS'S LETTER TO THE HILL ON CAP AND TRADE (H.R. 2454) (June 24, 2009), at <http://www.nfib.com/issues-elections/issues-elections-item?cmsid=49408> (arguing that “now is not the time to impose an \$846 billion energy tax on small business”).

10. See Energy Tax Prevention Act of 2011, H.R. 910, 112th Cong. (2011) (introduced by Reps. Upton (R-Mich.) and Whitfield (R-Ky.)). Sponsors of the legislation have cited the “job crushing” effect of greenhouse gas regulation. See statements catalogued at http://epw.senate.gov/public/index.cfm?FuseAction=Minority.PressReleases&ContentRecord_id=7d62b087-802a-23ad-41e4-93481b22c4a8.

11. Fred Upton & Jim Phillips, *How Congress Can Stop the EPA's Power Grab*, WALL ST. J., Dec. 28, 2010, available at <http://online.wsj.com/article/SB10001424052748703929404576022070069905318.html>; see also John M. Broder, *Inhofe and Upton: Just Say No to the E.P.A.*, N.Y. TIMES, Mar. 3, 2011, available at <http://green.blogs.nytimes.com/2011/03/03/inhofe-and-upton-just-say-no-to-the-e-p-a>.

12. See Keith Yost, *Global Warming Not Worth the Fight*, MIT: THE TECH ONLINE, Oct. 15, 2010, available at <http://tech.mit.edu/V130/N45/yost.html> (arguing that the United States should do little if anything about climate change and citing to studies by William Nordhaus, Robert Mendelsohn, and Richard Tol suggesting the costs of mitigating climate change exceed the benefits for the United States). One might argue that Congress has already addressed the problem by authorizing EPA to regulate GHG emissions under the Clean Air Act. See *Massachusetts v. EPA*, 549 U.S. 497 (2007) (holding that EPA possesses regulatory authority over GHGs under the CAA). However, it is a widely shared view among policymakers and academics that the CAA is not an optimal tool for addressing climate change. See Brigham Daniels et al., *Regulating Climate: What Role for the Clean Air Act?* 39 ELR 10837, 10840 (Sept. 2009) (“Given that Congress crafted the CAA as a response to local and regional air pollution, it is not surprising that crafting a sensible climate policy for the CAA feels a bit like jamming a square peg into a round hole.”). The view that the Clean Air Act is not the ideal vehicle for addressing climate change is also held by the Obama Administration. See Kim Chipman, *Clean Air Act Not Ideal to Regulate Carbon in U.S. Jackson Says*, BLOOMBERG, Apr. 26, 2011, <http://www.bloomberg.com/news/2011-04-26/clean-air-act-not-ideal-to-regulate-carbon-jackson-says-1-.html>.

13. See, e.g., 153 CONG. REC. S. 13505 (daily ed. Oct. 29, 2007) (statement of Sen. Inhofe) (“The [Nordhaus] study revealed that so-called global warming solutions would cost two or even three times the benefits they would theoretically achieve.”).

14. A good overview of the models is provided in the U.S. government's inter-agency document on the social cost of carbon: “IAMs translate emissions

are constrained in their predictive capacity to the extent that they simplify complex scientific and economic processes, but also because they omit certain categories of impact due to a lack of data, uncertainty, or both. Some simplification is necessary to make predictions about how climactic changes might affect the global economy. As we say in our article, “These omissions are not anyone’s fault, but rather, as many economists point out, result from the inherent limitations of economic modeling.”¹⁵

The central point of our article is that the assumptions built into existing economic models systematically understate the likely economic effects of climate change by omitting categories of harm (including cross-sectoral impacts, national security threat multipliers, biodiversity losses, and catastrophic events). They are not bad models, but it would be bad policy to forget or ignore the assumptions used to create them, and to take the resulting damage estimates as if they represent the full range of harms.

Morgenstern points out that economists traditionally treat certain categories of harm as too difficult to monetize. The preferred method is to omit these costs from the damage calculations and discuss them separately, in prose, as limitations, unknowns, or uncertainties. To illustrate how this is done, Morgenstern cites the above-mentioned IWG process.¹⁶ The IWG ultimately settled on four estimates for the social cost of carbon: \$5, \$21, \$35, and \$65 (in 2007 dollars). The first three values were calculated using discount rates of 5, 3 and 2.5 respectively. The IWG approach essentially averaged three IAMs and then applied three different discount rates. This produced three alternative cost-of-carbon estimates. The IWG generated the fourth value by averaging a high-damage estimate from each of the three IAMs and applying a moderate discount rate of 3%.¹⁷

The analysis released by the administration to support these estimates is conscientious. It acknowledges the limitations of the models, discusses the implications of these limitations,¹⁸ and commits the government to revisit and

revise the values as new information becomes available.¹⁹ Moreover, acknowledging the uncertainties in regulatory impact analysis, the report stresses “the importance and value of considering the full range”²⁰ of estimates rather than a single value. Nevertheless, the government ultimately brackets all of the assumptions and limitations when taking the crucial step of monetizing the damage estimates,²¹ addressing them only in discussion.²²

When faced with costs that are difficult or impossible to estimate, the conventional strategy of the IAMs is to assume those costs away. (See Table 1 at the end of this Reply.) Studies that survey different IAMs, including the IWG process, and the Aldy, et. al. article cited by Morgenstern, generally accept the results of the IAMs (and try to average across them) and, so, they too neglect these hard-to-measure costs. By contrast—and this is what Morgenstern protests—our article sets out to confront head-on the downward biases present in IAMs. We think it is possible to come up with an estimate of these harms that is better than ignoring them altogether.

Morgenstern quite rightly points out that the IWG report acknowledges some of the factors omitted from the IAMs’ damage estimates. These include several of the factors that we discuss in our paper.²³ Recognizing these omissions is important, but is not enough. Morgenstern himself proves our point. Even as he engages our concern over neglected factors, and argues that the best way to deal with them is to acknowledge the challenge of incorporating them, he ignores the necessary implication: that the estimates associated with this approach are biased downward. Morgenstern acknowledges the uncertainty associated with the IWG estimates, but says almost nothing about their bias.²⁴

It should be self-evident that assigning a value of zero to catastrophic events, nonmarket costs, cross-sectoral impacts, productivity effects, economic spillovers, national security, migration, disease, and more will cause us to underestimate the effects of climate change. Rather than ignoring these effects, we assign many of them an economic value based on what we think are entirely plausible, though admittedly contestable, assumptions. We do not claim to have the correct numbers. Indeed, we make an exceedingly modest claim: our effort is simply better

into changes in atmospheric greenhouse concentrations, atmospheric concentrations into changes in temperature, and changes in temperature into economic damages. The emissions projections used in the models are based on specified socio-economic (GDP and population) pathways. These emissions are translated into concentrations using the carbon cycle built into each model, and concentrations are translated into warming based on each model’s simplified representation of the climate and a key parameter, climate sensitivity. Each model uses a different approach to translate warming into damages. Finally, transforming the stream of economic damages over time into a single value requires judgments about how to discount them.” See IWG SCC Report, *supra* note 6 at 6.

15. Jody Freeman & Andrew Guzman, *Climate Change and U.S. Interests*, 41 ELR 10695, 10696 (Aug. 2011).

16. Morgenstern, *supra* note 1 at 10721.

17. The \$65 value represents “the higher- than-expected impacts from temperature change further out in the tails of the SCC distribution” using an SCC value for the 95th percentile at a 3 percent discount rate. The SCC estimates grow over time (e.g., the central value increases to \$24 per ton of CO₂ in 2015 and \$26 per ton of CO₂ in 2020). IWG SCC Report, *supra* note 6 at 1-2.

18. The report allocates 2 pages of 35 (or 51 including the appendix) to a discussion of the models’ limitations and an additional 2.5 pages to further discussion of the catastrophic risk and damage functions, but also reiterates in several places the constraints of the models. IWG SCC Report, *supra* note 6 at 30-34.

19. The report openly acknowledges the difficulty of the exercise: “The inter-agency group offers the new SCC values with all due humility about the uncertainties embedded in them and with a sincere promise to continue work to improve them.” IWG SCC Report, *supra* note 6 at 5.

20. IWG SCC Report, *supra* note 6 at 3.

21. IWG SCC Report, *supra* note 6 at 2 tbl. 15A.1.1

22. See IWG SCC Report, *supra* note 6, §15.A.4.

23. IWG SCC Report, *supra* note 6 at 30-31.

24. Morgenstern’s response to our own paper similarly illustrates how the focus of discussion inevitably falls on quantitative estimates. In our article we generate numerical estimates of certain costs, but also identify and discuss costs for which we are unable to do so (see Table 2 at the end of this Reply). Yet the commentators say almost nothing about the latter, while focusing almost exclusively on the former. This reinforces how numerical estimates take center stage while factors that are not quantified are neglected. Even our own estimates might be faulted for incompletely capturing the true costs of climate change, although they are an improvement on the IAMs.

than allocating these categories a value of zero.²⁵ We concede that an approach like ours might be suspect if it were arbitrary—if, for example, one simply pulled numbers out of the air or inflated them without reason. We take pains to avoid this mistake. To ground our estimates, we state reasonable premises about the potential effects of climate change under different proposed scenarios (all intuitive; none obviously far-fetched) and proceed from there to calculate possible impacts on GDP. Moreover, our estimates are based on published research by serious scholars. We then tally up these impacts to produce a total projected effect on GDP that is considerably greater than the average projections of the dominant IAMs.

Morgenstern points to the IWG estimates on the social cost of carbon as an exemplary approach to uncertainty, and he finds our own approach wanting by comparison. We think this criticism unjustified. Our article repeatedly emphasizes the fact that our estimates are imprecise. In recognition of this fact, we provide a range of impacts for several of our estimates, including the total. Presenting a range of possible outcomes is very much in line with the approach in the IWG report. Moreover, realizing that our estimates are far larger than conventional estimates, and wishing to guard against the possibility that we have overstated some costs, we cut our total projected impact on GDP in half. Even using this conservative calculation, the numbers still show it to be clearly in the economic interest of the United States to invest more heavily in the mitigation of climate change, which is of course the policy conclusion of our article.

Perhaps Morgenstern's most fundamental and pointed critique, and the source of our greatest disagreement, is summed up in the final words of his comment: "It is better to be generally correct than precisely wrong."²⁶ First, we do not believe we are wrong when compared to the IWG process or IAMs in general. The relevant comparison is between our own estimates of hard-to-quantify harms (e.g., biodiversity losses) and risks that depend on complex interactions (e.g., growth and productivity losses) and those of the IAMs. We feel strongly that ignoring costs known to be significant is a worse approach than doing the

best one can to estimate them. We believe, for this reason, that our results are superior for policy purposes than results that omit these costs from the damage estimates.

At bottom, this amounts to a methodological disagreement, which stems from a difference in normative view. The dominant perspective is that the existing economic models are good enough to be relied upon to make public policy, providing their assumptions and omissions are acknowledged. Yet the practical result is to relegate a broad range of effects to a discussion of the models' limitations and uncertainties, which in our view effectively makes them disappear. Our concern is that what counts, ultimately, are the numbers, and that qualifying discussions, no matter how sincere and nuanced, will be overlooked when IAMs are deployed for purposes of policymaking.²⁷

To illustrate, we return to the Obama Administration's interagency process on the social cost of carbon. As Morgenstern notes, the government's approach was laudable in its seriousness, inclusiveness, and thoroughness. The report in several places cautions against overconfidence and stresses the limitations of current scientific and economic models. It candidly admits that these estimates are the best the government can do under current circumstances. Yet in the end, the process culminated in a range of specific point estimates that agencies must incorporate into their cost-benefit analyses, with \$21 per ton of carbon serving as the central point estimate.

The range provided improves upon the government's past practice inasmuch as it seeks to harmonize inconsistent estimates used by different agencies²⁸; adopts a "global" value to reflect damages worldwide, instead of limiting the analysis to domestic impacts²⁹; and incorporates an upper estimate that attempts to account for the possibility of catastrophe.³⁰ None of this, however, makes the estimates *accurate*. Because of the systematic downward bias in the key IAMs on which the estimates rely (which nothing in the interagency group's process cured),³¹ there is a strong, perhaps even overwhelming, likelihood that the estimates still understate the economic impact of global climate change to the United States.

25. Richard Tol has described a number of omitted impacts, including many of the impacts we make an effort to monetize such as, "extreme climate scenarios, the very long term, biodiversity loss, the possible effects of climate change on economic development and even political violence" as "big unknowns." RICHARD TOL, COPENHAGEN CONSENSUS ON CLIMATE, AN ANALYSIS OF MITIGATION AS A RESPONSE TO CLIMATE CHANGE 17 (2009), available at http://fixthecclimate.com/uploads/tx_templavoila/AP_Mitigation_Tol_v_3.0.pdf. He concludes that the probability of catastrophic events, "seems low" while acknowledging that our understanding of what might cause them is still quite poor, and that if they were to happen, "they do have the potential to happen relatively quickly, and if they did, the costs could be substantial." *Id.*

26. Morgenstern also says: "Freeman and Guzman have substituted their scientific judgments for those of the integrated assessment modelers, with quite limited analytical support." We think this critique unfounded. Like all authors, we exercised our own judgment (otherwise, why write anything?), but we provided extensive support for our analysis both by explaining our reasoning and citing to the scientific support for our claims. The persuasiveness of our argument is, perhaps, in the eye of the beholder, but we are entirely comfortable defending the rigor, method, and integrity of our article.

27. One response to this might be that we should have faith that policymakers will take the relevant nuance into account. But anyone with any experience in politics knows this to be a risky, and likely naïve, view. It would be strange to fault us for being cautious in this regard.

28. The report cites to a DOT regulation in 2008 that assumed a domestic SCC value of \$7 per ton CO₂ (in 2006 dollars) for 2011 emission reductions; a DOE regulation in 2008 that adopted a domestic SCC range of \$0 to \$20 per ton CO₂ for 2007 emission reductions (in 2007 dollars); and EPA's 2008 Advance Notice of Proposed Rulemaking for Greenhouse Gases with preliminary SCC estimates of \$68 and \$40 per ton CO₂ for discount rates of approximately 2 percent and 3 percent, respectively (in 2006 dollars for 2007 emissions). IWG SCC Report, *supra* note 6 at 4.

29. IWG SCC Report, *supra* note 6 at 4.

30. Morgenstern approves of this effort to take into account catastrophic costs, but for reasons that are not clear to us, disapproves of our own similar effort.

31. The report reviews the three leading IAMs and then concludes: "We recognize that these representations are incomplete and highly uncertain. But given the paucity of data linking the physical impacts to economic damages, we were not able to identify a better way to translate changes in climate into net economic damages, short of launching our own research program." IWG SCC Report, *supra* note 6 at 9.

Moreover, there will be consequences if the agencies do not adopt the estimates from the IWG report. Their regulatory impact analyses might be rejected by OIRA, or subject to requests for modification. And as we have already noted, some of the ensuing regulations may be weaker, as a result, than they otherwise would be, were they informed by a cost estimate for carbon that reflected *some* value for the omitted categories of harm. Our point is this: in operationalizing the social cost of carbon for purposes of the regulatory review process under Executive Order 12866, what matters is that the agencies choose an acceptable number for their cost-benefit calculations. The agencies might discuss the range of values, but they know they will be “safe” if they adopt the central point estimate of \$21. All of the nuance about the models’ limitations might easily fall out.

Second, Morgenstern accuses us of failing to take account of the inherent uncertainty in our own analysis and in the problem more generally. We are, frankly, puzzled by Morgenstern’s claim here, as we not only repeatedly emphasized the uncertainty and high variance of the estimates we were producing, but we also generated a range of estimates for many of the individual costs we examined and for the total costs of climate change.³² Morgenstern asserts, for example, that, “[Freeman and Guzman] focus on a single estimate, comparable in some respects to the IWG’s central estimate.”³³ We are not sure what “single estimate” he refers to—our final estimate of harms is a range from 10.8% of GDP to 20% of GDP.³⁴

Contrary to what Morgenstern suggests, we do not make a claim to precision. We recognize that the variance for our estimates is large, as it is for those produced by the IAMs. Again, we are happy to admit that our estimates are not the “correct” ones. Our claim is more modest than that. We believe that the harms we identify (which many others have also identified) have positive costs, and decisionmakers should do their best to account for these costs when making policy.

In sum, to the extent Morgenstern cites the interagency process on the social cost of carbon as improving upon IAMs, we think the example misplaced, since the process essentially adopted the IAMs as they are. To the extent Morgenstern commends how the interagency process handled the considerable uncertainty associated with making such estimates (bracketing it from the damage estimates on the theory that there is no way, at the present time, to do better), our response is to point out that this is precisely the treatment we are concerned about. To reiterate a point made emphatically in our article, our aim is not to “unfairly

attack” the IAMs or the economists who have built them, but rather to incorporate more categories of harm so that our cost projections more completely, if still imperfectly, reflect the potential economic damage of climate change for the United States. The concern that motivated our article when we wrote it in 2008, and which motivates us still, is the potential for crucial nuance to get lost in translation from the academic to the policy world.

We take Johnson and Lashof’s comment as complementary to our own. They broadly agree with our analysis and offer some additional insights with which we largely agree. For example, our article intentionally avoids any argument based on moral obligation, and Johnson and Lashof reasonably want to include such concerns. As they acknowledge, we leave these issues out of our article to emphasize the point that even under a self-interested analysis the case for action is strong.

Johnson and Lashof also discuss the impact of discount rates and risk aversion. We address discount rates briefly, acknowledging the debate over their role in estimating future impacts. It is an awkward fact that the choice of discount rate is enormously important yet nobody really knows how to determine the “proper” rate. As Johnson and Lashof illustrate in their discussion, changes to the discount rate in the IWG social cost of carbon calculation can dramatically change the conclusions. Again, we have no serious dispute. We also concur with Johnson and Lashof that catastrophic harms and risk aversion should be taken into account.

Our main disagreement with Johnson and Lashof, to the extent there is one, relates to the appropriateness of using cost-benefit analysis to estimate the harms from climate change. Kristen Sheeran advances a similar position so we discuss their points together. Like Morgenstern, these commentators think cost-benefit analysis an inappropriate tool for the task. Their primary discomfort seems to be with how cost-benefit analysis deals with uncertainty. When there is enough uncertainty, or perhaps enough uncertainty of a particular kind, the argument goes, “benefit-cost analysis loses its ability to inform rational policy.”³⁵

We have a strong suspicion that much of the disagreement here is semantic rather than real. Johnson and Lashof argue for a policy that “reduces probabilities of catastrophic outcomes by strategically investing in a clean energy future” while Sheeran calls for the use of “[p]recaution, risk assessment, and risk management.” Much depends on what all of these terms mean, but we agree with many of the authors’ substantive claims about the difficulties of monetizing a variety of relevant harms. We agree that sensible policy requires evaluating and balancing the consequences of alternative policy proposals. In making that assessment, it is appropriate and important to take into account the uncertainties involved, the intertemporal nature of the problem, the public’s risk preferences, and equity, among other things. To do so, we must

32. We also cannot resist pointing out that when an IAM assigns a value of zero to a harm that we know will be greater than zero, that “estimate,” in addition to having a downward bias, ignores the uncertainty associated with that particular cost.

33. “They use limited data to analyze uncertainty and fail to evaluate the analytical choices they have made or to delineate the strengths of their analysis along with the uncertainties about its conclusions. In effect, Freeman and Guzman have substituted their scientific judgment for those of the integrated assessment modelers, with quite limited analytical support.” Morgenstern, *supra* note 1 at 10722.

34. Freeman & Guzman, *supra* note 15, at 10710.

35. Laurie T. Johnson & Daniel A. Lashof, *Comment on Climate Change and U.S. Interests by Freeman and Guzman*, 41 ELR 10712 (Aug. 2011).

confront difficult questions of how to value various harms. Nothing the commentators have written is inconsistent with this description. Our understanding of the difference between us and them is that we would call this undertaking a cost-benefit analysis and they would assign it a different name. Whatever it is called, we think we are talking about the same policymaking process.³⁶

The final comment on our article is by Jeffrey Hopkins, who urges us to address issues that we purposely set to one side. He suggests, for example, that we examine the futility and fairness arguments in favor of U.S. action on climate change. We certainly agree that these are important topics, but as we noted in our article, they were not important for the point we wished to make. Hopkins similarly proposes a discussion of how policymakers should think about uncertainty and how policy should respond to it. This has some of the flavor of the precautionary principle suggestions from Johnson, Lashof, and Sheeran. We have no major quarrel with what Hopkins proposes, except to say that our article is long enough already, and if it succeeds in delivering the message that the future costs of climate change are substantially higher than is conventionally understood, we will consider our mission to have been accomplished. We share with Hopkins the hope that new research, whether by ourselves or others, will address the issues he raises.

When we wrote *Climate Change and U.S. Interests* in 2008, we fully expected to be overtaken by events. Congress appeared ready to pass legislation to address climate change by putting a price on carbon. Presidential candidate Barack Obama claimed it would be an administration priority. Yet now, in 2011, Congress seems even further away from this prospect than ever. The debate over climate science has intensified. EPA has begun to regulate GHG emissions under the Clean Air Act, and Congress is debating whether to strip the agency of its authority to do so. Clearly, Congress has determined that meaningful action at the federal level to address global climate change is not worth the costs. Thus, the main impetus for our article remains. We continue to believe that a more accurate tally of what the United States stands to lose from climate change is an important input into the public policy debate.

Table 1: Quantitative Adjustments to Conventional Estimates of Climate Change Impacts

Factors Considered	Conventional Estimates of Reduction in U.S. GDP (%)	Marginal Impact on Annual GDP (%)
Conventional IAM Estimate	0.5	0.5
Optimism About Temperature Rise	0	1
Asymmetry Around Point Estimates	0	0.5
Catastrophic Events	0	0.5-3
Nonmarket Costs	0	1.4-3.5*
Export Losses	0	1.5
SUB TOTAL	0.5	5.4-10
Growth and Productivity	0	Double Above Impacts
TOTAL	0.5	10.8-20

* This includes only biological costs.

Table 2: Qualitative Adjustments to Conventional Estimates of Climate Change Impacts

Factors Considered	Impacts and Examples
Cross-Sectoral Effects	If climate change affects energy prices, agriculture will be affected
Supply Shocks From Abroad	Energy prices
Global Financial Markets	Impact on American investments abroad; lending to fund current account deficit
National Security	Total cost of Iraq War = \$3 trillion
Migration	Racial and ethnic tensions, undocumented immigration, human trafficking
Disease	Swine Flu, SARS, Avian Flu; U.S. cannot insulate itself from increases in incidence of disease

36. If, however, they mean that climate policy should be driven exclusively by a concern about minimizing the risk of catastrophic harms, with no regard for cost (which is not how we read their comments), we would part ways.