Institute *for* Policy Integrity

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VIA ELECTRONIC SUBMISSION

Environmental Protection Agency
Attn: Christopher Lieske, Office of Transportation and Air Quality

National Highway Traffic Safety Administration
Attn: Rebecca Yoon, Office of Chief Counsel

Subject: Comments on 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 76 Fed. Reg. 74,854 (proposed Dec. 1, 2011)
Docket Nos. EPA-HQ-OAR-2010-0799; NHTSA-2010-0131

The Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA; collectively, "the agencies") proposed a new fuel economy rule in November 2011. The Institute for Policy Integrity has previously submitted comments on related rulemakings,[1] which introduced some of the concepts addressed in the following recommendations. The Institute for Policy Integrity at New York University School of Law is a non-partisan think tank dedicated to improving the quality of government decisionmaking through advocacy and scholarship in the fields of administrative law, economics, and public policy.

The rule would raise the corporate average fuel economy standards for new automobiles and restrict the levels of greenhouse gases that vehicles may emit. While the proposed rule will generate large net social benefits, prior to the rule's final publication, the agencies should consider adopting several refinements to their calculation of benefits and their approach to vehicle attributes.

- ***The agencies should increase estimates of climate benefits to more accurately value the chance of catastrophic damages.*** Substantial economic literature, including much published in the last two years, supports the conclusion that current models do not place enough emphasis on catastrophic scenarios and, consequently, that some adjustment to the calculation of benefits is necessary. Disagreement over the exact size of that adjustment does not suggest the risk of catastrophe should be valued at zero.
- ***The agencies should increase estimates of climate benefits to account for risk aversion.*** Climate change is a categorically different kind of social problem: no single government can self-insure against the risk of irreversible, planet-wide damages. The government, therefore, should be risk averse toward climate change. Though the degree of risk society faces is a subject of contention, most economists believe there is some non-negligible amount of risk that must be accounted for. A risk premium should be incorporated, either as an adder to the value of climate benefits, or as a downward adjustment to discount rates.

[1] *See* Comments from Institute for Policy Integrity to EPA and NHTSA, on MY 2012-2016 light-duty standards and heavy-duty standards, *available at* http://www.policyintegrity.org.

- ***The agencies should continually revise estimates of climate benefits to reflect the most recent scientific and economic knowledge.*** Even if a better estimate of benefits will not change the stringency or structure of the proposed rule, accuracy remains important. Professional and legal norms for economic analysis require it; accurate benefits estimates will increase confidence in the justifications for the rule and inform the public debate; and the agencies' impact analysis will set a precedent for future rulemakings. The agencies should take the lead on adjusting estimates to account for risk and catastrophic damages, as well as the latest climate science.
- ***The agencies should make several other improvements in the valuation of climate benefits,*** including development of non-carbon dioxide estimates, incorporation of potential benefit revisions in the mid-term evaluation process, and accounting for the net upstream emissions from electric vehicles.
- ***The agencies should rethink their footprint-based standards, which may be unnecessary to respect consumer preferences, may negatively impact safety, and are likely to be overall inefficient.*** Increasing the safety of one car can impose a negative safety externality on others, and consumer preferences can adjust as average fleet-wide attributes shift. As a result, trying to eliminate the incentive to build smaller cars may block a cost-effective compliance strategy and may not guarantee a safer fleet.
- ***The agencies constant performance cost projections are likely to be an overestimate of the risk of lost consumer welfare.*** Since attributes like size and performance are at least partly relative, changing the fleet-wide average size or performance may not significantly impact overall consumer welfare. Manufacturers may not have to spend as much as the agencies' assume in order to prevent any aggregate consumer welfare loss. Similarly, any risk of lost consumer welfare unaccounted for in the agencies' constant performance cost projections is mitigated by the positionality of attributes.
- ***The agencies should consider how positionality and the bandwagon effect will shape the consumer market for new technologies.*** As fuel-efficient vehicles become more visible and more common, the perceived attractiveness of fuel efficiency may increase. Information diffusion and habit formation will also affect the future of the market for electric vehicles and other new technologies.

Part I. Climate Benefits

The proposed rule will significantly reduce greenhouse gas emissions and takes an important step in addressing climate change. However, the proposed rule underestimates the benefits of these emissions reductions. In so doing, it understates the need for increased reductions and sets standards that are more lenient than socially optimal. Developing the most accurate estimates of climate benefits and the appropriate stringency for emissions standards will set a valuable precedent for all future rulemakings that affect greenhouse gas emissions.

The agencies should make several improvements to their calculation of the rule's climate benefits. Most importantly, the agencies should update the social cost of carbon (SCC) estimate to: (1) reflect risk aversion, (2) appropriately weigh the possibility of catastrophic climate change, and (3) incorporate the most recent scientific advances on the relationship between greenhouse gas emissions and climatic stability.

Disagreement over the size of risk aversion and catastrophic risk does not mean they should be valued at zero. Without more fully accounting for risk aversion and catastrophic climate outcomes, the SCC estimates used in the rule will be too low.

The SCC revision process should be understood as an on-going activity that continually updates estimates to reflect the most recent science. The state of science on this issue continues to expand at a rapid pace, and it is important that the agencies incorporate recent insights as quickly as possible. The agencies should also seek to develop estimates for the benefits of non-carbon dioxide reductions, and the SCC revision process should be extended and incorporated into the mid-term evaluation of the regulation. Finally, the agencies should rethink the way they calculate emissions from alternative fuel vehicles.

Background on the Social Cost of Carbon

The social cost of carbon (SCC) is an "estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change."[2] Theoretically, the SCC includes all the economic losses associated with global climate change. An interagency working group (Working Group), which included both EPA and DOT, released initial estimates of the SCC in February 2010.[3]

That report harmonized the federal government's approach to valuing climate benefits and developed an initial set of four alternative estimates. The four estimates were built around the results from three integrated assessment models (IAMs), which "translate emissions into changes in atmospheric greenhouse concentrations, atmospheric concentrations into changes in temperature, and changes in temperature into economic damages."[4] The proposed rule discusses all four SCC estimates, but relies mostly on the "central" value, which is based on a 3% discount rate.[5] However, both the Working Group and the proposed rule note that the IAMs and the current SCC estimates contain significant limitations: incomplete treatment of catastrophe, uncertainty in the extrapolation of damages to high temperatures, and underdeveloped assumptions about risk aversion.[6] The agencies seek comment on the assumptions used to determine the SCC.[7]

The Agencies Should Increase the SCC Estimates to More Accurately Value Catastrophic Change

The possible levels of climate damages are often modeled as a distribution describing the probabilities of various economic outcomes. The Working Group estimated the SCC by analyzing probability distributions generated by three IAMs, using those distributions to calculate the expected climate damages society would experience at various concentrations of greenhouse gases. IAMs, however, generally undervalue the possible damages associated with catastrophic climate change by reducing the complexity of the problem[8]—though scientific research predicts a non-negligible chance of a planet-wide, truly disastrous climate catastrophe, IAMs do not give much weight to such low-probability scenarios that exist on the far end of the probability distribution curves.[9]

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[2] INTERAGENCY WORKING GROUP ON SOCIAL COST OF CARBON, U.S. GOV'T, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12,866, at 2 (2010) [hereinafter "WORKING GROUP REPORT"].

[3] *Id.*

[4] *Id.* at 5.

[5] 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 76 Fed. Reg. 74,854, 74,895, 75,292 fn. 774 (proposed Dec. 1, 2011) [hereinafter "Proposed Rule"].

[6] WORKING GROUP REPORT, *supra* note 2, at 29-31; Proposed Rule, *supra* note 5, at 75,127.

[7] Proposed Rule, *supra* note 5, at 74,930, 74,933.

[8] *See* NAT'L RES. COUNCIL, NAT'L ACAD. OF SCI., HIDDEN COSTS OF ENERGY: UNPRICED CONSEQUENCES OF ENERGY PRODUCTION AND USE 256-57 (2009).

[9] *See* Martin Weitzman, *On Modeling and Interpreting the Economics of Catastrophic Climate Change*, 91 REV. ECON. & STAT. 1, 1 (2009).

In short, the true probability distribution of climate damages has a longer and fatter right-hand tail than is represented in IAMs.[10] Weitzman argues that considering such "fat tails" increases the expected damages significantly, which could exert enormous influence on society's willingness to pay for emissions abatement.[11] That is, because extreme climate outcomes would impose such enormous economic losses, even relatively unlikely scenarios can shift the expected damages from climate change dramatically to the right. Should the possibility of these outcomes be great enough, the effect of such catastrophic damages could dominate the analysis. Tol notes similar difficulties with IAMs,[12] and the National Academy of Sciences found that IAMs insufficiently measure the totality of these effects.[13] (The fact that both Weitzman and Tol find similar problems with IAMs[14] is notable given their history of disagreement over optimal mitigation policies.) Because the Working Group's analysis relied heavily on IAMs that do not fully account for the possibility of catastrophic damages, the agencies should adjust SCC estimates upward to properly value expected climate damages.

In early 2010, the Working Group suggested that scholarly disagreement warranted further investigation before it would be appropriate to adjust the SCC to account for catastrophic damages.[15] The Working Group referred to the work of Nordhaus,[16] Pindyck,[17] and Newbold and Daigneault[18] to support its decision to delay addressing catastrophic damages. While Nordhaus's work is seminal in many ways, it is often recognized as undervaluing catastrophic outcomes. He relies heavily on one IAM (namely, DICE) that suffers from the problems explained above: it fails to fully account for the influence of catastrophic climate outcomes.[19] Newbold and Daigneault's results indicate that basing substantial SCC adjustments on catastrophic damages would depend heavily on the values assigned to model parameters. This merely shows that calculation of expected values is difficult and that extreme results such as Weitzman's[20] do not always hold. Their basic conclusion that current IAMs inadequately account for catastrophic damages[21] still cuts in favor of some upward adjustment to the SCC, not waiting for further research. Pindyck finds only moderate expected utility differences when considering a wide distribution of climate outcomes.[22] However, he uses a simplified IAM with different damage and growth functions that do not assume

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[10] *See* NAT'L RES. COUNCIL, *supra* note 8, at 293; Martin Weitzman, *Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change*, 5 REV. ENVTL. ECON. & POL'Y 275 (2011).

[11] *See generally* Weitzman, *supra* note 9.

[12] *See generally* Richard S. J. Tol, *Is the Uncertainty About Climate Change Too Large for Expected Cost-Benefit Analysis?*, 56 CLIMATE CHANGE 265 (2003).

[13] NAT'L RES. COUNCIL, *supra* note 8, at 256-57.

[14] *Compare* Weitzman, *supra* note 9, *with* Tol, *supra* note 12.

[15] *See* WORKING GROUP REPORT, *supra* note 2, at 29-31. The Working Group does not completely differentiate between the discrete effects of risk aversion and expected utility calculations when considering catastrophic damages, most likely because the scholars writing on these issues often consider both effects simultaneously.

[16] WILLIAM NORDHAUS, A QUESTION OF BALANCE: WEIGHING THE OPTIONS ON GLOBAL WARMING POLICIES (2008); William D. Nordhaus, *An Analysis of the Dismal Theorem* (Cowles Found., Discussion Paper No. 1686, 2009). For an update, see William D. Nordhaus, *The Economics of Tail Events with an Application to Climate Change*, 5 REV. ECON. & POL'Y 240 (2011).

[17] Robert S. Pindyck, *Uncertain Outcomes and Climate Change Policy* (NBER Working Paper No. 15,259, 2009). For more recent work, see Robert S. Pindyck, *Fat Tails, Thin Tails, and Climate Change Policy*, 5 REV. ENVTL. ECON. & POL'Y 258 (2011).

[18] Stephen C. Newbold & Adam Daigneault, *Climate Response Uncertainty and the Benefits of Greenhouse Gas Emissions*, 44 ENVTL. & RES. ECON. 351 (2009).

[19] *See, e.g.*, Weitzman, *supra* note 10, at 280; Carolyn Kousky, Robert E. Kopp & Roger Cooke, *Risk Premia and the Social Cost of Carbon: A Review* 5 (Economics: The Open-Access, Open-Assessment E-Journal, Discussion Paper No. 2011-19, 2011).

[20] *See* Weitzman, *supra* note 9, at 16 (finding that, in some circumstances, the possibility of catastrophic damages will result in a theoretical infinite willingness to pay to avoid climate catastrophes).

[21] *See generally* Newbold & Daigneault, *supra* note 18.

[22] *See* Pindyck, *Uncertain Outcomes and Climate Change Policy*, *supra* note 17, at 3-4.

fat tails. Yet it is fat tails and the growing possibility of extreme outcomes that drives much of the catastrophic damage analysis.

The Working Group claimed that "further research in this area is needed before its practical significance can be fully understood and a reasonable approach developed to account for such risks in regulatory analysis."[23] In fact, no amount of research can lead to a "full understanding" of this problem. Nevertheless, a practical approach to treating catastrophe can be developed and implemented. Indeed, because a greater possibility of catastrophic damages exists than is included in the IAMs used by the Working Group (the Working Group essentially admits that this is the case[24]), the *practical* approach is to adjust the SCC upward. The fact that there is disagreement about the size of this catastrophic damage adjustment does not suggest that it should be zero.[25]

Moreover, a substantial amount of research has been published since the Working Group's report, adding to a growing body of literature that highlights the limitations of IAMs with regard to catastrophic damages. In the next revision of the SCC estimates, the agencies and the Working Group must address the relevance of work by Pycroft, Vergano, Hope, Paci, and Ciscar,[26] Millner,[27] Ackerman, Stanton, and Bueno,[28] Dietz,[29] and Gerst, Howarth, and Borsuk.[30] Combined with the work of climate scholars like Weitzman and Tol,[31] the economic literature supports the proposition that IAMs do not place enough emphasis on catastrophic damages and, consequently, some adjustment should be made to account for this limitation.

The studies that attempt to calculate the amount of adjustment necessary generally find it to be large. Yohe and Tol opine that increasing the SCC by 50% "is not out of the question" given the non-zero risk of catastrophic climate change.[32] In stylized conditions of structural uncertainty, Weitzman shows that the SCC might be infinite.[33] This seems implausible, and several studies react by restricting the damage function to avoid this result.[34] Pycroft, Vergano, Hope, Paci, and Ciscar find that allowing for the possibility of different tail sizes in both the climate sensitivity parameter

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[23] WORKING GROUP REPORT, *supra* note 2, at 29.

[24] *See id.* at 31.

[25] *See*, *e.g.*, Ctr. for Biological Diversity v. NHTSA, 538 F.3d 1172, 1200 (9th Cir. 2008) ("[W]hile the record shows that there is a range of values, the value of carbon emissions reduction is certainly not zero.").

[26] Pycroft et al., *A Tale of Tails: Uncertainty and the Social Cost of Carbon Dioxide* (Economics: The Open-Access, Open-Assessment E-Journal, Discussion Paper 2011-36, 2011) (finding that tail shape can change the SCC dramatically and suggesting fatter tails may be more reasonable).

[27] Antony Millner, *On Welfare Frameworks and Catastrophic Climate Risks, in* SOCIAL SCIENCE RESEARCH NETWORK (2011) (arguing that satisfactory treatment of climate modeling requires consideration of catastrophe).

[28] Frank Ackerman et al., *Fat Tails, Exponents, Extreme Uncertainty: Simulating Catastrophe in DICE*, 69 ECOLOGICAL ECON. 1657 (2010) (finding that plausible increases in both the climate sensitivity and damage exponent parameters results in disastrous economic decline).

[29] Simon Dietz, *High Impact, Low Probability? An Empirical Analysis of Risk in the Economics of Climate Change*, 108 CLIMATE CHANGE 519 (2011) (discussing one method of bounding damages to avoid infinite willingness to pay for abatement).

[30] Michael D. Gerst, Richard B. Howarth & Mark E. Borsuk, *Accounting for the Risk of Extreme Outcomes in an Integrated Assessment of Climate Change*, 38 ENERGY POL'Y 4540 (2010) (finding that without aggressive abatement, the probability of catastrophic damages is high).

[31] *See* Weitzman, *supra* note 9; Tol, *supra* note 12. Participants at an EPA/DOE workshop following the interagency process likewise noted that existing research already suggests that IAMs could better assess high-end warming scenarios. ICF INT'L, DRAFT WORKSHOP REPORT: IMPROVING THE ASSESSMENT AND VALUATION OF CLIMATE CHANGE IMPACTS FOR POLICY AND REGULATORY ANALYSIS—PART 1, at 6 (2011), *available at* http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0564-50.pdf/$file/EE-0564-50.pdf.

[32] *See* Gary W. Yohe & Richard S. J. Tol, *The Stern Review and the Economics of Climate Change: An Editorial Essay*, 89 CLIMATE CHANGE 231, 237 (2008).

[33] *See generally* Weitzman, *supra* note 9.

[34] *See, e.g.*, Pindyck, *Uncertain Outcomes and Climate Change Policy*, *supra* note 17.

and the damage function lead to increases in the SCC of 33% to 115%.[35] A number of other studies suggest methods for addressing the problem of catastrophic changes.

Rather than waiting an indefinite amount of time for further insights, the agencies and the Working Group should evaluate the existing literature, make a decision about the best way to apply it, and begin incorporating greater consideration of catastrophic damages into the analysis to produce the most accurate SCC estimates available. If the agencies do not make an adjustment to the SCC estimates for catastrophic damages, the rule will underestimate greenhouse gas reduction benefits and will risk setting a precedent for future emissions standards to be less stringent than socially optimal.

The Agencies Should Increase the SCC Estimates to Account for Risk Aversion[36]

Climate change outcomes are uncertain: the exact damages each additional unit of greenhouse gas emissions will cause are unknown. Consequently, each unit of emissions contributes additional risk that climate damages will be worse than expected.

This risk can be valued by thinking of climate abatement as an investment. Most people are naturally risk averse; when investments involve risk, people are willing to pay for greater certainty than when only considering the expected returns of the investment.[37] For example, an investment option with less risk will typically sell at a higher price than a risky investment, even if the two alternatives have an equal expected payout. In portfolio theory, that price differential represents the risk premium that risk-averse actors demand for holding a risky asset. Investors also mitigate risk by buying investments that co-vary so that, ideally, when one investment performs poorly, the other performs well, increasing the certainty that the total investment portfolio will have positive returns. Thus, when investing in a range of assets, the covariance of the assets helps determine the price investors will pay for those assets.

The Working Group decided in early 2010 to continue "investigating" the issue of risk aversion in lieu of including a risk premium in the SCC. The Working Group did note that Anthoff, Tol, and Yohe found that risk aversion is at least as important as the rate of time preference[38] —a topic that the Working Group discusses in great detail. However, without citing studies with different results, it still concluded that further investigation was necessary before including a risk premium in the SCC.

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[35] *See* Pycroft et al., *supra* note 26.

[36] Some of the literature on risk premiums distinguishes risk and uncertainty based on Knight's definitions: risk involves known probabilities, while uncertainty involves the inability to determine the probabilities of different outcomes. FRANK H. KNIGHT, RISK, UNCERTAINTY, AND PROFIT (1921). However, the distinction between uncertainty and risk is not always clear. We do know that climate damages are not certain. We also know that people are willing to pay to increase the certainty of damages. For the sake of simplicity, these comments recommend a "risk" premium to account for the affects of aversion to both risk and uncertainty.

[37] *See* Sonia Quiroga & Ana Iglesias, *A Comparison of the Climate Risks of Cereal, Citrus, Grapevine and Olive Production in Spain,* 101 AGRICULTURAL SYSTEMS 91, 98-99 (2009) (specifying risk premium in relation to risk aversion among Mediterranean agricultural producers); Howard C. Kunreuther & Erwann O. Michel-Kerjan, *Climate Change, Insurability of Large-Scale Disasters, and the Emerging Liability Challenge*, 155 U. PA. L. REV. 1795 (2007) (discussing calculations for insurance policies amid climate change); Alicia N. Rambaldi & Phil Simmons, *Response to Price and Production Risk: The Case of Australian Wheat*, 20 J. FUTURES MKTS. 345 (2000). *See also* Joseph E. Aldy et al., *Designing Climate Mitigation Policy* 14 (Res. for the Future, Discussion Paper 08-16, May 2009) (noting that proper risk premium estimate is the subject of dispute, and that it varies with estimates of the marginal utility of consumption net of climate damages); David Anthoff, Richard S. J. Tol, & Gary W. Yohe, *Risk Aversion, Time Preference, and the Social Cost of Carbon*, 4 ENVTL. RESEARCH LETTERS 1 (2009) (distilling from historical data values for the elasticity of marginal utility with respect to consumption, and identifying salience of uncertainty in SCC calculation).

[38] WORKING GROUP REPORT, *supra* note 2, at 31 (*citing* Anthoff et al., *supra* note 37, at 1 ("[T]he assumed rate of risk aversion is at least as important as the assumed rate of time preference in determining the social cost of carbon.")).

It failed to mention the work of Heal and Kristrom,[39] Heal,[40] Hennlock,[41] Tol,[42] Yohe and Tol,[43] or additional work by Weitzman,[44] among many others that suggest the use of significant risk premiums. In short, the decision to delay inclusion of a risk premium in the SCC is inconsistent with the literature. Although scholars use different methods for calculating risk premiums and arrive at different results, disagreement over the size of these values does not suggest that they should be zero.[45] The degree of risk society faces is a subject of contention, but most economists believe that there is some non-negligible risk premium that must be accounted for in the SCC.[46]

More important than the precise value is the realization that positive risk aversion warrants incorporating a positive risk premium into the SCC.[47] There are two different pathways for risk aversion to be important for calculating the value of greenhouse gas abatement. In the first, mitigation steps taken today can be understood as an investment that is part of a larger portfolio of investments made by society. Under this framework, risk aversion can lead to a higher or lower social cost of carbon, depending on whether the value of greenhouse gas emissions in the future are correlated with the overall growth rate of the economy. To the extent that many of the effects of climate change will involve non-market impacts—the decimation of coral reefs, for example, or widespread extinction of terrestrial species—they may be substantially unrelated to the returns in the economy as a whole. If a substantial share of the damages from climate change is expected to be uncorrelated to returns in the economy as a whole, the discount rate should move toward the risk-free rate.

For policymakers today, there is also a great deal of uncertainty about the relationship between the greenhouse gas emissions and climate outcomes. Resolution of that uncertainty is structurally

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[39] Geoffrey Heal & Bengt Kristrom, *Uncertainty and Climate Change*, 22 ENVTL. RESOURCE ECON. 3 (2003) (analogizing climate change to insurance markets).

[40] Geoffrey Heal, *The Economics of Climate Change: A Post-Stern Perspective*, 96 CLIMATE CHANGE 275 (2009) (identifying the effects of uncertainty and risk aversion and suggesting that society will pay to avoid climate change risks).

[41] Magnus Hennlock, *Robust Control in Global Warming Management: An Analytical Dynamic Integrated Assessment* (University of Gothenberg, Working Papers in Economics No. 354, 2009) (finding that the preference for avoiding uncertainty entails a higher SCC due to the need for an ambiguity premium).

[42] Richard S. J. Tol, *The Social Cost of Carbon: Trends, Outliers, and Catastrophes* 2 ECONOMICS: THE OPEN-ACCESS, OPEN-ASSESSMENT E-JOURNAL (2008).

[43] Yohe & Tol, *supra* note 32.

[44] Martin L. Weitzman, *Additive Damages, Fat-Tailed Climate Dynamics, and Uncertain Discounting*, 3 ECONOMICS: THE OPEN-ACCESS, OPEN-ASSESSMENT E-JOURNAL 1 (2009); and Martin L. Weitzman, *GHG Targets as Insurance Against Catastrophic Climate Damages* (NBER, Working Paper No. 16136, 2010).

[45] *See, e.g.*, Gary Yohe, *Toward an Integrated Framework Derived from a Risk-Management Approach to Climate Change*, 95 CLIMATE CHANGE 325, 329 (2009) (suggesting the need to account for risk and uncertainty in climate change policy); Yohe & Tol, *supra* note 32, at 237 (arguing that the optimal carbon tax must be augmented by a non-zero risk premium); Heal & Kristrom, *supra* note 39; Heal, *supra* note 40; Hennlock, *supra* note 41; Antony Millner, Simon Dietz, & Geoffrey Heal, *Ambiguity and Climate Policy* (Center for Climate Change Economics and Policy, Working Paper No. 28, 2010) (finding that aversion to uncertainty in some cases leads to very large "ambiguity" premiums); Gerst et al., *supra* note 30 (showing that ignoring uncertainty underestimates climate damages); *and* Robert E. Kopp et al., *The Influence of the Specification of Climate Change Damages on the Social Cost of Carbon* (Economics: The Open-Access, Open-Assessment E-Journal, Discussion Paper No. 2011-22, 2011) (finding that uncertainty and risk aversion can significantly increase the SCC). Much of this literature review is based on Kousky, *supra* note 19. *See also Ctr. for Biological Diversity*, *supra* note 25.

[46] *See, e.g.*, Anthoff et al., *supra* note 37, at 5 (finding SCC estimates over $5,000 per ton of carbon dioxide for some parameter values); Millner et al., *supra* note 45; Kousky et al., *supra* note 19, at 14 (concluding after surveying the literature on risk and uncertainty premiums that these premiums could be "quite large").

[47] *See generally* Yohe, *supra* note 45; Yohe & Tol, *supra* note 32, at 237 ("While reasonable people disagree how much of a risk premium should be placed on top of the Pigou tax, it should be clear that no reasonable person would argue that this premium should be zero."); Kousky et al., *supra* note 19. *See also* Klaus Keller, Gary Yohe, & Michael Schlesinger, *Managing the Risks of Climate Thresholds: Uncertainties and Information Needs*, 91 CLIMATE CHANGE 5 (2008) (discussing the proper portfolio of mitigation policies).

similar to the realization of a risk that is uncorrelated with market returns, and can be thought of as serving the same function within an investment portfolio.

In addition, the relationship between reductions in greenhouse gas emissions and economic growth reflects *causation* as well as correlation. Severe climate change could bear negatively and directly on overall economic productivity. For example, sea level rise could threaten large parts of the coastal United States, especially low-lying areas like Florida. In effect, such a causal relationship will be a source of negative correlation between the benefits of mitigation and broader market returns. In climate scenarios with greater temperature change, total damages from climate change will be higher, but total economic activity will be lower (*ceteris paribus*)—marginal damages and therefore marginal benefits of mitigation will be high (due to convexity of damages) while the returns to the broader economy will tend to be low (the productivity effect).

The second pathway for risk aversion to impact the SCC concerns how investment in climate change mitigation reduces the variance of expected outcomes for the economy as a whole. The distribution of possible climate outcomes is a function of emissions, such that each ton of emissions can amplify the variance of aggregate economic damages and thereby further increase systematic risk. This means that, in addition to increasing the likelihood of catastrophic outcomes, each additional unit of emissions also increases the uncertainty about which outcome will occur. Thus, a full risk premium in the climate change context values the ability of emissions abatement to reduce the variance of outcomes.

Despite these justifications, the Working Group noted that government is usually risk neutral and questioned whether the climate change context merits different treatment. In fact, the nature of the climate problem requires government to be risk averse. For most social problems, the government is large enough that it can self-insure against disaster and act without aversion to risk. But because climate change is qualitatively different than other social problems involving risk, the agencies should treat it differently. The Working Group noted the suggestion in the Office of Management and Budget's *Circular A-4* that government agencies should "generally" assume the perspective of a risk neutral actor. But it also observed that society should not always be risk neutral, that *Circular A-4* "allows for a different assumption on risk preference in regulatory analysis if it is adequately justified,"[48] and that agencies should deviate from the risk neutral perspective when necessary.[49] The global nature of climate change catastrophes requires such a deviation. *Circular A-4* endorses the use of expected values without a risk premium—here, the average damages of all possible climate outcomes—only when society is risk neutral. However, society will not be neutral when risks cannot be offset by other investments. Compensating for the loss of habitability on Earth is impossible; the ability of the planet to sustain human life is irreplaceable. The magnitude of the damages associated with the risk of catastrophic climate change overwhelms the ability of society to match these damages with gains from other investments.[50] This suggests that risk aversion is necessary for society to account for the uniquely problematic nature of climate change.

The Working Group attempted to account for risk aversion by including a 95th percentile SCC estimate at a 3% discount rate.[51] The decision to include consideration of risk aversion in one of four estimated SCC values misses the point. Risk and uncertainty are systematic in the climate change context. Consequently, *all* SCC estimates should include risk premiums to account for these factors. Furthermore, it is not clear whether the selection of the 95th percentile SCC estimate was

[48] *See* WORKING GROUP REPORT, *supra* note 2, at 31.

[49] *See id.* at 30 (citing OFFICE OF MGMT. & BUDGET, EXECUTIVE OFFICE OF THE PRESIDENT, CIRCULAR A-4, 42 (2003)).

[50] *See* Weitzman, *supra* note 9, at 11.

[51] *See* WORKING GROUP REPORT, *supra* note 2, at 30.

chosen based on a reasoned connection to the risks under consideration, or out of simple convenience.

Studies that either calculate a risk premium or that include a risk premium when estimating the SCC generally find such premiums to be substantial. Heal finds a premium between 0.1% and 8.13% of national income.[52] Tol calculates a risk premium with "conservative assumptions" around $6-$7/ton of carbon dioxide.[53] Antoff, Tol, and Yohe report SCCs from about $16/ton of carbon dioxide to over $5,000/ton when incorporating uncertainty into the calculation.[54] Finding that uncertainty and equity interact to increase the SCC, they report a final SCC estimate of more than $50/ton of carbon dioxide.[55]

These studies constitute several ballpark examples of premium size. Other studies suggest both higher[56] and lower[57] values for risk premiums. Different assumptions about the degree of risk aversion and parameters in IAMs can radically change modeling outcomes. The point is that the values under consideration are often very large relative to current SCC estimates. The presence of many high estimates for risk premiums suggests that they should be given substantial weight in determining the SCC.

The wealth of studies on this subject provides the agencies with sufficient know-how to incorporate a risk premium into the SCC estimates. The agencies and the Working Group should analyze the range of approaches toward risk and implement the best method for incorporating a defensible risk premium into the SCC. In particular, the agencies should consider including either a "risk adder" or a downward adjustment of the discount rate.[58] Without a risk premium, the SCC estimates will be too low and the rule will undervalue benefits from greenhouse gas reductions, setting a precedent for future emissions standards to be inefficiently lenient.

Risk Aversion and Catastrophic Damages Likely Interact, Necessitating Even Larger SCC Values

The combination of risk aversion and uncertainty about catastrophic damages implies an even greater upward adjustment to SCC estimates may be necessary. Millner, Deitz, and Heal argue that differences among complex climate change models expose large gaps in our knowledge regarding climate damages.[59] Substantial uncertainty remains for a variety of IAM parameters.[60] In the presence of risk aversion, this deep uncertainty coupled with the possibility of catastrophic climate damages implies that the risk adjustment may need to be very large to account for society's desire to avoid catastrophic climate damages. Each unit of emissions reduction not only decreases the average expected future damages, but also thins the fat tails in damage probability distributions,

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[52] *See* Heal, *supra* note 40, at 287.

[53] *See* Tol, *supra* note 42, at 6.

[54] *See* Anthoff et al., *supra* note 37, at 5-6.

[55] *See id.* at 6.

[56] *See, e.g.*, Dietz, *supra* note 29.

[57] *See, e.g.*, Robert Mendelsohn, *Is the* Stern Review *an Economic Analysis?*, 2 REV. ENVTL. ECON. & POL'Y 45 (2008).

[58] Reducing the discount rate is one way to account for risk aversion. *See* Kousky et al., *supra* note 19, at 4. However, the effect of emissions abatement investments on the overall level of risk in the economy does not affect the discount rate as described by modern portfolio theory. There are also independent reasons for lowering the discount rates used by the Working Group, *see* Letter from Institute for Policy Integrity & Environmental Defense Fund, to Lisa P. Jackson, Administrator, EPA, 15 (Nov. 27, 2009) *available at* http://www.policyintegrity.org. Any downward adjustment to the discount rate to account for risk should not diminish those independent reasons to also lower the discount rate.

[59] *See* Millner et al., *supra* note 45.

[60] *See, e.g.*, Pindyck, *Uncertain Outcomes and Climate Change Policy*, *supra* note 17; Newbold & Daigneault, *supra* note 18.

thereby reducing the likelihood of catastrophic outcomes.[61] If the government is risk averse, the SCC should include a large risk premium to account for all of these effects.

The Agencies Should Continually Revise the SCC to Reflect the Most Recent Scientific Knowledge

Since the Working Group report, there have been substantial advances in climate science that should be taken into account in the models that underlie the SCC. Several arguments favor revising the SCC to account for the most recent scientific advances as soon as possible in advance of the final rulemaking. First, professional and legal norms for accurate cost-benefit analysis require doing so. Executive Orders instruct federal agencies to accurately weigh the costs and benefits of regulation and base decisions on "the best reasonably obtainable scientific, technical, [and] economic . . . information."[62] Although the stringency of the proposed emissions standards was negotiated prior to the rulemaking,[63] and the rule will remain cost-benefit justified even with the underestimated SCC values,[64] developing an accurate cost-benefit analysis for the final rule is still important. Given that the tremendous private benefits of the rule are somewhat controversial (though they are clearly real and should be counted),[65] accuracy in the estimation of social benefits will help increase confidence in the judgment that total benefits will outweigh costs. Moreover, in addition to aiding the choice between regulatory alternatives, cost-benefit analysis is a way of presenting information to the public and decisionmakers.[66] The analysis shapes the public debate not just about this rule, but about future related rulemakings on climate or efficiency.

Second, regulatory impact analysis often builds off of methodologies established in previous rulemakings. EPA and DOT's regulatory impact analyses in particular have a history of setting a precedent for other federal—and even state—agencies to consider the SCC in their own rulemakings.[67] Even if improving the accuracy of the SCC will not affect the stringency or structure of the present rulemaking, it could influence future emissions and efficiency standards developed in other rulemaking contexts or by other agencies. EPA and NHTSA therefore have a responsibility to include the most accurate SCC values, reflecting the most up-to-date scientific and economic literature, in their final rulemaking.

Third, by incorporating the latest scientific developments, the agencies ensure that their analyses do not fall out of date, and can help encourage climate research. Revising the SCC to account for the most recent scientific developments will signal to researchers that the government cares deeply about better understanding these issues, stimulating additional research into these topics. The agencies can even use the revision as an opportunity to identify key outstanding questions, in order to direct future research.

In its February 2010 report, the Working Group committed to "updating these [initial] estimates as the science and economic understanding of climate change . . . improves" and "revisiting the SCC values within two years or at such time as substantially updated models become available."[68] The

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[61] *See, e.g.*, Kousky et al., *supra* note 19, at 3.

[62] Exec. Order 12866, § 1(b)(6)-(7); Exec. Order 13563 § 1(c) ("each agency is directed to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible").

[63] WHITE HOUSE, DRIVING EFFICIENCY (2011), *available at* http://www.whitehouse.gov/sites/default/files/fuel_economy_report.pdf.

[64] Proposed Rule, *supra* note 5, at 74,890.

[65] *See infra* Part II.

[66] *See* Nathaniel Keohane, *The Technocratic and Democratic Functions of the CAIR Regulatory Analysis*, *in* REFORMING REGULATORY IMPACT ANALYSIS at 33 (Harrington, W., Heinzerling, L., & Morgenstern, R. eds., 2009).

[67] *See* WORKING GROUP REPORT, *supra* note 2, at 3-4.

[68] WORKING GROUP REPORT, *supra* note 2, at 3.

agencies can make good on this commitment by ensuring that the SCC used in the final rulemaking is based on the most recent climate science.[69]

The Agencies Should Work Toward Developing Non-Carbon Dioxide Benefits Estimates

The Working Group had also planned to develop better methods for estimating the benefits of reducing non-carbon dioxide greenhouse gases within the same two-year timeframe mentioned above.[70] The SCC does not smoothly translate into damage figures for other greenhouse gases like methane and hydrofluorocarbons, because of different radiative forcing, atmospheric lifetimes, and environmental impacts.[71] As a result, the proposed rule excludes the monetized value of non-carbon dioxide greenhouse gas reductions, even though such reductions make important contributions to the program's climate benefits.[72] The agencies should commit to developing better estimates of non-carbon dioxide benefits during the SCC revision process, ideally in time to incorporate such estimates in the final rulemaking.

Factors for the Mid-Term Evaluation Should Specifically Include Benefit Estimate Revisions

Periodic review of ongoing regulations is a valuable check on efficiency,[73] and the practice is now enshrined in executive order.[74] The agencies' plan to conduct a mid-term evaluation of the rule in advance of model year 2022 is commendable.[75] Unfortunately, EPA's list of relevant factors to consider during this review process lacks key elements. While there is a catch-all listing of "other factors," there is no specific mention of reviewing any changes in benefits estimates,[76] such as any revised SCC values. The agencies should amend their list of factors to specifically reflect any potential changes to benefits estimates, in addition to changes to costs or the state of technology.

EPA Should Move Quickly Toward Fully Counting Upstream Emissions from Electric Vehicles

In the proposed rule, EPA continues its practice of incentivizing electric vehicle technology by treating such vehicles as producing zero emissions and by letting manufacturers apply a multiplier when counting electric vehicles in their fleet averages.[77] Yet, as EPA knows, electric vehicles are not responsible for zero greenhouse gas emissions: electric vehicles run on energy from the electric grid, produced largely by carbon-emitting combustion. EPA's program in essence allows for a triple undercounting of greenhouse gas emissions—once by not accounting for emissions from electric cars, twice by counting electric cars more than once when averaging, and finally by allowing the credits to be traded to other manufacturers—and allowing for increases in greenhouse gas emissions at every step. Any form of subsidization of new technology should be neutral with respect to greenhouse gas emissions; it should definitely not contribute to their increase. Although

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[69] In its Preliminary Regulatory Impact Analysis from November 2011, NHTSA simply repeated the two-year timeline without noting any concrete next steps. *See* NHTSA, PRIA, at 654 (2011), http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/2017-25_CAFE_PRIA_final.pdf. The proposed rule itself even more vaguely refers to a revision "in the next few years." Proposed Rule, supra note 5, at 75,127. Though EPA and Department of Energy have co-hosted two workshops over the past two years bringing together top climate modelers, *see* http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/ClimateEconomics.html, the agencies have not publicly committed to any specific plans to reconvene the interagency working group and update the SCC as of the date of these comments.

[70] WORKING GROUP REPORT, *supra* note 2, at 12 ("The goal is to develop these estimates by the time we issue revised SCC estimates for carbon dioxide emissions.").

[71] *Id.*

[72] Proposed Rule, *supra* note 5, at 75,141.

[73] *See* Comments from Policy Integrity to EPA and DOT on Retrospective Review (Mar. 18, 2011, Apr. 1, 2011, June 27, 2011, July 3, 2011), *available at* http://www.policyintegrity.org.

[74] Exec. Order 13,563 § 6.

[75] Proposed Rule, *supra* note 5, at 74,879.

[76] *Id.* at 74,986.

[77] *Id.* at 74,878, 75,012-14.

it may be a valid policy goal to incentivize new technology, EPA should achieve this goal by providing grants and subsidies to manufacturers and scientists exploring all promising emission-reducing technologies. By giving inflated regulatory incentives to a certain type of technology rather than allowing manufacturers to find the most efficient and effective solution, EPA will disincentivize other forms of technology that may be more cost-effective at reducing greenhouse gas emissions.

Fortunately, EPA at least plans to limit these distorting credits starting with model year 2022, dropping the multiplier and capping the number of cars that can be counted as having zero emissions; any remaining electric vehicles will be assigned their net upstream emissions.[78] The agency asks for comments on whether there should be an interim period where only half of upstream emissions are counted, whether any changes should be made to the current electric vehicle incentive program, and whether similar incentives should be extended to other specific technologies.[79] For the reasons given above, EPA should either eliminate these incentives, or at least move as quickly as possible toward fully accounting for the upstream emissions of alternative fuel vehicles.

Part II. Vehicle Attributes

The agencies assume that the current market accurately reflects the range of consumer preferences for vehicle attributes like performance, carrying capacity, safety, and comfort, failing only with respect to fuel economy technology. The agencies want to ensure that the proposed rule will preserve both consumer choice and the same mix of vehicle options. If instead the rule were to impact vehicle attributes like size and power, the agencies worry that consumers might experience a loss in welfare, erasing some of the large net benefits the rule should generate for consumers and society.[80]

To this end, the agencies take two steps. First, they tie the prescribed standards to vehicle footprint, so that larger vehicles will generally be subject to less stringent controls compared to smaller vehicles. Second, the agencies apply an assumption of constant performance to their cost estimates, believing that manufacturers will spend whatever extra it costs to maintain current vehicle attributes as they increase fuel economy.[81]

The agencies should rethink both their attribute-based standards and their estimation of costs. First, the footprint-based standards may be unnecessary to respect consumer preferences, may negatively impact safety, and may be overall inefficient. Several arguments call into question the footprint-based approach, but a particularly important one is that large vehicles can impose a negative safety externality on other drivers.

Second, the agencies' constant performance cost estimates represent an upper bound to possible consumer welfare losses and are most likely overestimates, because vehicle attributes are partly positional and consumer preferences can shift with changing attributes. Similarly, the unlikely chance that the agencies' cost projections underestimate consumer welfare losses is further mitigated by the actual nature of consumer preferences. Finally, those same insights from positional goods theory and the bandwagon effect should be considered in the agencies' forecast for the future consumer market for new technologies like electric vehicles.

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[78] Proposed Rule, *supra* note 5, at 74,878, 75,012-14.

[79] *Id.*

[80] *Id.* at 74,859, 74,931.

[81] *Id.* at 74,930.

Footprint-Based Standards May Be Unnecessary to Respect Consumer Preferences, May Negatively Impact Safety, and May Be Overall Inefficient

The agencies choose to set regulatory stringency according to vehicle footprint, in part because the statute requires NHTSA to base standards on attributes related to fuel economy.[82] The agencies offer five justifications for choosing a footprint-based approach:[83]

- First, they claim the optimal attribute-based standard will achieve greater overall fuel savings than the optimal flat standard, since an attribute-based approach encourages all manufacturers to add new technologies every year, even those manufacturers with fleets that are already relatively efficient.
- Second, out of concerns for safety, the agencies want to remove the incentive to build smaller cars in order to comply with the standard.
- Third, the agencies believe the attribute-based approach will be more equitable than a flat standard, which could impose disproportionate burdens on some manufacturers.
- Fourth, the agencies want to preserve the current vehicle mix in the marketplace in order to respect consumer choice.
- Fifth, the agencies believe a footprint-based approach involves a lower risk of manufacturers "gaming" the system, at least compared to a weight-based approach.

All five justifications are problematic.

<u>The first justification</u> assumes that attribute-based approaches will increase overall fuel savings since, under a flat standard, manufacturers with fleets that are already relatively fuel efficient would have little incentive to continue upgrading. However, this claim very much depends on whether the proposed attribute-based standard is actually optimal: an inefficient footprint-based standard is unlikely to achieve greater overall fuel savings than the optimal flat standard.

Moreover, given that reducing vehicle size, weight, and performance are relatively cheap and readily available compliance options,[84] even the optimal footprint-based standard may suffer from inefficiencies by disincentivizing an otherwise cost-effective strategy. Wenzel's research suggests that "a fuel economy standard that discourages vehicles with smaller footprint . . . will not be as effective in reducing fuel consumption and associated greenhouse gas emissions as a single stringent standard applied across all vehicle sizes. . . . A single stringent fuel economy standard would discourage the continued use of light trucks (with low fuel economy) as essentially substitutes for cars, and encourage greater use of lighter and smaller vehicles."[85]

NHTSA should consider the advantages and disadvantages of all fuel economy-related attributes, and choose the attribute-based approach that will allow it to maximize net benefits of the rule; EPA should do the same with all possible approaches, including non-attribute, flat standards. One fuel economy-related attribute the agencies do not seem to have considered[86] that may warrant analysis is vehicle fuel type.

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[82] *Id.* at 74,912 (citing EPCA/EISA).

[83] *Id*. at 74,912-13.

[84] *See generally* Christopher R. Knittel, *Automobiles on Steroids: Product Attribute Trade-Offs and Technological Progress in the Automobile Sector* (U.C. Davis Inst. of Transportation Studies UCD-ITS-RR-09-16, 2009).

[85] Tom Wenzel, *Analysis of the Relationship Between Vehicle Weight/Size and Safety, and Implications for Federal Fuel Economy Regulation*, at 43 (Report for the U.S. Dep't of Energy, Lawrence Berkeley National Laboratory Paper LBNL-3143E, 2010).

[86] Proposed Rule, *supra* note 5, at 74,913.

The second justification offered is that a footprint-based approach will avoid negative safety impacts. To start, the footprint-based approach does not completely eliminate the incentive to build smaller cars to comply with the rule. The mathematical formulas that set the standards are only strictly increasing along the range from 40 square feet to either 55 square feet for cars or 75 square feet for trucks; at other points, the curve is flat.[87] Admittedly, that central range covers most vehicle models.[88] However, at least several dozen models (mostly subcompacts and sports cars) fall in the 30-40 square feet range,[89] which are all subject to the same standards.[90] At a minimum, the manufacturers of these models may have an incentive to decrease footprints as a compliance strategy, since doing so would not trigger more stringent standards.

Manufacturers could also decrease weight without decreasing footprint as a compliance strategy. The overall effects of such a choice on safety are not immediately clear, though at least some evidence suggests that redesigning truck-based SUVs into car-based crossover SUVs resulted in both lighter vehicles and decreased safety risks to drivers and others.[91]

More importantly, the relationship between size and safety is neither simple nor unidirectional. To the extent smaller cars fare worse in crashes with bigger cars, increasing size may improve an individual driver's safety; but it may simultaneously impose a negative safety externality on other drivers, whose cars are now relatively smaller compared to the growing average fleet size. Decreasing size may have similarly opposing impacts on safety. Therefore, maintaining or increasing the average size of the entire fleet does not guarantee the safest outcome, and decreasing the fleet's average size in response to a fuel economy rule might have no overall change in safety levels (though at some point, reducing the size or changing attributes could affect the vehicle's intrinsic safety, as distinct from its relative safety). As Wenzel, a leading researcher on this subject, has explained, "a fuel economy standard that discourages vehicles with smaller footprint, or lower weight, will not necessarily reduce casualties. . . .Details of vehicle design, which can be improved through direct safety regulations, will have a greater effect on occupant safety than fuel economy standards that are structured to maintain vehicle size or weight."[92]

The third justification put forward is that a flat standard would inequitably affect some manufacturers more. However, to the extent that the fuel economy program can incorporate a trading scheme for compliance credits,[93] the market would help smooth out any disproportionate impacts on certain manufacturers. Additionally, trading will ensure that manufacturers with relatively efficient fleets still have an incentive to continue improving fuel economy (in order to generate credits), which will further mitigate the agencies' first concern, mentioned above.

The fourth justification states that the agencies need to preserve the current vehicle mix in order to respect consumer choice. The agencies do not, however, adequately explain why maintaining the current vehicle mix is necessary to protect consumer welfare. The negative safety externality generated by larger vehicles indicates that the vehicle fleet may, on average, be too big; furthermore, some vehicle downsizing may represent a cost-effective method for compliance and have little impact on consumer welfare (as explained below).[94] Preserving the current vehicle mix

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[87] *Id.* at 74,871-74.

[88] Wenzel, *supra* note 85, at 7.

[89] *Id.* A very few luxury car models have footprints in the 55-80 square feet range, which also have flat standards.

[90] Proposed Rule, *supra* note 5, at 74,871-74.

[91] Wenzel, *supra* note 85, at 43.

[92] *Id.*

[93] Proposed Rule, *supra* note 5, at 74,968.

[94] *See infra* note 99, and accompanying text.

is therefore not necessary to protect consumer welfare, and there is no reason to preserve the current mix as an end unto itself.

The fifth justification sees a footprint-based standard as a way to discourage "gaming" behavior, especially compared to a weight-based standard. A weight-based standard may be easier to game than a footprint-based standard, but that does not mean that manufacturers will not still game the proposed regulation in ways that reduce overall efficiency. In fact, it seems the footprint-based standard creates an incentive to expand vehicle size in order to relax the applicable standard. Given that automobile manufacturers already respond to very fine-tuned tax incentives for fuel economy,[95] it certainly seems possible that the proposed rule will encourage some gaming of the average footprint.

NHTSA should remember that footprint and weight are not the only possible fuel economy-related attributes on which to base policy. For example, it might be much harder for manufacturers to game either a much flatter attribute-based standard or a standard differentiated by vehicle fuel type. EPA should assess whether a different approach, including a non-attribute, flat standard, might be the best at discouraging gaming.

In conclusion, a footprint-based standard may be unnecessary to respect consumer preferences, and may interfere with downsizing that could be, on the whole, consumer-welfare enhancing; it may have negative impacts on safety, given the negative safety externality that relative size can generate; and it may simply be inefficient compared to a more optimal, flatter standard. The agencies should seriously rethink whether the footprint-based approach is the best option.

If the agencies do go forward with a footprint-based approach, they should study its effects carefully and revisit the matter when more evidence is available. The first footprint-based fuel economy standards took effect with model year 2012.[96] The agencies therefore now have an opportunity to begin analyzing how the attribute-based standards influence manufacturers' production decisions. The agencies should consider whether the results of such a study challenge the footprint-based approach, at least during the planned mid-term evaluation, if not sooner.

Constant Performance Cost Projections Likely Overestimate the Risk of Lost Consumer Welfare, and the Agencies Should Treat Them as an Upper Bound

The agencies build an assumption of constant performance into their compliance cost estimates. They believe that manufacturers will spend whatever extra it costs to maintain current vehicle attributes as they increase fuel economy, in order to preserve consumer welfare. The cost projections therefore depend on the agencies' best guesses about how changed attributes would impact consumer preferences and welfare. As the agencies note, "[b]ecause welfare losses are monetary estimates of how much consumers would have to be compensated to be made as well as in the absence of the change, the price increase measures the loss to the buyer."[97]

As a result, if the agencies are wrong about how changing attributes would impact consumer preferences, then they are overestimating how much manufacturers will need to spend to maintain consumer welfare. The agencies acknowledge that their cost estimate is likely to be an overestimate:

> because the consumer has choices other than buying the same vehicle with a higher price; she could choose a different vehicle, or decide not to buy a new vehicle. The consumer

[95] James Sallee & Joel Slemrod, *Car Notches: Strategic Automaker Responses to Fuel Economy Policy* (NBER Working Paper No. 16604, 2010). Also see attached symposium paper on the energy paradox, at 11-12.

[96] Proposed Rule, *supra* note 5, at 74,912.

[97] *Id.* at 75,116.

> would choose one of those options only if the alternative involves less loss than paying the higher price. Thus, the *increase in price that the consumer faces would be the upper bound of loss of consumer welfare*, unless there are other changes to the vehicle due to the fuel economy improvements that make the vehicle less desirable to consumers."[98]

Positional goods theory reinforces the conclusion that the agencies' cost estimate is an upper bound and is likely an overestimate.[99] The value of a "positional good" depends on how it compares with similar goods possessed by others.[100] The owner of a positional good derives more welfare from that good than expected when considering only its functional qualities. The prominent explanation for this phenomenon is that highly visible consumption becomes a signal for status,[101] and people value status because they anticipate it will translate into more favorable treatment in economic and social interactions.[102] For example, jewelry, silk ties, and expensive champagne all have very little functional value, but their consumption is conspicuous and conveys status to others.

Other goods, like cars, have both functional and positional value. Consumers may partially value vehicle size and horsepower for their functional utility like hauling capacity and speed, but a growing body of research indicates that many consumers do not necessarily want the biggest and fastest car, so long as their car is bigger and faster than their friends' and neighbors'. According to a recent U.S. survey on the visibility of 31 expenditure categories (from food to mobile phones), new or used motor vehicle purchases were the second most visible expenditure; related expenditures on gasoline/diesel, vehicle maintenance, and insurance were all substantially less visible.[103] Surveys also consistently confirm that cars are highly positional goods, that people prefer a relative increase in a car's value to an absolute increase,[104] and that the more visible features of cars are more positional.[105] Financial savings, in contrast, are typically considered non-positional.[106]

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[98] *Id.* at fn. 525 (emphasis added).

[99] See attached symposium paper on positional goods for additional details.

[100] Robert H. Frank, *The Demand for Unobservable and Other Nonpositional Goods*, 75 AM. ECON. REV. 101, 101 (1985).

[101] *Id.* at 107 ("When an individual's ability level cannot be observed directly, such observable components of his consumption bundle constitute a signal to others about his total income level, and on average, therefore, about his level of ability. . . . [I]mperfect information about ability might create incentives for people to rearrange consumption patterns to favor observable goods."). Consumption patterns might vary depending on the relevant population in the status competition. People might compete among friends, neighbors, and coworkers; within their socio-economic class; with higher classes; or on a society-wide basis. *See* Fredrik Carlsson et al., *Do You Enjoy Having More than Others? Survey Evidence of Positional Goods*, 74 ECONOMICA 586, 590 (2007). If a particular population has more reliable, independent information on abilities or income, consumption patterns for observable goods might shift. Frank, *supra* note 100, at 108.

[102] Y. Weiss & C. Fershtman, *Social Status and Economic Performance: A Survey*, 42 EURO. ECON. REV 801, 802 (1998). Status can be instrumental, in that higher status can carry better consumption opportunities, access to better employment, and even better marriage prospects. Ed Hopkins & Tatiana Kornienko, *Running to Keep in the Same Place: Consumer Choice as a Game of Status*, 94 AM. ECON. REV. 1085, 1087 (2004). Factors like psychology, biological hardwiring, and envy also should not be ignored.

[103] Ori Heffetz, *A Test of Conspicuous Consumption: Visibility and Income Elasticities*, 93 REV. OF ECON. & STAT. 1101, 1106 (2011) (vehicle purchase had a visibility index of 0.73, second only to tobacco products (0.76); gasoline/diesel had a visibility index of 0.39, car repairs were at 0.42, and car insurance fell near the bottom at 0.23).

[104] Specifically, a majority of people surveyed would prefer a world in which their car is superior to other people's but less valuable overall, versus a world in which their car has more absolute value but is inferior to the societal average. *See*, *e.g.*, Carlsson et al., *supra* note 101, at 588, 593 (reporting results of a Swedish survey); Francisco Alpizar et al., How *Much Do We Care About Absolute Versus Relative Income and Consumption?*, 56 J. OF ECON. BEHAVIOR & ORG. 405, 412 (2005) (reporting results of Costa Rican survey). Though some such surveys were conducted in other countries, if anything positionality for cars could be stronger in the United States, given the American affinity for cars and the income distribution. *See* Reid R. Heffner et al., *Effects of Vehicle Image in Gasoline-Hybrid Electric Vehicles* 2 (U.C. Davis Inst. of Transportation Studies UCD-ITS-RR-05-08, 2005) ("In the words of automobile psychologist G. Clotaire Rapaille, Americans are in 'a permanent search of an identity' and 'cars are very key . . . [they are] maybe the best way for Americans to express themselves.'"); Hopkins & Kornienko, *supra* note 102 (noting that positional effects increase as society's income increases, because the portion of income spent on conspicuous consumption increases). On the other

The more observable prestige features of vehicles include newness, brand, size, design, and power. While all these traits have functional value (such as capacity, safety, and performance),[107] they also all have relative value: consumers value power not just for speed but for the status signal and for the ability to out-accelerate others at a traffic light; consumers do not necessarily want a *big* car, but they do want a *bigger* car.[108] As Bob Lutz, Vice Chairman of General Motors, has stated, "aspirational aspects overwhelm the functional differences" when customers choose cars.[109] Importantly, many vehicle prestige features—especially larger size and increased performance—reduce fuel economy.[110] And given the low visibility of gasoline expenditures and of financial savings, fuel efficiency itself is currently a relatively non-positional good (though there is some chance that the agencies' new vehicle labeling requirements could start to make fuel economy more visible and positional).

A vehicle's size and weight are also positional for safety reasons, in addition to status motivations. To the extent smaller cars fare worse in crashes with bigger cars, consumers may value bigger cars not because of any intrinsic safety value, but because of the average fleet size. According to Wenzel's research on the relationship between vehicle weight/size and safety, while an increase in footprint decreases the risk of casualty to the driver, an increase in footprint—especially for pick-up trucks and sports cars—raises the risk of both fatality and casualty to *other* drivers.[111]

The trouble with positional goods is they impose externalities. This is obvious in the safety context: if Joan upgrades from her compact car to a large pick-up truck, she may feel somewhat safer, but her purchase marginally increases the risk to all other drivers. It also applies in the status context. Again, if Joan buys a big, fast, flashy car to move up the status hierarchy, John's big, fast, flashy car is no longer as rare. John feels relatively worse off and so will have to invest in an even bigger, faster, flashier car just to restore his previous status position. As a result, both consumers spend resources without actually improving their relative status.

Because vehicle purchase decisions are made non-cooperatively but in fact alter the spending behavior and relative safety of others, consumers get stuck on a "positional treadmill" that does not increase welfare.[112] Yet if any individual opts out of this "expenditure arms race," it would only

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hand, cars are often more a necessity and less a luxury in the United States than in other countries. *See* Mark Grinblatt et al., *Interpersonal Effects in Consumption: Evidence from the Automobile Purchases of Neighbors* (Yale ICF Working Paper No. 04-10, 2004).

[105] Carlsson et al., *supra* note 101, at 588, 593 (finding support for hypothesis that "visible goods and their characteristics, such as the value of cars, are more positional than less visible goods and their characteristics, such as car safety.").

[106] *See, e.g.* Omer Moav & Zvika Neeman, *Savings Rates and Poverty: The Role of Conspicuous Consumption and Human Capital* (2009), *available at* http://www.hecer.fi/Seminars/Papers/moav_paper.pdf.

[107] Carlsson et al., *supra* note 101, at 595, could not provide a clear answer to the question of whether cars are completely positional. On average cars are highly positional, but that reflects a good deal of heterogeneity: cars may be completely positional for some people, but are possibly completely non-positional for others. *Id.* at 596.

[108] Erik Verhoef & Bert van Wee, *Car Ownership and Status: Implications for Fuel Efficiency Policies from the Viewpoint of Theories of Happiness and Welfare Economics* 4 (Tinbergen Institute Discussion Paper TI 2000-076/3, 2000) ("However, most cars in most Western countries have engines with much more power than needed, given the characteristics of infrastructure, speed limits, and travel distances.").

[109] George Will, *Americans and Their Cars*, TOWNHALL DAILY, Apr. 18, 2002, *available at* http://townhall.com/columnists/GeorgeWill/2002/04/18/americans_and_their_cars.

[110] *See* Knittel, *supra* note 84.

[111] Wenzel, *supra* note 85, at 19, 36. Effect of footprint on fatality risk to driver: P-value 0.215, R^2 value 0.01. Effect of footprint on fatality risk to *other* drivers: P-value <0.001, R^2 value 0.38 (though the data for trucks drives this relationship much more than for cars). Effect of footprint on casualty risk to driver: P-value <0.001, R^2 value 0.26. Effect of footprint on casualty risk to *other* drivers: P-value <0.001, R^2 value 0.26 (though again the data for trucks drives this relationship much more than for cars).

[112] Robert H. Frank, *Positional Externalities Cause Large and Preventable Welfare Losses*, 95 AM. ECON. REV. 137, 137 (2005).

move that consumer backwards on the status or safety hierarchy, which for most consumers is unacceptable.[113] And given limited resources and limited market options, the over-consumption of positional goods results in under-consumption of non-positional goods (such as fuel efficiency). If consumers could maintain their relative economic position, they might be more willing to pay for non-positional goods.[114]

Fuel economy regulation, therefore, is a cooperative solution that allows consumers to achieve what they could not in the non-cooperative open market: namely, an increase in fuel economy without losing position in the status hierarchy.[115] Regulations similarly help consumers select fuel economy without falling behind in the safety/size rankings, since with time the average fleet size will shift.[116]

In other words, positional goods theory explains that consumer valuations of vehicle attributes like size and performance are relative, which means consumer preferences can adjust as average fleet-wide attributes shift. As a result, changing the fleet-wide average size or performance may not significantly impact overall consumer welfare. In the context of the agencies' cost estimates, this means that manufacturers may not have to spend as much as the agencies' assume in order to prevent any aggregate consumer welfare loss. Consequently, the agencies' constant performance cost projects likely overestimate the actual cost of the regulation.

To improve the accuracy of their cost estimates, the agencies should reanalyze their assumption that "changes in vehicle attributes can significantly affect the overall utility that vehicles offer to potential buyers,"[117] in light of positional goods theory. A better understanding of the positionality of cars will help the agencies refine their projections for how much manufacturers will need to spend to maintain actual consumer welfare. Even if a more accurate cost estimate is unlikely to change the stringency or structure of the proposed rule,[118] refining the cost estimate remains important. Not only is an accurate cost-benefit analysis based on the best available evidence required by professional and legal norms,[119] but a better cost estimate will enhance confidence in

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[113] Frank, *supra* note 100, at 105-06.

[114] Robert H. Frank & Cass R. Sunstein, *Cost-Benefit Analysis and Relative Position*, 68 UNIV. OF CHICAGO LAW REV. 323, 326 (2001) ("If people could maintain their relative economic position, they would be willing to pay more, and possibly a great deal more, to purchase many of the goods that regulation attempts to deliver. . . .[W]hen an individual buys additional safety in isolation, he experiences not only an absolute decline in the amounts of other goods and services he can buy, but also a decline in his relative living standards. In contrast, when a regulation requires *all* workers to purchase additional safety, each worker gives up the same amount of other goods, so no worker experiences a decline in relative living standards. If relative living standards matter, then an individual will value an across-the-board increase in safety more highly than an increase in safety that he alone purchases.").

[115] Correcting for negative externalities and collective action problems is a classic case for regulation. "Analytically, positional externalities are no different from ordinary environmental pollutants." *Id.* at 364. Such regulation is not about taking public action just because one consumer's increased consumption makes another consumer unhappy or envious; rather, regulation is justified to address a market failure. *Id.* at 365. Even if not everyone wants to solve this particular collective action problem, "we do not require unanimity as a precondition for unquestionably legitimate collective action in other spheres." *Id.* at 366. *See also* Verhoef & van Wee, *supra* note 91, at 13-14. ("On the free market, consumers would inefficiently strongly stimulate each other to purchase more luxurious variants. Corrective taxes [or a CAFE standard with tradable permits] may protect consumers against such treadmills.").

[116] Regulations also correct a supply-side problem, since theory predicts manufacturers will devote their research and development budget to status goods until government adjusts the incentives. Ben Cooper et al., *Status Effects and Negative Utility Growth*, 111 ECON. J. 642 (2001).

[117] Proposed Rule, *supra* note 5, at 75,331.

[118] *See supra* note 63, and accompanying text.

[119] *See supra* note 62, and accompanying text.

justifications for the rule, will improve the public debate over fuel economy, and will set a valuable precedent for future rulemakings.[120]

Any Risk of Lost Consumer Welfare Unaccounted for in the Agencies' Constant Performance Cost Projections Is Mitigated by the Positionality of Attributes

Despite the constant performance price projection model, the agencies worry that "if estimates do not include adequate allowances to prevent attribute sacrifices, technological costs will underestimate true economic costs."[121] The agencies acknowledge that, even with footprint-based standards and a constant performance approach, the proposed rule could cause manufacturers to forego future planned attribute improvements or even, "[i]n extreme cases," to change current attributes.[122] NHTSA conducted a sensitivity analysis to test this possibility, and found that even if lost consumer welfare equaled 50% of total private benefits, the rule would still be cost-benefit justified.[123]

Nevertheless, for use in the final rulemaking, NHTSA is developing a fuller model of buyers' decisions to estimate explicitly any welfare changes that could result from the combination of price increases, fuel economy increases, and altered vehicle attributes.[124] NHTSA should be sure to build the lessons from positional goods theory into its model, and the agencies should use the positionality of vehicle attributes and explain why their cost estimates are not likely to underestimate consumer welfare losses; in fact, to the contrary, position goods theory would predict that the cost projections are more likely to be overestimates.

Positionality and the Bandwagon Effect Will Shape the Consumer Market for New Technology

The agencies ask for comment on factors that may affect the consumer market for electric vehicles and other advanced technologies.[125] In conducting this analysis, the agencies should consider the malleability of consumer preferences and valuations for new technologies.

If fuel efficiency becomes a sufficiently visibility trait (perhaps as a result of the vehicle labeling rule, marketing campaigns, and related efforts), it is possible that consumers could start competing for the highest fuel efficiency. But even if that does not happen, consumers' valuation of fuel efficiency will undoubtedly change over time and as a result of the proposed regulation.[126]

The bandwagon effect occurs when the perceived attractiveness of a good increases as more people consume it. Growing empirical evidence suggests an environmental bandwagon: people are more likely to make environmental choices when they think everyone else is doing the same.[127]

The separate though conceptually related effects of information diffusion and habit formation might also affect the market for more fuel-efficient vehicles. Car choices are strongly influenced by

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[120] *See supra* notes 65-67, and accompanying text.

[121] Proposed Rule, *supra* note 5, at 75,202.

[122] *See* NHTSA, PRIA, *supra* note 69, at 708.

[123] *Id.* at 719.

[124] Proposed Rule, *supra* note 5, at 75,202.

[125] *Id.* at 75,117.

[126] Heffner et al., *supra* note 104, at 3 ("As more hybrid models enter the market, the meanings of HEVs are likely to evolve.").

[127] For example, when hotel guests are told they should "join their fellow citizens" in saving water by reusing towels, reuse rates increase by 34%; similarly, when electric bills present a comparison of neighborhood consumptions, usage decreases by 2%. *See* Hunt Allcott & Sendhil Mullainathan, *Behavior and Energy Policy*, 327 SCI. 1204 (2010); Hunt Allcott, *Social Norms and Energy Conservation*, 95 J. PUB. ECON. 1082 (2011).

the purchases of peers,[128] perhaps because consumers often deal with the need to justify their choices by deferring to the preferences of others.[129] Consumers might currently have a negative opinion of vehicles running on unknown technology or of unknown model types;[130] but once more fuel-efficient vehicles increase market share and become more familiar to consumers as a result of the proposed regulations, new consumer habits will form, and willingness to pay for fuel efficiency might increase.

Conclusion

The agencies should increase their estimates of climate benefits to more accurately value the chance of catastrophic damages. Substantial economic literature, including much published in the last two years, supports the conclusion that current models do not place enough emphasis on catastrophic scenarios and, consequently, that some adjustment to the calculation of benefits is necessary. Disagreement over the exact size of that adjustment does not suggest the risk of catastrophe should be valued at zero.

The agencies should increase their estimates of climate benefits to account for risk aversion. Climate change is a categorically different kind of social problem: no single government can self-insure against the risk of irreversible, planet-wide damages. The government, therefore, should be risk averse toward climate change. Though the degree of risk society faces is a subject of contention, most economists believe there is some non-negligible amount of risk that must be accounted for. A risk premium should be incorporated, either as an adder to the value of climate benefits, or as a downward adjustment to discount rates.

The agencies should continually revise their estimates of climate benefits to reflect the most recent scientific and economic knowledge. Even if a better estimate of benefits will not change the stringency or structure of the proposed rule, accuracy remains important. Professional and legal norms for economic analysis require it; accurate benefits estimates will increase confidence in the justifications for the rule and inform the public debate; and the agencies' impact analysis will set a precedent for future rulemakings. The agencies should take the lead on adjusting estimates to account for risk and catastrophic damages, as well as the latest climate science.

The agencies should make several other improvements in the valuation of climate benefits, including development of non-carbon dioxide estimates, incorporation of potential benefit revisions in the mid-term evaluation process, and accounting for the net upstream emissions from electric vehicles.

The agencies should rethink their footprint-based standards, which may be unnecessary to respect consumer preferences, may negatively impact safety, and may be overall inefficient. Increasing the safety of one car can impose a negative safety externality on others, and consumer preferences can adjust as average fleet-wide attributes shift. As a result, trying to eliminate the incentive to build smaller cars may block a cost-effective compliance strategy and may not guarantee a safer fleet.

The agencies should treat their constant performance cost projections as an overestimate of the risk of lost consumer welfare. Positional goods theory explains that vehicle attributes like size, power, and safety have relative value. Since attributes like size and performance are at least partly relative, changing the fleet-wide average size or performance may not significantly impact overall

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[128] Grinblatt et al., *supra* note 104 (reporting results of study in Finland that found car purchases strongly influenced by purchases of neighbors, most likely because of information sharing).

[129] James Bettman et al., *Constructive Consumer Choice Processes*, 25 J. CONSUMER RES. 3 (1998).

[130] Eugenio Miravete & Maria Moral, *Qualitative Effects of Cash-For-Clunkers Programs* (2009), *available at* http://www.eugeniomiravete.com/papers/EJM-MJM-Clunkers.pdf.

consumer welfare. Manufacturers may not have to spend as much as the agencies' assume in order to prevent any aggregate consumer welfare loss.

The agencies should consider how positionality and the bandwagon effect will shape the consumer market for new technologies. As fuel-efficient vehicles become more visible and more common, the perceived attractiveness of fuel efficiency may increase. Information diffusion and habit formation will also affect the future of the market for electric vehicles and other new technologies.

Respectfully Submitted,

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