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The Social Cost of Carbon, Greenhouse Gas Policies, and Politicized Benefit/Cost Analysis

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ARTICLE

THE SOCIAL COST OF CARBON, GREENHOUSE GAS POLICIES, AND POLITICIZED BENEFIT/COST ANALYSIS

*by: Benjamin Zycher**

ABSTRACT

Benefit/cost analysis can be a powerful tool for examination of proposed (or alternative) public policies, but, unsurprisingly, decisionmakers' policy preferences can drive the analysis, rather than the reverse. That is the reality with respect to the Obama Administration computation of the social cost of carbon, a crucial parameter underlying the quantitative analysis of its proposed climate policies, now being reversed in substantial part by the Trump Administration. The Obama analysis of the social cost of carbon suffered from four central problems: the use of global benefits in the benefit/cost calculation, the failure to apply a 7% discount rate as required by Office of Management and Budget guidelines, the conflation of climate and GDP effects of climate policies, and the inclusion of non-climate effects of climate policies as co-benefits, as a tool with which to overcome the trivial temperature and other climate impacts of those policies. Moreover, the Obama analysis included in its "market failure" analysis the fuel price parameter that market forces are likely to incorporate fully. This Article suggests that policymakers and other interested parties would be wise to concentrate on the analytic minutia underlying policy proposals because policy analysis cannot be separated from politics.

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* Resident scholar, American Enterprise Institute. The views expressed are mine, and responsibility for any errors is mine. Thanks are due William R. Allen, Richard J. Buddin, Laurence A. Dougharty, and participants in the conference on "Environmental Protection: Carrots or Sticks," cohosted by the Classical Liberal Institute of the NYU School of Law and the Texas A&M University School of Law, held March 8–10, 2018 at the Texas A&M University School of Law.

I. Introduction

In its 2015 proposed "Phase 2" rule on Greenhouse Gas ("GHG") Emissions and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles, the Environmental Protection Agency (the "EPA") asserted the following estimates of the central environmental effects attendant upon the proposed rule:

> The results of the analysis, summarized in Table VII-37, demonstrate that relative to the reference case, by 2100 projected atmospheric CO_2 concentrations are estimated to be reduced by 1.1 to 1.2 part [*sic*] per million by volume [ppmv], global mean temperature is estimated to be reduced by 0.0026 to 0.0065 °C, and sea-level rise is projected to be reduced by approximately 0.023 to 0.057 [centimeters.][1]

In addition, the EPA estimated (in Table VII-37) that the rule would increase ocean pH alkalinity (that is, would reduce "acidification") by 0.0006 units.[2]

Those asserted environmental effects of the proposed rule are particularly interesting in the context of historical changes in the various parameters and the EPA projections of baseline changes from 1990 to 2100.[3] Figure 1 summarizes those data and projections.

1. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles, Phase 2, 80 Fed. Reg. 40138, 40408–49 (proposed July 13, 2015) (to be codified at 49 C.F.R. pts. 512, 523, 534, et. al.), https://www.regulations.gov/document?D=EPA-HQ-OAR-2014-0827-0002.

2. *Id.* at 40409 tbl.V-II-37.

3. Those projections were made with the EPA climate model ("Model for the Assessment of Greenhouse-Gas Induced Climate Change, a Regional Climate Scenario Generator") developed at the University Corporation for Atmospheric Research. *About*, U. Corp. For Atmospheric Res., http://www.cgd.ucar.edu/cas/wigley/magicc/ (last visited June 26, 2018) [https://perma.cc/HF2B-GLGT] [hereinafter MAGICC]. The model is available at http://www.magicc.org/ [https://perma.cc/TG42-SFTQ].

FIGURE 1

Proposed Medium- and Heavy-Duty Engines Efficiency Rule in Context			
Parameter	Historical Trend[4]	EPA 1990–2100 Projection[5]	Effect of Rule
CO_2e Concentration	1.6ppm/year	+66 ppm	-1.1–1.2 ppm
Sea Levels	3.3mm/year	+23–56 cm	-0.23–0.57 mm
Ocean pH	~8.15 to 8.05 pH	-0.30 pH	+0.0006 pH
Temperature Change	~0.55°C	+1.8–4.8°C	-0.0026–0.0065°C

Consider the parameters summarized in Figure 1: the EPA estimates the effects of the proposed rule in the context of the historical trends and the baseline projections for 2100. The estimated effect on atmospheric concentrations of CO_2e (a reduction of 1.1–1.2 ppm) is a nine-month reduction in such concentrations from the historical average annual increase.[6] Sea levels, with a long-term rise of 3.2 millimeters per year, would rise thirty-two centimeters over the course of a century. Assuming the upper bound of the EPA projection (fifty-six centimeters), the upper boundary of the rule's purported effect (0.57 millimeters) is about 0.1%.[7] For ocean pH, the effect of the rule is an increase in average alkalinity (as purported for 2100) from about 7.80 to 7.80006.[8] The temperature effect estimated between .0026 and .0065 degrees[9] is effectively zero—it does not differ from zero as a matter of statistical significance because the standard deviation of the surface temperature record is about 0.11°C.[10]

4. NAT'L OCEANOGRAPHIC & ATMOSPHERIC ADMIN., CO_2 (July 5, 2018), ftp://ftp.cmdl.noaa.gov/ccg/co2/trends/co2_annmean_mlo.txt [https://perma.cc/4GP3-7UMW] (CO_2e concentration); Anny Cazenave et al., *The Rate of Sea-Level Rise*, 4 NATURE CLIMATE CHANGE 358, 358 (2014) (sea levels); *Climate Change Indicators: Ocean Acidity*, ENVTL. PROTECTION AGENCY, https://www.epa.gov/climate-indicators/climate-change-indicators-ocean-acidity (last updated Aug. 2016) [https://perma.cc/4DWU-9VNS]; Michael Wallace, *Ocean pH Accuracy Arguments Challenged with 80 Years of Instrumental Data*, WATTS UP WITH THAT? (Mar. 31, 2015), https://wattsupwiththat.com/2015/03/31/ocean-pH-accuracy-arguments-challenged-with-80-years-of-instrumental-data/?cn-reloaded=1 [https://perma.cc/H2V8-BCFE] (ocean pH); Roy Spencer, *Latest Global Temps*, DR. ROY SPENCER, http://www.drroyspencer.com/latest-global-temperatures/ (last visited July 28, 2018) [https://perma.cc/43C7-F4RC] (lower atmosphere temperature trend anomalies

5. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles, Phase 2, 80 Fed. Reg. 40138, 40409 tbl.V-II-37 (proposed July 13, 2015) (to be codified at 49 C.F.R. pts. 512, 523, 534, et. al.), and attendant discussion.

6. *See supra* Figure 1.

7. *Id.*

8. *Id.*

9. *Id.*

10. *See* J. Hansen, et al., *GISS Analysis of Surface Temperature Change*, 104 J. GEOPHYSICAL RES. 30,997, 31,006 (1999).

The EPA then states that "[t]he agencies estimate that the proposed standards would result in net economic benefits exceeding $100 billion, making this a highly beneficial rule."[11]

How is it possible that the trivial temperature and other estimated effects summarized above could yield more than $100 billion in net economic benefits? The answer is found in the Obama Administration's methodology for analysis of the social cost of carbon ("SCC")—that is, the estimated (or purported) marginal uninternalized economic damage caused by GHG emissions.[12] This conclusion is possible only because of the assumptions and approach underlying the SCC analysis, which, as discussed below, are deeply problematic.[13] Those underlying analytic problems can be summarized as follows:

- The use of "global" benefits from GHG reductions in the benefit/cost calculation;[14]
- The failure to apply a 7% discount rate to the stream of (asserted) future benefits and costs of GHG reductions, as mandated by Office of Management and Budget ("OMB") analytic guidelines;[15]
- The conflation in the integrated assessment models of climate and gross domestic product ("GDP") effects; and[16]
- The inclusion of non-climate effects of climate policies as co-benefits, as a tool with which to overcome the trivial temperature and other related impacts of those policies.[17]

Note that these analytic problems are independent of the climatology assumptions underlying the analysis of the costs of increasing atmospheric concentrations of GHG. Notwithstanding ubiquitous assertions that the science is settled, in reality, it is not. The issue of the equilibrium climate sensitivity of the atmosphere is hotly debated,[18] and the existing body of evidence on temperature and other

11. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles, Phase 2, 80 Fed. Reg. 40138, 40169 (proposed July 13, 2015) (to be codified at 49 C.F.R. pts. 512, 523, 534, et. al.).

12. *See* Interagency Working Group on Social Cost of Greenhouse Gases, U.S. Gov't, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 3 (2016), https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf [https://perma.cc/XXS4-XWZ8] [hereinafter 2016 Interagency Working Group on Social Cost of Greenhouse Gases].

13. *See supra* Section II.

14. *See* discussion *supra* Section II.A.

15. *See* discussion *supra* Section II.B.

16. *See* discussion *supra* Section II.C.

17. *See* discussion *supra* Section III.

18. *See, e.g.*, Patrick J. Michaels & Paul C. Knappenberger, *The Collection of Evidence for a Low Climate Sensitivity Continues to Grow*, Cato Inst. (Sept. 25, 2014, 5:09 PM), https://www.cato.org/blog/collection-evidence-low-climate-sensitivity-continues-grow [https://perma.cc/TR74-3LKP] [hereinafter Michaels & Knappenberger, *The Collection of Evidence*].

climate phenomena is not consistent with the argument that climate impacts are both visible and serious.[19] Even the direction, let alone the magnitude, of feedback effects are not known, and the same is true with respect to how rising temperatures might affect such phenomena as weather patterns, ice sheet dynamics, sea levels, agriculture, *ad infinitum*.[20] Moreover, the Intergovernmental Panel on Climate Change in its Fifth Assessment Report is deeply dubious about the various extreme adverse effects popularized as looming impacts of increasing atmospheric concentrations of GHG.[21] Scientific "truth" is not majoritarian; it never can be "settled" because new evidence emerges constantly.

These observations are not relevant to the methodological critique presented here, but the *policy* issues raised by the GHG/climate question would remain difficult even if there existed both unanimity and certainty on the underlying *scientific* issues.

Section II discusses in more detail the first three analytic problems noted above. Section III offers some observations on the application of the estimated SCC in specific regulatory proposals with particular emphasis on the use of "co-benefits" as part of the purported benefit stream and on some benefit/cost issues in the larger context of GHG policies. Section IV offers some concluding observations on the distinction between internalized and uninternalized parameters and on the incentives of regulatory bureaus.

II. Analytic Flaws Inherent in the Obama IWG SCC Methodology

The Obama Administration estimated in 2016 an SCC of $36 (in year-2007 dollars) per metric ton of CO_2e in 2015.[22] (That figure is about $42 per metric ton in year-2017 dollars.)[23] This dollar figure re-

19. *See e.g.*, Benjamin Zycher, *Paris in the Fall: COP-21 vs Climate Evidence*, Am. Enterprise Inst. (Nov. 30, 2015), http://www.aei.org/publication/paris-in-the-fall-cop-21-vs-climate-evidence/ [https://perma.cc/J549-5SVE] [hereinafter Zycher, *Paris in the Fall*]. *See generally* Patrick J. Michaels & Paul C. Knappenberger, Lukewarming: The New Climate Science that Changes Everything xi–xv (2015) (arguing that climate models have over-predicted the effects of increasing atmospheric GHG concentrations) [hereinafter Michaels & Knappenberger, Lukewarming].

20. Zycher, *Paris in the Fall supra* note 19.

21. *See* Working Group I of Intergovernmental Panel on Climate Change, Working Group I Contribution to the IPCC Fifth Assessment Report: Climate Change 2013: The Physical Science Basis, 12–78 & tbl.12.4 (2013), http://www.climatechange2013.org/images/uploads/WGIAR5_WGI-12Doc2b_FinalDraft_Chapter12.pdf [https://perma.cc/UEF3-6CQT].

22. *See* 2016 Interagency Working Group on Social Cost of Greenhouse Gases, *supra* note 12, at 4 tbl.ES-1.

23. *See Table 1.1.4. Price Indexes for Gross Domestic Product*, Bureau of Econ. Analysis (Aug. 29, 2018), https://apps.bea.gov/iTable/iTable.cfm?reqid=19&step=3&isuri=1&1910=x&0=-99&1903=4&1904=2007&1905=2017&1906=a&1911=0 [https://perma.cc/6R6C-5PSZ].

sults in part from the use of a 3% discount rate, a methodological approach that will be addressed more fully below.[24] For now it is crucial to recognize that the SCC estimate is one central key to understanding how purported regulatory impacts that are effectively zero can yield net economic benefits in the tens or hundreds of billions of dollars. Once a non-trivial SCC figure is accepted for benefit/cost analysis, the actual climate impacts of regulations—after all, they are the supposed goal—become irrelevant.[25] Merely multiply the purported reduction in GHG emissions attendant upon the regulation by the estimated SCC, and large net benefits can be made to appear in the benefit/cost analyses.[26] Thus, the derivation of the SCC is crucial to understanding this dimension of climate policymaking.

A. *The Use of Global Benefits*

Circular A-4, issued by the OMB, is explicit: only the benefits and costs of regulations enjoyed or borne domestically are to be used in benefit/cost analysis.[27] International effects are to be reported separately.[28] The reason for this is obvious: if domestic costs and global benefits are used in benefit/cost analysis, then the United States would have to bear all of the regulatory burdens for the entire world.[29]

The Obama Administration attempted to circumvent this obvious and elementary economic analysis by arguing that the global-benefits approach is appropriate for the SCC analysis because the effects of increasing GHG concentrations are global in nature.[30] That is a *non*

24. *See* discussion *supra* Section II.B.

25. Benjamin Zycher, *The Achilles' Heel of the Obama Climate Regulations*, AM. ENTERPRISE INST. (Feb. 9, 2017), http://www.aei.org/publication/the-achilles-heel-of-the-obama-climate-regulations/ [https://perma.cc/H9HN-3PU8] [hereinafter Zycher, *Achilles' Heel*].

26. *See* INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, U.S. GOV'T, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 11 (2010), https://www.epa.gov/sites/production/files/2016-12/documents/scc_tsd_2010.pdf [https://perma.cc/F6PA-MRWK] [hereinafter 2010 INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES].

27. *See Circular A-4*, OFF. OF MGMT. & BUDGET (Sept. 17, 2003), https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4/ [https://perma.cc/KTF8-AN6K] ("[A]nalysis should focus on benefits and costs that accrue to citizens and residents of the United States. Where you choose to evaluate a regulation that is likely to have effects beyond the borders of the United States, these effects should be reported separately."). *See also Regulatory Impact Analysis: A Primer*, JACOBS, CORDOVA & ASSOCIATES 5, http://regulatoryreform.com/wp-content/uploads/2015/02/USA-Circular-a-4_regulatory-impact-analysis-a-primer.pdf (last visited July 28, 2018) [https://perma.cc/2UKX-BH49].

28. *Id.*

29. In this case, U.S. policies would attempt to equate marginal domestic costs with marginal global benefits.

30. *See*, COUNCIL OF ECONOMIC ADVISERS, 2017 ECONOMIC REPORT OF THE PRESIDENT 423 (2017), https://obamawhitehouse.archives.gov/sites/default/files/docs/chapter_7-addressing_climate_change_2017.pdf [https://perma.cc/3LAD-EZRU].

sequitur. In that case, the United States would reduce emissions of a given effluent to the point that such emissions would be optimal for the entire world with only the United States bearing the costs. If the United States' benefit/cost analysis incorporated both global benefits and global costs, the enormous cost calculation would reduce the domestic political viability of any such United States policy, and in any case, the country would not be able to enforce regulatory requirements on other nations in an effort to spread the costs. At the same time, if all nations were to adopt a global benefit approach, the efficient level of effluents ostensibly would be achieved, but this ignores the individual incentives to obtain a free ride on the efforts of others, and so is not a reasonable underlying analytic assumption.[31]

The Obama-Administration SCC methodology means not only that other economies would have incentives to allow the United States to bear all of the attendant costs (that is, to engage in "free riding" on United States policies), but also that it would be *economically efficient* for them to do so. If they were to reduce emissions further, global emissions would be lower than optimal because the global marginal cost of emissions reductions (borne by the United States alone in this framework) would exceed the global marginal benefits.[32] This also is inconsistent with the standard theory of efficient emissions reductions, under which the marginal cost of those reductions is equated across emitters.[33]

For example, the global benefits orientation is inconsistent with the objective, implicit but clear, under the Obama Clean Power Plan[34] of regionalizing emissions reductions across the United States, ostensibly to equate the marginal costs of reducing GHG emissions across states, but actually to force most states into regional cap-and-trade wealth transfer systems, the dominant feature of which would be payments from red states to blue ones.[35]

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31. *See* Zycher, *Achilles' Heel supra* note 25.

32. This problem is separate from the industry relocation incentives yielded by the adoption of such policies only by the United States. Note that in the 2010 Interagency Working Group analysis, the domestic SCC is about 7–23% of the global value, or about $3–10 per ton of GHG emissions if we apply the 2016 IWG estimate of the SCC of $42 (year 2017 dollars) for 2015. *See* 2010 INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, *supra* note 26, at 11; 2016 INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, *supra* note 12, at 29.

33. Zycher, *Achilles' Heel supra* note 25.

34. *See* 40 C.F.R. §§ 60.5700–60.5880 (2017).

35. *See Hearing on EPA's Final Clean Power Plan Rule Before the H. Comm. on Sci., Space, and Tech.*, 114th Cong. 6–7 (2015) (written testimony of Anne E. Smith, Ph.D., Vice-President, NERA Economic Consulting), http://docs.house.gov/meetings/SY/SY00/20151118/104182/HHRG-114-SY00-Wstate-SmithA-20151118.pdf [https://perma.cc/6HEP-3HT7]; *see also* Benjamin Zycher, *'Carbon Pollution' and Wealth Redistribution*, THE AMERICAN (June 26, 2013), http://www.aei.org/publication/carbon-pollution-and-wealth-redistribution-2/ [https://perma.cc/JEK3-TG9H].

The Trump Administration has re-estimated the SCC using only domestic benefits and costs, as summarized in Figure 2.

FIGURE 2

Domestic SCC, 2015–2050[36] **(year-2017 dollars per metric ton)**		
Year	3% discount rate ("dr")	7% dr
2015	5.50	1.10
2020	6.60	1.10
2025	7.70	1.10
2030	7.70	1.10
2035	8.80	1.10
2040	9.90	2.20
2045	9.90	2.20
2050	10.10	2.20

The domestic estimates presented in Figure 2 are an order of magnitude smaller than the global estimate ($42 per ton in year-2017 dollars) published by the Obama Administration, as noted above.[37]

B. *Failure to Use a Seven Percent Discount Rate*

OMB Circular A-4 requires federal agencies to apply both 3% and 7% discount rates to the streams of benefits and costs of proposed regulations to allow a comparison of the respective present values.[38] For its analysis of the SCC, the Obama Administration used 2.5%, 3%, and 5% discount rates, but not 7%.[39] The reason for this is obvious: At 7%, the SCC becomes small or negative.[40] Figure 3 summarizes the Dynamic Integrated Climate-Economy ("DICE") model baseline results for the analysis using 2300 as the end year.

36. ENVIRONMENTAL PROTECTION AGENCY, REGULATORY IMPACT ANALYSIS FOR THE REVIEW OF THE CLEAN POWER PLAN: PROPOSAL 44 tbl.3-7 (2017), https://www.epa.gov/sites/production/files/2017-10/documents/ria_proposed-cpp-repeal_2017-10.pdf [https://perma.cc/T77Y-4JYS]; and my computations.

37. *See* 2016 INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, *supra* note 12, at 4 tbl.ES-1.

38. *See Circular A-4*, *supra* note 27. A-4 allows a 3% discount rate in addition to the 7% rate if a consumption displacement model is deemed appropriate. *Id.* That obviously is not solely the case for climate policies, which would affect investment flows substantially; but A-4 (p. 34) requires the use of both 3% and 7% discount rates so as to account for both the consumption and investment effects of proposed regulations, and to allow for sensitivity analysis.

39. 2016 INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, *supra* note 12, at 3.

40. *See* ENVIRONMENTAL PROTECTION AGENCY, *supra* note 36, at 44 tbl.3-7.

FIGURE 3

DICE Average Baseline SCC, End Year 2300[41] (year-2017 dollars)				
Year	2.5% dr	3% dr	5% dr	7% dr
2010	54.27	35.00	10.27	4.68
2020	66.33	44.03	14.10	6.84
2030	77.51	52.60	17.86	8.97
2040	89.66	62.08	22.16	11.48

Figure 4 presents the same analysis using the Framework for Uncertainty, Negotiation, and Distribution ("FUND") integrated assessment model.

FIGURE 4

FUND Average Baseline SCC, End Year 2300[42] (year-2017 dollars)				
Year	2.5% dr	3% dr	5% dr	7% dr
2010	34.60	19.79	2.18	-0.62
2020	38.34	22.52	2.96	-0.43
2030	38.64	25.38	3.86	-0.15
2040	46.06	28.39	4.91	0.22
2050	50.08	31.53	6.12	0.73

In the DICE model, the difference in the SCC calculation for 2050 using 3% and 7% discount rates is 80%, declining from $71.92 to $14.27 per metric ton.[43] In the FUND model, the SCC for 2010–2050 at a 7% discount rate declines to approximately zero or becomes negative.[44] Note that in the 2016 Obama Administration revision, the 2050 SCC is about $30 per metric ton (year-2017 dollars) at a 5% dis-

41. *See* William Nordhaus, *Evolution of Modeling of the Economics of Global Warming: Changes in the DICE Model, 1992–2017*, 148 Climatic Change 623 (2018); *see also* Kevin D. Dayaratna & David W. Kreutzer, *Loaded DICE: An EPA Model Not Ready for the Big Game*, HERITAGE FOUND. (Nov. 21, 2013), http://thf_media.s3.amazonaws.com/2013/pdf/BG2860.pdf [https://perma.cc/JA2V-RKCU]; and my computations.

42. Dayaratna & Kreutzer, "Unfounded FUND: Yet Another EPA Model Not Ready for the Big Game," Heritage Foundation Backgrounder No. 2897, April 29, 2014, at http://thf_media.s3.amazonaws.com/2014/pdf/BG2897.pdf; and my computations. *See generally Description of Integrated Assessment Models FUND and PAGE*, GLOBAL CCS INSTITUTE, https://hub.globalccsinstitute.com/publications/social-cost-carbon-closer-look-uncertainty/description-integrated-assessment-models (last visited July 28, 2018) [https://perma.cc/9JY6-LJPA] (describing the FUND model).

43. *See supra* Figure 3.

44. *See supra* Figure 4.

count rate, $80 at 3%, and $111 at 2.5%.[45] The effect of changes in the assumed discount rate is very substantial, and it is clear that the failure of the Obama Administration to adhere to the requirements of OMB Circular A-4 was driven by imperatives heavily political rather than analytic.

The Obama Administration attempted to obfuscate this obvious underlying reason to shunt aside the requirements of OMB Circular A-4 by arguing that the use of an artificially low discount rate is appropriate methodologically as a device to give sufficient weight to the interests of future generations, the members of which cannot vote now.[46] Consider this formulation of that stance from the Council of Economic Advisers:

> The estimates of the cost of emissions released in a given year represent the present value of the additional damages that occur from those emissions between the year in which they are emitted and the year 2300. The choice of discount rate over such a long time horizon implicates philosophical and ethical perspectives about tradeoffs in consumption across generations, and debates about the appropriate discount rate in climate change analysis persist.[47]

Accordingly, we must ask whether an artificially low discount rate serves the interests of future generations. Consider a *homo sapien*s baby born in a cave some tens of thousands of years ago, in a world with a resource base virtually undiminished and environmental quality effectively untouched by mankind. That child at birth would have had a life expectancy on the order of ten years; had it been able to choose, it is obvious that it willingly would have given up some resources and environmental quality in exchange for better housing, food, water, medical care, safety, *ad infinitum*.[48] That is, it is obvious that people willingly would choose to give up some environmental quality in exchange for a life both longer and wealthier. Few Americans, for example, would choose to live on a pristine desert island.

In other words, the central interest of future generations in this context is a bequest from previous generations of the most valuable possible capital stock, of which the resource base and environmental quality are two important dimensions among many, and among which there are always tradeoffs. That future bequest preference requires efficient resource allocation by the current generation. If regulatory and other policies implemented by the current generation yield less

45. *See* 2016 Interagency Working Group on Social Cost of Greenhouse Gases, *supra* note 12, at 4 tbl.ES-1.

46. *See, e.g.*, Council of Economic Advisers, *supra* note 30, at 440.

47. *Id.*

48. On the life expectancy estimate, telephone interview with Gail Kennedy, Professor, Dep't of Anthropology, Univ. of Cal. L.A. (Feb. 16, 2011). Note here the implicit normative assumption that the "interests" of any individual or group are those that they would define for themselves or, more important, reveal through choice behavior.

wealth currently and a smaller total capital stock for future generations, then, perhaps counterintuitively, some additional emissions of effluents would be preferred (efficient) from the viewpoint of those future generations.[49] In short, it is not appropriate to use an artificially low discount rate to increase the weight given the interests of future generations. Harberger and Jenkins estimate "social discount rates of averaging around 8% for the advanced countries and 10% for healthy developing countries and Asian Tigers."[50] Broughel estimates a social discount rate of about 7%.[51]

Moreover, the economic costs of climate policies—increased energy costs and attendant effects—are substantially more certain than the benefits, that is, the future impacts of those policies in terms of temperatures and other such phenomena as storms and sea levels.[52] That latter uncertainty about policy benefits is driven by the reality that the magnitude and even the direction of the feedback effects of increasing GHG concentrations are unknown, so that the equilibrium climate sensitivity of the atmosphere is substantially disputed in the scientific literature.[53] This means that the assumed benefit stream of such policies over time should be subject to a state-options analysis or, more crudely, to an application of a discount rate higher than that applied

49. The capital stock includes both tangible capital and such intangibles as the rule of law, the stock of knowledge, culture, and the like. Greater wealth for the current generation yielded by resource consumption allows the expansion of other dimensions of the capital stock defined broadly.

50. Arnold C. Harberger & Glenn P. Jenkins, Musings on the Social Discount Rate, 6 J. Benefit-Cost Analysis 6, 6 (2015).

51. James Broughel, *The Social Discount Rate: A Baseline Approach* 24 (George Mason Univ., Mercatus Ctr., Working Paper, 2017), https://www.mercatus.org/system/files/mercatus-broughel-social-discount-rate-v1.pdf [https://perma.cc/P7L8-L7A4]. *See generally* Robert S. Pindyck, *Climate Change Policy: What Do the Models Tell Us?*, 51 J. Econ. Literature 860 (2013) (presenting a useful summary and critique of the literature on social discount rates); Juzhong Zhuang, *et. al.*, *Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis: A Survey* 2–14 (Asian Dev. Bank ERD, Working Paper No. 94, 2007), https://www.adb.org/sites/default/files/publication/28360/wp094.pdf [https://perma.cc/YG9E-RSNH] (presenting a useful summary of the older literature on social discount rates).

52. Zycher, *Achilles' Heel supra* note 25. Indeed, there is substantial evidence that the shorter-term effects are likely to be positive on net, driven by increased agricultural output, improved agricultural and vegetation water efficiency, and similar effects caused by a CO_2 "fertilization" effect. *See Change in Leaf Area (1982–2015)*, NASA, https://www.nasa.gov/sites/default/files/thumbnails/image/change_in_leaf_area.jpg (last visited July 28 2018) [https://perma.cc/XH88-7RS8]. Note that this recent greening is likely to have been the result of several factors, among them increased fertilizer use, CO_2 fertilization effects, and other factors. *See World Food Situation*, Food & Agric. Org. U.N., http://www.fao.org/worldfoodsituation/csdb/en/ (last updated May 7, 2018) [https://perma.cc/DDC2-RGUY]; *see also* Mgmt. Info. Servs., Inc., The Social Costs of Carbon?: No, the Social Benefits of Carbon 3 (2014), https://www.eenews.net/assets/2014/01/22/document_pm_03.pdf [https://perma.cc/3QLK-MUHH].

53. *See e.g.*, Michaels & Knappenberger, *The Collection of Evidence*, *supra* note 18; Michaels & Knappenberger, Lukewarming, *supra* note 19, at 81–85.

to the cost stream.[54] Note also that a future glaciation is very likely.[55] Anthropogenic warming might prove highly advantageous during such a period, particularly given that cold ambient temperatures are responsible for far more deaths than hot ones.[56]

C. *Conflation of Assumed Climate and GDP Effects*

In the integrated assessment models, the SCC is a percent decline in projected GDP, translated into a dollar figure and then divided by total assumed GHG emissions.[57] That the GDP projections extend out to the years 2150 and 2300, depending upon the particular analysis being pursued, is a source of some amusement—even quarterly GDP projections are problematic—the problems inherent in which are not generally recognized. Nonetheless, it is not too unreasonable to use historical long-term real GDP growth rates, or a range of them, to make such projections. One real problem is that the central parameters driving long-term growth—labor inputs, capital investment, technological advances ("total factor productivity"), and legal and regulatory institutions—are very difficult to predict over such long-time horizons.

In any event, the problem is that very small climate effects of changing GHG concentrations can yield a very large SCC if assumed future GDP is sufficiently large. In the DICE model, the scenario with the highest future GDP and a mid-range climate effect has the highest SCC.[58] The scenario with the smallest future GDP and the greatest climate effects has the smallest SCC.[59] Are these reasonable methodological outcomes?

54. *See e.g.*, Daniel A. Graham, Cost-Benefit Analysis Under Uncertainty, 71 AM. ECON. REV. 715, 716–19 (1981).

55. *See e.g.*, Sandy Eldredge & Bob Biek, *Ice Ages – What Are They and What Causes Them?*, UTAH GEOLOGICAL SURV. (Sept. 2010), https://geology.utah.gov/map-pub/survey-notes/glad-you-asked/ice-ages-what-are-they-and-what-causes-them/ [https://perma.cc/JM6K-45E2].

56. *See* Antonio Gasparrini, et. al., *Morality Risk Attributable to High and Low Ambient Temperature: A Multicountry Observational Study*, 386 LANCET 369, 373 (2015).

57. Paul C. Knappenberger & Patrick J. Michaels, *The Current Wisdom: The Administration's Social Cost of Carbon Turns "Social Cost" on Its Head*, CATO INST. (Apr. 3, 2014, 5:43 PM), https://www.cato.org/blog/administrations-social-cost-carbon-turns-social-cost-its-head?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+Cato-at-liberty+(Cato+at+Liberty) [https://perma.cc/FXZ7-UPMH].

58. *Id.*

59. *See* Pindyck, *supra* note 51, at 860.

III. Co-Benefits and Other Benefit/Cost Problems in the SCC Context

A. *Reductions in Ozone and Other Effluents as Co-benefits of GHG Regulation*

The Obama Administration estimate of the SCC as applied to specific regulatory efforts is interesting. The respective benefit/cost analyses include not only the purported benefits of reductions in GHG emissions but also those of reduced emissions of such other effluents as sulfur dioxide, nitrogen oxide, and fine particulates, and the resulting health effects of reduced ambient ozone levels.[60] A close examination of the benefit/cost analysis for the Clean Power Plan (CPP) reveals that the costs of that rule were discounted at a rate of 5%;[61] accordingly, it is appropriate, narrowly, to use the EPA-claimed benefits of the rule for a 5% discount rate. Figure 5 summarizes those estimates.

Figure 5

Clean Power Plan Net Benefits, 2030[62] (billions of year-2017 dollars)		
	Rate-Based Approach	Mass-Based Approach
Climate Benefits	7.0	7.0
Compliance Costs	9.2	5.6
Net Climate Benefits	-2.2	1.4
Air Quality Co-Benefits	25.3	21.2
Total Net Benefits	23.1	22.6
Notes. Air quality co-benefits reported for 3% and 7% discount rates. The figures represented are the average.		

The climate net benefits—ostensibly the very purpose of the Clean Power Plan—are negative under the rate-based approach and very small under the mass-based approach.[63] It is the inclusion of purported air quality co-benefits that yields all or almost all of the net benefits of the rule.[64]

This "co-benefit" approach is deeply problematic because the Clean Air Act explicitly requires the EPA, upon making an "endangerment" finding for a given effluent, to promulgate a National Ambient Air

60. *See e.g.*, Environmental Protection Agency, Regulatory Impact Analysis for the Clean Power Plan Final Rule 3-45 to 3-47 (2015), https://www3.epa.gov/ttnecas1/docs/ria/utilities_ria_final-clean-power-plan-existing-units_2015-08.pdf [https://perma.cc/JPB6-J8UR].

61. *See id.* at ES-21 to ES-22.

62. *Id.* at ES-21 tbl.ES-9, ES-22 tbl.ES-10; and my computations.

63. *See supra* Figure 5.

64. *Id.*

Quality Standard ("NAAQS") that "protects the public health" with "an adequate margin of safety."[65] Accordingly, the EPA "co-benefits" benefit/cost analysis is appropriate only if the existing NAAQS for the various effluents fail to satisfy the requirements of the law or if the law itself creates a standard that is inefficiently lax.[66] If neither of those conditions is true, then the co-benefits analysis will reduce emissions of the other effluents to levels that are inefficiently low, that is, to levels at which the marginal costs of reductions exceed the marginal benefits.[67] *At least one of those three conditions must be true.* If a given region is in "nonattainment," that condition is evidence that achievement of the NAAQS is costlier than it would be worth, and that imposition of a standard even more stringent is unlikely to be appropriate.[68]

Note that the Obama-Administration EPA used the same co-benefit analysis for the CPP, for the ozone rule,[69] for the fine particulate matter (PM 2.5) rule,[70] and for the Utility Mercury and Air Toxics Standards.[71] Note also that the IWG in its SCC analysis used the assumed global benefits of reductions in GHG emissions as the basis for the SCC analysis, while the CPP net benefits largely or wholly are created by assumed reductions in domestic pollutants, as just discussed. This is an inconsistency that has gone largely unnoticed in the Washington policy community.[72]

B. *Benefit/Cost Analysis of GHG Policy in the Larger Context*

As projected by the climate model developed by the EPA and used for regulatory analysis,[73] the future temperature effects of United States and international climate policies are trivial or effectively zero.[74] Figure 6 summarizes those model projections under a set of assumptions (in particular, a climate sensitivity of 4.5 degrees for a

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65. 42 U.S.C. § 7409(b)(1) (2012).

66. Zycher, *Achilles' Heel supra* note 25.

67. *Id.*

68. *Cf.* Don J. Frost, Jr. & Henry C. Eisenberg, *Legislative, Regulatory and Judicial Challenges to the 2015 Ozone National Ambient Air Quality Standards*, SKADDEN (Jan. 30, 2017), https://www.skadden.com/insights/publications/2017/01/legislative-regulatory-and-judicial-challenges-to [https://perma.cc/65YV-K5UE].

69. *See* National Ambient Air Quality Standards for Ozone, 80 Fed. Reg. 65292 (Oct. 26, 2015) (codified at 40 C.F.R. §§ 50.14, 50.19, 51.166, 52.21, 53.23, 58.10–58.11, 58.13, 58.50).

70. *See* Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements (Mar. 23, 2015) (to be codified at 40 C.F.R. §§ 51.1000–51.1016).

71. *See* Mercury and Air Toxics Standards (MATS) Electronic Reporting Requirements (Apr. 6, 2017) (codified at 40 C.F.R. §§ 63.10021, 62.10031).

72. Zycher, *Achilles' Heel supra* note 25.

73. This model was developed at the National Center for Atmospheric Research with funding provided by the EPA. *See* MAGICC, *supra* note 3.

74. *See infra* Figure 6.

doubling of GHG concentrations) that exaggerate the future temperature effect of given GHG reductions.

FIGURE 6

Land-Ocean Average Notional Temperature Reductions, 2100[75] (degrees Celsius)	
Region Emissions Reduction	Temperature Reduction
U.S. (Obama 17%)	0.015
U.S. (China agreement, additional 10%)	0.010
China (assumed 20%)	0.200
Remaining Industrialized World (assumed 30%)	0.200
Remaining Developing World (assumed 20%)	0.100
Total	0.525
COP-21 (Paris) (immediate, strict relative to BAU)	0.170
Notes. This Figure assumes IPCC AR4 A1B midrange emissions path, climate sensitivity 4.5°C. GHG emissions reductions from 2005 baselines: U.S. by 2020/2025, others by 2030.[76]	

The Obama-Administration Climate Action Plan called for United States GHG emissions by 2020 17% below 2005 levels.[77] In addition, the United States-China Joint Announcement on Climate Change called for an additional 10% reduction by the United States by 2025.[78] The 17% reduction would decrease temperatures by the year 2100 by .015 degrees.[79] The additional 10% reduction yields another .01 degrees.[80] Given that the standard deviation of the temperature record is

75. I made the computations using MAGICC, *supra* note 3.

76. For the COP-21 Agreement, see United Nations Framework Convention on Climate Change, *Paris Agreement*, http://unfccc.int/files/home/application/pdf/paris_agreement.pdf (last visited Sept. 21, 2018) [https://perma.cc/YN29-YYN5]. For the COP-21 individual nationally-determined reductions from BAU, see United Nations Framework Convention on Climate Change, *INDCs as Communicated by Parties*, http://www4.unfccc.int/submissions/indc/Submission%20Pages/submissions.aspx (last visited Sept. 21, 2018) [https://perma.cc/Y42E-VG8P].

77. *See* EXEC. OFFICE OF THE PRESIDENT, THE PRESIDENT'S CLIMATE ACTION PLAN 4 (2013), https://obamawhitehouse.archives.gov/sites/default/files/image/president27sclimateactionplan.pdf [https://perma.cc/XK9P-KLJW].

78. *See US-China Joint Announcement on Climate Change*, OFF. PRESS SECRETARY, WHITE HOUSE (Nov. 11, 2014), https://www.whitehouse.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change [https://perma.cc/6VSH-SVPU]. *See also* Benjamin Zycher, *Observations on the U.S.-China Climate Announcement*, THE HILL (Nov. 14, 2014, 7:30 AM), http://thehill.com/blogs/pundits-blog/energy-environment/224076-observations-on-the-us-china-climate-announcement [https://perma.cc/5GY7-88VX]; Benjamin Zycher, *The U.S.-China Climate Agreement Hangover*, THE HILL (Dec. 8, 2014, 6:30 AM), http://thehill.com/blogs/pundits-blog/energy-environment/226272-the-us-china-climate-agreement-hangover [https://perma.cc/Y5WR-RFHZ].

79. *See supra* Figure 6.

80. *See supra* Figure 6.

about 0.11 degrees,[81] these effects would be too small to be distinguished from statistical noise, let alone to affect sea levels, cyclones, and other climate phenomena. If we assume an additional 20% cut in GHG emissions by China by 2030, temperatures would be reduced by another 0.2 degrees,[82] and if we assume a 30% cut in emissions by the rest of the industrialized world, temperatures would be reduced by another 0.2 degrees.[83] If we assume also a 20% reduction by the less-developed world by 2030, temperatures would be reduced by another one tenth of a degree.[84] The total: slightly more than 0.5 degrees.[85] The entire Paris Agreement incorporates national commitments far more modest; if implemented immediately and enforced strictly, the effect would be a temperature reduction of 0.17 degrees by 2100.[86]

Note that these model predictions use underlying parameters highly favorable to the policies under examination, that is, assumptions that increase the predicted effects of the policies. The most important is a "climate sensitivity" (the temperature effect in 2100 of a doubling of GHG concentrations) assumption of 4.5 degrees, a number 50% greater than the median of the range reported by the Intergovernmental Panel on Climate Change in its latest assessment report.[87] And even the latter is about 40% higher than the median of the estimates published in the recent peer-reviewed literature.[88]

In the context of benefit/cost analysis of regulatory proposals: how much are such temperature effects—small or effectively zero—worth? The answer is obvious, as is the underlying reason that the Obama Administration used global benefits, an artificially-low discount rate, and purported co-benefits in its analyses.

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81. *See* J. Hansen, *supra* note 10, at 31,006.

82. Note that the Chinese INDC commitment at COP-21 was for a "peak" in GHG emissions by 2030. There was no commitment on the level of that "peak," and no commitment on the path of Chinese GHG emissions after 2030. *Enhanced Action on Climate Change: China's Intended Nationally Determined Contributions*, U.N. FRAMEWORK CONVENTION CLIMATE CHANGE 5, http://www4.unfccc.int/Submissions/INDC/Published%20Documents/China/1/China's%20INDC%20-%20on%2030%20June%202015.pdf [https://perma.cc/7WYT-2D3D].

83. *See supra* Figure 6.

84. *See supra* Figure 6.

85. *See supra* Figure 6.

86. *See supra* Figure 6.

87. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS REPORT SUMMARY FOR POLICYMAKERS 10 (2014), https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf [https://perma.cc/C3PU-S96E].

88. *See* Nic Lewis, *How Sensitive is Global Temperature to Cumulative CO2 Emissions?*, JUDITH CURRY (July 14, 2018), https://judithcurry.com/2015/11/30/how-sensitive-is-global-temperature-to-cumulative-co2-emissions/#more-20572 [https://perma.cc/8ESQ-TTRB] (discussing the recent estimates in the peer-reviewed literature); Judith Curry, *Climate Sensitivity: Lopping Off the Fat Tail*, JUDITH CURRY (Mar. 23, 2015), https://judithcurry.com/2015/03/23/climate-sensitivity-lopping-off-the-fat-tail/ [https://perma.cc/6PT3-HC5V]; Michaels & Knappenberger, *The Collection of Evidence*, *supra* note 18.

IV. Concluding Observations

Let us return to the EPA proposed "Phase 2" efficiency rule for medium and heavy trucks with which this discussion began.[89] Despite the fact that GHG policy, ostensibly, is an effort to correct for a private-sector inefficiency—the purported adverse effects of GHG emissions are not reflected in market prices—the Phase 2 rule refers to "fuel savings" almost 200 times, and it is those asserted fuel savings that in substantial part drive the estimated benefits of the rule.[90] The rule states explicitly that it "estimate[s] the changes in fuel expenditures, or the fuel savings, using fuel prices estimated in the Energy and Information Administration's [("EIA")] 2014 Annual Energy Outlook."[91] For gasoline, that EIA projection for year 2020 is a per-gallon price of $3.32 in year-2017 dollars.[92]

Note that the average gasoline price at that time was about $2.50.[93] Accordingly, an assumed price of $3.32 in 2020 implies a real price increase of about 10% annually.[94] That assumed price path is inconsistent with standard economic analysis, which predicts that the expected price path for a good the consumption of which is substitutable over time (that is, that can be stored more-or-less economically) should rise at the market rate of interest.[95] Since interest rates are far lower than 10% (the interest rate on AAA corporate bonds is about 4%[96]), one wonders why gasoline stocks are not rising sharply so as to take advantage of so rapid an increase in expected prices. Why did the EPA in its analysis of this rule not use market expectations as reflected in futures prices?

More fundamentally, in what sense are fuel costs not internalized fully in market prices? Is it reasonable to assume for analytic purposes

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89. *See* Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles, Phase 2, 80 Fed. Reg. 40138, 40408–49 (proposed July 13, 2015) (to be codified at 49 C.F.R. pts. 512, 523, 534, et. al.).

90. *See id.* at 40166 tbl.I-8.

91. See *id.* at 40440 & tbl.IX-6; and accompanying discussion.

92. *See Energy Price by Sector and Source*, Energy Info. Admin. (2014), https://www.eia.gov/outlooks/archive/aeo14/pdf/tbla3.pdf [https://perma.cc/6YHP-A3YE]. Reference cases. Assumes 120,476 btu per gallon of gasoline. *See Energy Units and Calculators Explained*, Energy Info. Admin., https://www.eia.gov/energyexplained/index.cfm?page=about_energy_units (last visited July 28, 2018) [https://perma.cc/ZN6Y-VBQV].

93. *See Weekly Retail Gasoline and Deiseal Prices*, Energy Info. Admin., https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_nus_a.htm (last visited July 28, 2018) [https://perma.cc/WX6J-3ZYG].

94. Compute $(3.32/2.50)^{1/3} = 1.0992$.

95. *See* Benjamin Zycher, *World Oil Prices: Market Expectations, the House of Saud, and the Transient Effect of Supply Disruptions*, Am. Enterprise Inst. 4 (June 2, 2016,), http://www.aei.org/wp-content/uploads/2016/06/World-Oil-Prices.pdf [https://perma.cc/5QTG-9CFC].

96. *See Interest Rates and Bond Yields*, U.S. Gov't Pub. Office (May 2018), https://www.govinfo.gov/content/pkg/ECONI-2018-05/pdf/ECONI-2018-05-Pg30.pdf [https://perma.cc/DDC4-SYCT].

that the EPA projection of future fuel prices is better than that of the decentralized market? Is it the government or millions of private-sector decisionmakers, who have their own money at risk, which have the more powerful incentives to make unbiased price predictions?

The analytic saga of the SCC and the GHG regulatory framework appears to comport with the standard literature predicting that government agencies have powerful incentives to maximize their budgets (or some such variation as their discretionary budgets).[97] Even if we shunt aside all of the analytic problems inherent in that body of climate regulatory policymaking—all of which is biased in favor of regulatory action—the regulations are all cost and no benefit. What other set of incentives can explain such agency behavior? Policy analysis cannot be separated from politics.

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97. *See* William A. Niskanen, *Bureaucrats and Politicians*, 18 J. L. & ECON. 617, 618 (1975); William A. Niskanen, *Bureaucracy,* and Kelly H. Chang, *et. al.*, *Rational Choice Theories of Bureaucratic Control and Performance*, *in* THE ELGAR COMPANION TO PUBLIC CHOICE 258, 262–67, 271-292 (William F. Shughart II & Laura Razzolini, eds., 2001); DENNIS C. MUELLER, PUBLIC CHOICE III 359–385 (2003).