DISCOUNT DOUBLE-CHECK: AN ANALYSIS OF THE DISCOUNT RATE FOR CALCULATING THE SOCIAL COST OF CARBON

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INTRODUCTION

Former Massachusetts governor Mitt Romney drew both applause and scorn for quipping during his acceptance speech at the 2012 Republican National Convention: "President Obama promised to begin to slow the rise of the oceans and to heal the planet. My promise is to help you and your family."[1] While the line drew thunderous laughter from the home crowd, it was condemned by advocates of environmental reform for making a mockery of the pressing challenges posed by global climate change.[2]

The polarized response to Governor Romney's retort cannot be simply chalked up to the throes of a tight presidential campaign, nor does it merely reflect a deep partisan chasm over the credibility of scientific evidence supporting manmade climate change.[3] The punch line also invoked sharp divisions over the degree of sacrifice that we should make for future generations: mitigating the long-term impacts of greenhouse gas emissions will primarily benefit future generations, yet it comes with a high present-day price tag, diverting money that could be used to help individuals who are struggling today.[4]

In regulatory decisionmaking, this problem is analyzed through the practice of *discounting*. This allows policymakers to compare

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1. *See* John McQuaid, *Romney's Rising Oceans Joke*, FORBES (Aug. 31, 2012, 10:39 AM), http://www.forbes.com/sites/johnmcquaid/2012/08/31/romneys-rising-oceans-joke/. For a video of Romney's line and the audience's boisterous response, see Jim hoft, *Mitt Romney: Obama Promised to Begin to Slow the Rise of the Oceans. . . I Promise You Jobs*, YOUTUBE (Aug. 30, 2012), https://www.youtube.com/watch?v=GBkYBGVVpSc.

2. *See* McQuaid, *supra* note 1; *see also* Philip Bump, *Romney Treats Climate Change as a Punchline*, GRIST (Aug. 30, 2012), http://grist.org/news/romney-uses-the-bully-pulpit-to-mock-climate-change/.

3. A recent poll indicated a gap of more than forty percentage points—sixty-six percent to twenty-four percent—in belief for whether human activity is the main cause of global warming for self-identified Democrats versus self-identified Republicans, respectively. *GOP Deeply Divided over Climate Change*, PEW RESEARCH CTR. (Nov. 1, 2013), http://www.people-press.org/2013/11/01/gop-deeply-divided-over-climate-change/.

4. While estimates of mitigation costs vary widely, many analyses project a global reduction in consumption of somewhere between one and four percent by 2030 if all countries begin mitigation immediately. *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: MITIGATION OF CLIMATE CHANGE 15 (Ottmar Edenhofer et al. eds., 2014). However, some have plausibly argued that mitigating climate change can immediately boost public welfare through wealth redistribution. *See generally* NAOMI KLEIN, THIS CHANGES EVERYTHING 8–10 (2014). I endorse this belief, but this Note does not focus on it since cost-benefit analysis—for better or (mostly) worse—uses the total amount of societal wealth, rather than the distribution of this wealth, as its proxy for public welfare. Rather than offer an existential critique of cost-benefit analysis, I work within its confines in this Note because the practice is so widely engrained in regulatory decision-making.

costs and benefits that occur at different points in time by converting all monetary figures along a time continuum onto a single scale. The choice of how much to discount, while integrating many technical determinations such as metrics of economic activity and development, is a profound moral decision about the value of future generations. When we discount, we effectively determine how much we value future versus present welfare. At a discount rate of three percent, for instance, a benefit of $100 that is accrued in one year is valued at $97 today. Yet at a discount rate of seven percent, that same benefit has a present value of only $93.[5]

The practice of discounting—and the selection of a particular discount rate—has broad implications for public policy. Whenever federal agencies undertake major regulatory initiatives, they must attempt to convert the costs and benefits of regulatory action to present dollar values. As a general matter, agencies should only promulgate rules with net positive present values—in other words, after everything has been converted into present value, benefits must exceed costs.[6] The choice of discount rate is fundamental to the policy selection process. Using a three-percent discount rate, a government agency engaging in cost-benefit analysis could endorse a proposed regulation that nets a $100 benefit in one year if it requires a $97 present expenditure; however, using a discount rate of seven percent, cost-benefit analysis would cap present spending for this same initiative at $93.

Applying a higher discount rate often has the effect of limiting the willingness of policymakers to undertake regulatory initiatives. Regulatory policy generally features costs principally incurred in the present or near future with benefits spread out over time; therefore, applying a higher discount reduces the calculated benefits of regulation.[7] This principle is especially pronounced when benefits are ac-

5. Discount rates of three percent and seven percent are commonly applied in regulatory cost-benefit analysis. *See* OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, CIRCULAR A-4, at 33–34 (2003) [hereinafter CIRCULAR A-4].

6. President Bill Clinton directed agencies undertaking "significant regulatory action" [defined, *inter alia*, as regulations that have annual economic effects of at least $100 million] to "maximize net benefits . . . unless a statute requires another regulatory approach." Exec. Order No. 12,866, 3 C.F.R. § 638 (1993), *reprinted as amended in* 5 U.S.C. § 601 app. at 89–93 (2013). President Barack Obama amended this executive order in 2011 by instructing regulatory agencies to also consider "values that are difficult or impossible to quantify, including equity, human dignity, fairness, and distributive impact." Exec. Order No. 13,563, 3 C.F.R. § 215 (2012), *reprinted in* 5 U.S.C. § 601 app. at 103–05 (2013). The practice of cost-benefit analysis and its role in agency rulemaking is described in further detail in Part I.

7. Daniel A. Farber, *From Here to Eternity: Environmental Law and Future Generations*, 2003 U. ILL. L. REV. 289, 295–96.

crued in the distant future: a $100 benefit in twenty years has a net present value of approximately $54 using a discount rate of three percent, but only $23 if a discount rate of seven percent is applied—a difference of more than 2.3 times. Over a hundred-year horizon, this disparity balloons to a factor of sixty-seven.[8] Yet despite a general consensus that some discounting is appropriate when future benefits or costs are involved,[9] there is wide disagreement over the proper discount rate.[10] This, in turn, produces great uncertainty over how much regulation is appropriate.

Climate change is the prototypical example of a problem that will require severe near-term costs to address, even though most of the benefits will not be realized for decades or centuries. Many scientists agree that an investment of more than $40 trillion in technology and infrastructure will be needed over the coming decades to prevent environmental catastrophe.[11] Yet the benefits of mitigating climate change—including reduced mitigation costs, prevented economic losses, and a reduction in life-threatening weather events—will be realized principally in the distant future, when climate change is expected to take its greatest toll.[12] For this reason, selection of the proper discount rate in regulations bearing on climate change is of paramount importance for calibrating the optimal degree of regulation. In fact, the discount rate is the second most significant variable to consider when determining the appropriate expenditure for reducing carbon emis-

8. The discount rate is an annualized figure; when calculating present value for longer time horizons, we must therefore apply the discount rate once more for each additional year. To calculate the present value of $100 in twenty years at a discount rate of three percent, we must multiply $100 by 0.97 twenty times or, in other words, multiply it by $(0.97)^{20}$. At a discount rate of seven percent, this same value equals $100 times $(0.93)^{20}$.

9. Some economists, philosophers, and policymakers argue that discounting the benefits of human life and health is improper. For a good account of this argument, see Ben Trachtenberg, *Health Inflation, Wealth Inflation, and the Discounting of Human Life*, 89 OR. L. REV. 1313 (2011). Because this view lies outside the academic mainstream and is politically nonviable, I do not discuss it in this Note.

10. *See generally infra* Section II.B.

11. *See* INT'L ENERGY AGENCY, ENERGY TECHNOLOGY PERSPECTIVES 2014: HARNESSING ELECTRICITY'S POTENTIAL 8–16 (2014). Note that net losses in the near term will not approach this total cost of investment due to economic gains from new energy markets, savings from energy efficiency, and savings from environmental mitigation. In fact, the International Energy Agency estimates that fuel savings alone will surpass the costs of investment in alternative energy by 2050. *Id.* at 8.

12. Carbon dioxide released into the atmosphere can remain for hundreds of years, producing a warming effect for many generations. *See* Anthony C. Fisher, Uncertainty, Irreversibility, and the Timing of Climate Change 12 (Oct. 2001) (unpublished manuscript), http://stephenschneider.stanford.edu/Publications/PDF_Papers/timingFfisher.pdf.

sions—trailing only the relationship between atmospheric greenhouse gas concentrations and global temperatures.[13]

In 2009, the White House commissioned a working group of leading scientists and economists throughout the federal government to begin the challenging task of computing how much should be spent to reduce carbon emissions.[14] Known as the Interagency Working Group on Social Cost of Carbon (the "Working Group"), this group was charged with calculating the present value of the societal benefit of reducing carbon emissions by one ton, which is known as the *social cost of carbon* ("SCC"). The SCC was intended to provide a clear value for use in regulatory cost-benefit analysis. For instance, if the Working Group (hypothetically) set the SCC at $40, a federal agency would be justified in promulgating a regulation that eliminated one ton in carbon dioxide emissions if the regulation costs $40 or less.

The Working Group published its original SCC estimates in 2010,[15] increasing them in 2013 in response to updated scientific data.[16] Given the significance of the SCC to energy and environmental regulation, it may seem especially important for the Working Group to provide a clear SCC value that can be easily applied in regulatory cost-benefit analysis. But rather than endorse a single value, the Working Group provided a menu of widely different SCC values.[17] This was a result of a failure to agree on the appropriate discount rate. Noting that "the choice of a discount rate, especially over long periods of time, raises highly contested and exceedingly difficult questions of science, economics, philosophy, and law,"[18] the Working Group provided separate SCC estimates based on three different discount rates: 2.5, 3, and 5%.[19]

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13. *See* David Weisbach & Cass R. Sunstein, *Climate Change and Discounting the Future: A Guide for the Perplexed*, 27 YALE L. & POL'Y REV. 433, 441 (2009).

14. *See* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS 4 (2010).

15. *Id.* at 1–3.

16. *See* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, TECHNICAL SUPPORT DOCUMENT: SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS 4 (2013) (advising that the Working Group published the document to "provide[ ] an update of the SCC estimates based on the latest peer-reviewed version of the models").

17. *See infra* Part I.

18. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 17.

19. *Id.* at 1. The Working Group also provided a fourth SCC estimate representing the ninety-fifth percentile of damage estimates from climate change at a three percent discount rate. For the three other SCC estimates, which varied only on the selection of discount rate, the Working Group calculated the central tendency of mitigated damages using numerous peer-reviewed models of climate change. *See id.* at 12.

The differences between these three discount rates may appear minor, but as noted above, even small variations in the discount rate—particularly when applied over long-term periods—can have significant effects. In fact, these three discount rates yield widely divergent SCC values: the SCC for present-day emissions reductions is $58 using a 2.5% discount rate, but only $12 when a rate of 5% is applied.[20] In other words, a federal agency using the lower SCC estimate may promulgate rules requiring nearly *five times* the expenditure on reducing carbon emissions than an agency using the higher SCC estimate. This is a vast difference that can cause major discrepancies in environmental and energy policy. An agency applying the SCC value of $58 will likely undertake significant action to combat climate change, whereas an agency applying the lowest SCC value of $12 will be hard-pressed to regulate in this respect at all.[21]

This Note analyzes the various methods that the Working Group used to calculate discount rates. It argues that most of these approaches—with one key exception—fail to account for long-term uncertainty and, as a result, severely undervalue regulatory benefits. That exception is *hyperbolic discounting*, a recently developed approach that accounts for long-term uncertainty by applying different discount rates into the distant future and then averaging the results. Hyperbolic discounting produced the SCC value that applied a 2.5% discount rate.[22]

Ultimately, I argue that the Working Group should calculate a single SCC value based on hyperbolic discounting and rescind its other SCC values that apply unsound cost-benefit principles. In Part I, I provide background on cost-benefit analysis and the SCC. In Part II, I provide an overview of the economic principles underlying discounting and discuss salient controversies in the context of climate change. In Part III, I highlight hyperbolic discounting as the best method to encapsulate the uncertainty surrounding discounting in the context of climate change. In Part IV, I review the practical benefits of providing a single SCC estimate based on sound cost-benefit principles.

20. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 16, at 18.
21. *See infra* Part I.
22. *See infra* Part III.

I.
COST-BENEFIT ANALYSIS AND THE SPECTER OF UNCERTAINTY

Curbing global greenhouse gas emissions over the coming years will require the full range of policymaking tools, from diplomacy and financing at the international level, to regulatory policymaking at the domestic level. Although climate change cannot be cured at the domestic level alone, regulatory actions taken by the U.S. government represent an important step toward reducing emissions globally.[23] Just a few of the regulatory decisions with critical implications for greenhouse-gas emissions include setting fuel-emissions standards for motor vehicles, determining whether to permit drilling on public lands, and capping pollution from power plants.[24] As these determinations are all made at the regulatory level, they cannot proceed before undergoing cost-benefit analysis.

Cost-benefit analysis has been a routine element of federal rulemaking since President Reagan issued Executive Order 12,291 in 1981, which consolidated White House authority over federal rulemaking through the creation of a formal mechanism for the Office of Management and Budget ("OMB") to review regulatory proposals.[25] Through this Executive Order and subsequent executive orders issued by Presidents Clinton and Obama, executive agencies considering any major regulation[26] must "assess both the costs and the benefits

23. Approximately twelve percent of present global greenhouse gas emissions occur in the United States. *See CAIT Climate Data Explorer*, WORLD RESOURCES INST., http://cait.wri.org/historical (last visited Feb. 1, 2016). The United States is responsible for an even greater percentage of global emissions if this figure is revised to reflect the fact that many energy-intensive products are produced internationally for domestic consumption. *See* Glen P. Peters et al., *Growth in Emissions Transfers via International Trade from 1990 to 2008*, 108 PROC. NAT'L ACAD. SCI. 8903, 8903 (2011).

24. For a sampling of regulatory cost-benefit analyses that have already applied SCC estimates, see U.S. ENVTL. PROT. AGENCY, FACT SHEET: SOCIAL COST OF CARBON 3 (2013), http://www.epa.gov/climatechange/Downloads/EPAactivities/scc-fact-sheet.pdf.

25. *See* Exec. Order No. 12.291, 3 C.F.R. § 127 (1982), *revoked by* Exec. Order No. 12,866, 3 C.F.R. § 638 (1993), *reprinted as amended in* 5 U.S.C. § 601 app. at 89–93 (2013).

26. A "major rule" is defined as:

> any regulation that is likely to result in: (1) an annual effect on the economy of $100 million or more; (2) a major increase in costs or prices for consumers, individual industries, Federal, State, or local government agencies, or geographic regions; or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of United States-based enterprises to compete with foreign-based enterprises in domestic or export markets.

of the intended regulation and . . . propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs."[27] Pursuant to these executive orders, the OMB requires agencies to "assess quantitatively the benefits and costs of the proposed rule and its alternatives."[28]

Cost-benefit analysis can be an extraordinarily complex undertaking. To the extent possible, the agency must monetize costs and benefits of regulations in order to quantitatively compare them to one another.[29] This includes both benefits and costs that are inherently monetary—such as increased cost or consumer savings—as well as those that are more difficult to monetize, such as health and safety benefits.[30] This inevitably is an imprecise calculation, primarily for two reasons. First, the agency must attempt to forecast future conditions using inexact scientific and/or economic models. Second, the agency must ascribe monetary values, which are also the product of imprecise economic models, to its projections of future outcomes.[31] As such, there is a considerable amount of uncertainty and imprecision inherent in any cost-benefit analysis.

The OMB instructs agencies to "assess[ ] the sources of uncertainty and the way in which benefit and cost estimates may be affected under plausible assumptions."[32] To the extent practicable, agencies should "assess[ ] the relative likelihood of each scenario quantitatively"[33] and, using these determinations, "report benefit and cost estimates . . . that reflect the full probability distribution of potential

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Exec. Order No. 12,866 § 3.

27. *Id.*

28. CIRCULAR A-4, *supra* note 5, at 3.

29. *Id.* at 2 ("Where all benefits and costs can be quantified and expressed in monetary units, benefit-cost analysis provides decision makers with a clear indication of the most efficient alternative, that is, the alternative that generates the largest net benefits to society.").

30. The OMB provides considerable guidance to federal agencies on treating nonmonetized benefits and costs. *See id.* at 26–31. It notes that "[s]ound quantitative estimates of benefits and costs, where feasible, are preferable to qualitative descriptions of benefits and costs because they help decision makers understand the magnitudes of the effects of alternative actions." *Id.* at 26.

31. Circular A-4 features a section titled "Quantitative Assessment of Uncertainty" providing guidance on how agencies should respond to both types of imprecision. *See id.* at 39–42.

32. *Id.* at 38.

33. *Id.* at 39. The OMB recognizes that "[i]n some cases, the level of scientific uncertainty may be so large that you can only present discrete alternative scenarios without assessing the relative likelihood of each scenario quantitatively," and instructs agencies in these circumstances to "present results from a range of plausible scenarios, together with any available information that might help in qualitatively determining which scenario is most likely to occur." *Id.*

consequences."[34] In other words, agencies must make their best effort to quantify the relative likelihood of different outcomes using the data available and make cost-benefit assessments that properly account for each source of uncertainty. In making these calculations, agencies must take care to avoid simplistic assessments based on the average or median value of a particular variable without accounting for the full probability distribution.[35]

A number of inputs are regularly used in cost-benefit analysis across different sectors and different agencies. Detailed economic models have been developed to quantify many of the common non-monetary benefits of regulation. For instance, economists have developed monetary estimates of the value of a life saved (known as the *value of a statistical life*, or "VSL"), which are now regularly used in cost-benefit analyses.[36] Whereas many agencies had not valued mortality risks in regulatory analysis when the science was less developed, they now follow common practices to calculate the VSL.[37] Yet despite the widespread implementation of VSL into regulatory cost-benefit analysis, there remain a number of other important costs and benefits that cannot be monetized due to current scientific limitations.[38]

The social cost of carbon was developed as a calculation so that agencies could monetize the net carbon emissions produced by their rulemakings. Agencies did not monetize carbon emissions for years due to the belief that it was too difficult given uncertainty about the precise effects of climate change and the complexity of translating these effects into monetary values.[39] Beginning in the 1990s, independent researchers produced a series of models that combined projections of climate and economic conditions to estimate the value of economic harm that would be produced by climate change.[40] By the late 2000s, agencies were occasionally, and inconsistently, applying

34. *Id.* at 18.

35. *See id.* at 40 (instructing agencies to "provide some estimates of the central tendency (e.g., mean and median) along with any other information [they] think will be useful such as ranges, variances, specified low-end and high-end percentile estimates, and other characteristics of the distribution").

36. For a concise summary of VSL calculations and their adaption into federal regulatory analysis, see Richard L. Revesz, *Quantifying Regulatory Benefits*, 102 CALIF. L. REV. 1423, 1436–39 (2014).

37. Nonetheless, different agencies continue to use differing VSL values in cost-benefit analysis. *See id.* at 1437–38.

38. *See* CIRCULAR A-4, *supra* note 5, at 26–27 (noting that "some important benefits and costs (e.g., privacy protection) may be inherently too difficult to quantify or monetize given current data and methods").

39. *See* Revesz, *supra* note 36, at 1439.

40. The Working Group relied on three models—known as FUND, DICE, and PAGE—that were each first presented in the early 1990s and have since received

these models to monetize the cost of carbon emissions in regulatory cost-benefit analysis.[41] Ultimately, the U.S. Court of Appeals for the Ninth Circuit decided in 2008 that the scientific projections were sufficiently advanced that agencies could not ignore the cost of carbon emissions in regulatory cost-benefit analysis.[42]

The Working Group was formed in the wake of this decision to perform the difficult work of determining the value that carbon emissions should be assigned in regulatory cost-benefit analysis, and was comprised of a number of experts from numerous cabinet departments and executive-branch offices.[43] The Working Group used the existing models to estimate the probability distribution of damages that would be caused by climate change.[44] Consistent with its objective to "develop a range of SCC values,"[45] the Working Group provided four SCC estimates based on different assumptions regarding the discount rate and the severity of climate change: three estimates assumed mean damages at discount rates of 5, 3, and 2.5%, while a fourth estimate used a 3% discount rate but assumed that damages from carbon emissions were far worse than anticipated. As updated, the SCC values based on these four estimates are currently $12 (at the 5% discount rate), $38 (at the 3% discount rate), $58 (at the 2.5% discount rate), and $109 (with ninety-fifth percentile damages).[46]

As discussed above, the SCC has already been used to justify federal vehicle fuel standards, carbon pollution standards for new power plants, and mercury and air toxins standards.[47] These are likely just the tip of the iceberg of regulatory initiatives limiting greenhouse gas emissions that make use of SCC estimates.[48] An international co-

periodic updates. *See* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 5 n.2.

41. *See id.* at 3 (describing uses of SCC estimates prior to the Working Group's report).

42. *See* Ctr. for Biological Diversity v. NHTSA, 538 F.3d 1172, 1203 (9th Cir. 2008) (striking down a rule setting corporate average fuel economy standards for light trucks as arbitrary and capricious). The Ninth Circuit found that in not monetizing the value of reductions in carbon emissions, NHTSA "put a thumb on the scale by undervaluing the benefits and overvaluing the costs of more stringent standards." *Id.* at 1198.

43. *See* Revesz, *supra* note 36, at 1439.

44. *See* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 5–8 (describing the Working Group's use of the FUND, DICE, and PAGE models).

45. *Id.* at 1.

46. *See* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 16, at 3.

47. *See* U.S. ENVTL. PROT. AGENCY, *supra* note 24.

48. While the SCC was computed for official use only for federal regulatory action, the figure can also be instrumental for setting regulation at the state, local, or international level.

hort of scientists and policymakers agree that more stringent regulation will be needed—both domestically and abroad—in the years ahead.[49]

II.
An Introduction to Discounting for Climate Change

Discounting not only is among the most critical determinations when proposed regulations will have significant long-term consequences,[50] but also can be among the most contentious. This is magnified in the context of climate change due to its unusually long-term time horizon.

In Section II.A, I describe the fundamental features of discounting and discuss their application to climate change. In Section II.B, I then examine several of the unique controversies that are prominent in the context of climate change. Along the way, I highlight how the Working Group dealt with these different issues in producing its various discount rates.

I do not presently advocate for a particular approach or a specific discount rate; I will leave this unenviable task to more qualified individuals. However, I hope to illustrate the difficulties of setting the discount rate for the SCC and thereby demonstrate why this problem has yielded such persistent and intractable disagreement.

A. Discounting 101: Private Rate of Return vs. Social Rate of Time Preference

The principle underlying discounting is that a dollar today is worth more than a dollar tomorrow.[51] By assigning a discount rate, we are effectively determining how much we value present consumption relative to future consumption. How we set that rate depends largely on the nature of the decision we face.

Let us start by considering a rather simple hypothetical: you are an investor deciding whether to invest $100 in a startup company that you expect to yield $105 in one year. The seasoned investor will normally compare her expected return from this startup with what she

49. *See, e.g.*, Intergovernmental Panel on Climate Change, *supra* note 4, at 10 ("Scenarios reaching atmospheric concentration levels of about 450 ppm CO_2eq by 2100 (consistent with a *likely* chance to temperature change below 2°C relative to pre-industrial levels) include substantial cuts in anthropogenic GHG emissions by mid-century through large-scale changes in energy systems and potentially land use.").

50. *See supra* note 13 and accompanying text.

51. *See* Farber, *supra* note 7, at 297.

would ordinarily expect to earn in the market. Assuming that the market normally yields an annual return of seven percent,[52] the investor will hold onto the money rather than invest in the startup because it will appreciate to $107 after one year—two dollars more than the project's yield. In essence, the investor has analyzed the proposed investment through cost-benefit analysis using a discount rate of seven percent, which is the rate of return that she would expect to earn on the market. Since the investor would incur an up-front cost of $100 with a benefit, in present value, of only $97.65 (the expected return, $105, minus seven percent), the investment has an expected negative value, and, therefore, the investor should not invest in the startup company.

The value that we expect to realize on the market provides the correct discount rate in this scenario because it represents the opportunity cost of not investing in the project.[53] This is called the *private rate of return* because it describes the rate of return that we can normally expect to realize on our investment; only if we can make a higher rate of return on the proposed investment should we invest rather than keep our money in the market.[54] The OMB places the private rate of return at seven percent, which, as noted above, represents the long-term average for real rate of return on corporate capital in the United States.[55] The private rate of return once provided the discount rate for all regulatory cost-benefit analysis,[56] and this figure continues to be used "whenever the main effect of a regulation is to displace or alter the use of capital in the private sector."[57] In other words, this discount rate is most appropriate for regulatory decisions that resemble, or will primarily affect, private investment decisions such as the hypothetical presented above.

While the private rate of return provides the appropriate discount rate for many regulatory cost-benefit analyses, it is not universally applicable for all of regulatory analysis. To illustrate this, let us return to the investment hypothetical but make a few changes. Rather than an investor deciding whether to put your money in a startup venture, you

52. Seven percent roughly represents the average real rate of return on corporate capital in the United States. *See* CIRCULAR A-4, *supra* note 5, at 33.

53. *See* Weisbach & Sunstein, *supra* note 13, at 445.

54. *Id.*

55. *See supra* note 52 and accompanying text.

56. *See* OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, CIRCULAR A-94 (1972) [hereinafter CIRCULAR A-94] (recommending a discount rate of ten percent for all federal regulatory cost-benefit analyses, based on the private rate of return as calculated at the time).

57. CIRCULAR A-4, *supra* note 5, at 33.

are an ordinary individual on a relatively fixed budget considering whether to spend $100 to purchase a new computer or to keep your money to purchase something (either a different computer or something else entirely) in a year. The relevant question here is not how much your money will appreciate in the next year, rather, it is how much you value buying this particular computer now compared to having to wait to spend your money. This requires a different discount rate that accurately reflects the value that you place on receiving the benefits of computer ownership earlier in time.[58] This is an important conceptual distinction: the private rate of return describes how much your money would appreciate if you invest it rather than consume it. The *social rate of time preference* describes how much you value present consumption relative to future consumption.[59]

In a perfectly rational market without any distortions, the private rate of return would equal the social rate of time preference. Yet strong empirical evidence indicates that, in practice, the social rate of time preference is considerably lower than the private rate of return.[60] This can be seen through inflation and other price fluctuations, which limit the marginal purchasing power of investment yields.[61] For in-

58. *See* MARK HARRISON, VALUING THE FUTURE: THE SOCIAL DISCOUNT RATE IN COST-BENEFIT ANALYSIS 6 (2010), http://www.pc.gov.au/research/supporting/cost-benefit-discount/cost-benefit-discount.pdf.

59. Farber clearly illustrates the distinction between these two approaches as follows:

> One rationale says that you could invest the price of a candy bar today and buy two candy bars next year with the proceeds, instead of having one candy bar next year. The other rationale says that you would be willing to trade a candy bar today for two candy bars next year, if the exchange is possible. Thus, under one rationale, we are comparing different numbers of candy bars in *one* future year; the other rationale compares candy bars in *different* years.

Farber, *supra* note 7, at 297.

60. *Id.* at 297–98. Why the private and social rates of return differ is a question far too technical for this Note. One prominent explanation, however, is taxation. *See* Daniel A. Farber & Paul A. Hemmersbaugh, *The Shadow of the Future: Discount Rates, Later Generations, and the Environment*, 46 VAND. L. REV. 267, 281 (1993); Richard G. Newell & William A. Pizer, *Uncertain Discount Rates in Climate Policy Analysis*, 32 ENERGY POL'Y 519, 521 (2004).

61. The OMB uses the difference between the private rate of return and consumer prices as a proxy to calculate the social rate of time preference. *See* CIRCULAR A-4, *supra* note 5, at 33–34 ("If we take the rate that the average saver uses to discount future consumption as our measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. Over the last thirty years, this rate has averaged around three percent in real terms on a pretax basis. For example, the yield on 10-year Treasury notes has averaged 8.1 percent since 1973 while the average annual rate of change in the CPI over this period has been 5.0 percent, implying a real 10-year rate of 3.1 percent.").

stance, an investment yield of seven percent will not produce a corresponding increase of seven percent in purchasing power due to the fact that consumer prices rise over time. The social rate of time preference can be estimated by subtracting the inflation rate from the private rate of return.[62] The OMB calculates this to be around three percent,[63] and counsels agencies to apply this as their discount rate in cost-benefit analysis "[w]hen regulation primarily and directly affects private consumption."[64]

Administrative agencies frequently face uncertainty over whether to apply the higher discount rate based on the private rate of return or the lower discount rate based on the social rate of time preference, since major regulatory programs inevitably affect both private capital allocation and individual consumption.[65] Nonetheless, economists largely agree that the social rate of time preference provides the preferable discount rate for climate regulation, including regulations to reduce greenhouse gas emissions.[66] This is because climate regulation is

62. A. MYRICK FREEMAN III ET AL., THE MEASUREMENT OF ENVIRONMENTAL AND RESOURCE VALUES: THEORY AND METHODS 179 (3d ed. 2014).

63. CIRCULAR A-4, *supra* note 5, at 33.

64. *Id.*

65. *See* Cass R. Sunstein, *The Real World of Cost-Benefit Analysis: Thirty-Six Questions (and Almost as Many Answers)*, 144 COLUM. L. REV. 167, 200 (2014). The OMB instructs agencies to analyze proposed regulations using both the three-and seven-percent discount rates. OFFICE OF MGMT. & BUDGET, REGULATORY IMPACT ANALYSIS: FREQUENTLY ASKED QUESTIONS (FAQS) 6 (2011), https://www.whitehouse.gov/sites/default/files/omb/assets/OMB/circulars/a004/a-4_FAQ.pdf. Sunstein notes that, as a practical matter, the choice between the two discount rates is rarely dispositive because most proposed regulations pass muster under both discount rates. *See* Sunstein, *supra*, at 200. Even major environmental regulations aimed at combating climate change continue to be analyzed under both a three percent and a seven percent discount rate. For instance, the Environmental Protection Agency analyzed the proposed Clean Power Plan using both discount rates. *See* Carbon Pollution Emissions Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 34,830, 34,839 (June 18, 2014) (to be codified at 40 C.F.R. pt. 60).

66. *See* KENNETH ARROW ET AL., BENEFIT-COST ANALYSIS IN ENVIRONMENTAL, HEALTH, AND SAFETY REGULATION 13–14 (1996) ("The rate at which future benefits and costs should be discounted to present values will generally not equal the rate of return on private investment. The discount rate should instead be based on how individuals trade off current for future consumption."); Newell & Pizer, *supra* note 60, at 521 ("Because climate policy decisions ultimately concern the future welfare of people—not firms—the consumption interest rate is more appropriate."). The Working Group relied heavily on Arrow's account in selecting the discount rates for their SCC estimates. *See* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 18–19.

aimed directly at benefiting individual welfare—not private investment decisions—by improving health and quality of life.[67]

Despite a general belief that the social rate of time preference provides the more appropriate discount rate, the Working Group nonetheless calculated one value of the SCC using a discount rate of five percent in recognition of "the possibility that climate change damages are positively correlated with market returns."[68] This value was largely derived from the private rate of return.

B. Salient Controversies in Climate Change

As described above, the social rate of time preference is generally believed to provide the appropriate discount rate in the context of climate change. But this is not the end of the analysis—it is just the beginning. After deciding that the social rate of time preference is appropriate, economists must then determine the numerical value of the social rate of time preference that will apply.

The social rate of time preference is normally valued at three percent, based on recent economic conditions.[69] Yet due to a number of unique empirical and ethical challenges that arise when applying the social rate of time preference to climate change—which produce great uncertainty over the value of the discount rate to apply—this discount rate cannot be simply imported into the SCC.[70] I highlight several of the most salient and contentious controversies in this Section.

1. Uncertainty over Long-Term Background Conditions

Measurements of the social rate of time preference based on long-term monetary and investment decisions do not coalesce into a single, neat value. While the OMB suggests the use of a three-percent social discount rate, it acknowledges uncertainty and states that this

67. Newell & Pizer, *supra* note 60, at 521 ("Because climate policy decisions ultimately concern the future welfare of people—not firms—the consumption interest rate is more appropriate.").

68. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 23. It is not entirely clear from their analysis why the Working Group selected a rate of five percent rather than seven percent, as is traditionally used to represent the private rate of return, although one possibility for the lower rate was to account for long-term uncertainty in economic conditions that influence the private rate of return.

69. *See supra* note 61 and accompanying text.

70. For a full account of the difficulties and challenges faced by the Working Group in setting the discount rates, see INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 17–23.

rate represents only an "approximation."[71] While some level of imprecision regarding the appropriate discount rate may normally be acceptable, in the realm of climate change policy, any inaccuracies are gravely magnified when applied over decades or centuries.[72]

One source of considerable uncertainty is that people discount future gains at a higher rate than future losses.[73] Moreover, there is evidence that people apply lower discount rates to the medium- and long-term futures than they do in the short term.[74] Yet even this research is inconclusive and difficult to read, particularly when it involves discounting of human life and health.[75] Evidence suggests that individuals discount human life differently than they do other goods[76]—presenting a challenge that is particularly pertinent in environmental regulation, including regulation intended to mitigate the effects of climate change.

As difficult as it is to calculate the social rate of time preference today, determining the appropriate discount rate to apply over decades is even harder. This is because the inputs that go into calculating the social rate of time preference are based on numerous observed social conditions from the present and recent past. Future changes in any one of these factors—including the rate of economic growth, the rate of capital accumulation, the degree of diminishing returns, or the rate of pure time preference over the distant future—could affect the social rate of time preference.[77] In fact, economists estimate that the social rate of time preference over the next four hundred years may fluctuate from anywhere from two to seven percent.[78]

Moreover, certain factors related to our willingness and ability to combat climate change in the future may impact the appropriate discount rate in this specific setting. For example, game-changing technological advances may produce stunning rates of environmental progress—or, more pessimistically, technology may fail to progress at

71. *See* CIRCULAR A-4, *supra* note 5, at 33 ("If we take the rate that the average saver uses to discount future consumption as our measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. Over the last thirty years, this rate has averaged around 3 percent in real terms on a pre-tax basis.").

72. *See supra* note 8 and accompanying text.

73. George Lowenstein & Richard H. Thaler, *Anomalies: Intertemporal Choice*, 3 J. ECON. PERSP. 181, 184, 187 (1989).

74. Farber & Hemmersbaugh, *supra* note 60, at 283.

75. *Id.* at 283–84.

76. *Id.*

77. Martin L. Weitzman, *Why the Far-Distant Future Should Be Discounted at Its Lowest Possible Rate*, 36 J. ENVTL. ECON. & MGMT. 201, 203 (1998).

78. *See* Newell & Pizer, *supra* note 60, at 522.

the projected rate.[79] Likewise, future generations may value the environment more than they do today, possibly due to increases in social welfare or environmental scarcity.[80] Since these changes would alter long-term time preferences for environmental protection and carbon emissions, they should affect the discount rate in calculations of the SCC.

The Working Group calculated the present social rate of time preference at "about 2.7 percent," noting that this is "roughly consistent with [the OMB's] recommendation to use three percent to represent the consumption rate of interest."[81] But it also acknowledged some of the difficulties with forecasting this calculation into the distant future.[82] The Working Group ultimately settled on a discount rate of three percent to represent the social rate of time preference, as it found this to be "consistent with estimates provided in the economics literature and the OMB's Circular A-4 guidance for the consumption rate of interest."[83] A discount rate of three percent produces an SCC value for the present day of $38,[84] which the Working Group considers the "central value" of its various SCC estimates.[85]

2. *Concerns over Intergenerational Equity: The Normative Perspective*

A more direct challenge to the use of traditional discounting practices for the SCC is that they do not adequately account for the rights of future generations. This perspective begins with the premise of intergenerational equity—in other words, the principle that individuals of different generations should be treated equally.[86] It argues that traditional discounting practices inherently favor the present generation because they are based on the near-sighted time preferences of

79. *Id.*

80. Weisbach & Sunstein, *supra* note 13, at 444.

81. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 20.

82. *See, e.g.*, *id.* at 18 ("[T]he preferences of future generations with regard to consumption versus environmental amenities may not be the same as those today . . . .").

83. *Id.* at 23.

84. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 16, at 18.

85. *See* INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 25. Sunstein notes that as the "central value," this figure, as a practical matter, has become the default value used in regulatory cost-benefit analysis. *See* Sunstein, *supra* note 65, at 202.

86. The normative critique of observed discount rates is hardly new. Philosopher Frank Ramsey argued more than eighty years ago that failing to equitably save for future generations is "ethically indefensible and arises merely from the weakness of the imagination." Frank P. Ramsey, *A Mathematical Theory of Saving*, 38 ECON. J. 543 (1928).

individuals with finite lifespans. Such people "are likely to be guided in their private consumption decisions in a manner that is not necessarily optimal for a society that has a collective commitment to life in perpetuity."[87]

As explained above, the social rate of time preference represents decisions that individuals make about how much to save for the future. While individuals may consider the lives of their children or grandchildren when deciding how much to save, it is unlikely that they are thinking much further into the distant future.[88] The normative approach argues that this line of reasoning is inadequate for a problem like climate change, which can have effects over many generations.[89] In essence, individuals engaged in market behavior "are simply not considering the relevant question" for intergenerational policy decisions.[90]

To more clearly illustrate this point, imagine an individual living on a deserted island with a fixed supply of food over a hundred-year period.[91] If she follows observed discounting behavior, the castaway will frontload her food consumption by eating more than half the food during the first fifty years. This presents no ethical dilemma.[92] Now tweak the hypothetical such that two different individuals consecutively inhabit the island over the same hundred-year horizon: one (whom I call "Today") for the first fifty years, and the other ("Tomorrow") for the next fifty. In this scenario, discounting practices would counsel Today to consume significantly more than Tomorrow. Yet, "[i]t would be difficult to construct an attractive ethical theory that privileged the first individual in this manner merely because she lived fifty years earlier than the second individual."[93] According to

87. JOHN V. KRUTILLA & ANTHONY C. FISHER, THE ECONOMICS OF NATIONAL ENVIRONMENTS: STUDIES IN THE VALUATION OF COMMODITY AND AMENITY RESOURCES 61 (rev. ed. 1985).

88. Weisbach & Sunstein, *supra* note 13, at 446.

89. *See id.*

90. *Id.* ("[O]bserved interest rates are not a good guide for decisions over very long time periods. Individuals, in setting the market rate of return, are simply not considering the relevant question.").

91. This hypothetical is adapted from a very similar hypothetical in Richard L. Revesz & Matthew R. Shahabian, *Climate Change and Future Generations*, 84 S. CAL. L. REV 1097, 1122–25 (2011).

92. *See id.* at 1124.

93. *Id.* at 1122 (quoting Richard L. Revesz, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 COLUM. L. REV. 941, 998 (1999)) (internal quotation marks omitted). This view appears to be widely shared: in a study that placed individuals in the role of policymaker, people chose to evenly allocate the food between Today and Tomorrow—not award the majority of food to Today, as discounting would require. *Id.* at 1122–23.

this objection, it would be ethically impermissible not to bear a relatively small cost today to avoid environmental catastrophe for future generations simply because we happen to live in the present.

The normative perspective—like the traditional practices it seeks to replace—does not provide a clear discount rate. It should be noted, however, that intergenerational equity does not imply a discount rate of zero. There are several reasons for this fact. For one, society generally becomes wealthier over time, and intergenerational equity counsels that wealthier individuals in the future should be allocated less due to the declining marginal utility of wealth and theories of distributive justice.[94] Likewise, policymakers operating according to principles of intergenerational equity need to consider the fact that costs incurred in the present are likely to burden future generations by limiting social and technological progress, such that future generations may be better off if we take a more gradual approach toward combating climate change.[95]

The OMB acknowledges in its guidance on regulatory analysis that "it may not be appropriate for society to demonstrate a [time] preference when deciding between the well-being of current and future generations."[96] It counsels agencies to discount across generations at "perhaps at a lower rate than for intragenerational analysis," but cautions that some degree of discounting remains appropriate due to increasing social wealth.[97] The OMB proposes a discount rate of anywhere between one and three percent for intergenerational costs and benefits, but otherwise offers little guidance on discounting costs and benefits that accrue to future generations.[98]

The Working Group drew from the normative approach in setting its discount rates, but "rel[ied] primarily on the descriptive approach."[99] It concluded that the normative approach can justify discount rates "between roughly 1.4 and 3.1 percent" but reported that it was "difficult to justify rates at the lower end of this range."[100] Yet Daniel Farber, a prominent legal scholar who has written considerably about discounting, estimates that the long-term discount rate following

94. *See* Weisbach & Sunstein, *supra* note 13, at 447.

95. *See* Cass R. Sunstein, *Cost-Benefit Default Principles*, 99 MICH. L. REV. 1651, 1714 (2001).

96. CIRCULAR A-4, *supra* note 5, at 35.

97. *Id.* at 36.

98. *Id.* Sunstein notes that despite this guidance, a regulatory agency would face "serious questions and doubts" if it based its regulation off of a lower discount rate due to concerns for intergenerational equity. Sunstein, *supra* note 65, at 200–01.

99. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 19.

100. *Id.* at 22.

principles of intergenerational equity should fall between one and two percent, reflecting the real rate of return on riskless investment.[101] Even economists applying similar principles of intergenerational equity cannot agree on the appropriate discount rate, adding further confusion to a problem already rife with uncertainty.

III.
Discounting with Uncertainty: Hyperbolic Discounting

It is easy to suggest that the Working Group should provide a single SCC value. But this raises the question that led the Working Group to provide multiple SCC values in the first place, namely, how to select the proper discount rate. How could the Working Group have selected a single discount rate when uncertainty prevails?

This Part proceeds in three Sections. In the first Section, I discuss how regulators have traditionally responded to uncertainty in the discount rate and assess why this method is inappropriate in the context of climate change. In the second, I highlight a series of alternative methods that apply hyperbolic discounting, which reliably account for long-term uncertainty and thereby produce a sounder result. In the third, I describe how the Working Group failed to adequately apply these alternate methods by proposing multiple SCC values based on three different discount rates.

A. The Problem with Averaging

Regulators have traditionally responded to uncertainty by applying the average or central value of potential discount rates. In fact, the OMB applies averaging to calculate both the discount rate based on the private rate of return (the seven-percent rate) and the discount rate based on the social rate of time preference (the three-percent rate). The OMB's Circular A-4 (a reference of the Office's best practices on cost-benefit analysis) notes that the higher discount rate represents an "estimate of the *average* before-tax rate of return to private capital in the U.S. economy."[102] Regarding the lower discount rate, Circular A-4

101. *See* Farber & Hemmersbaugh, *supra* note 60, at 284–85. The authors largely align their calculation with the real rate of return on riskless investment, explaining that this metric is most suitable for estimating intergenerational discount rates because "investment rates are less likely to reflect impulsive decisions and are more likely to reflect thoughtful deliberation. They are also more likely to reflect long-term preferences, as opposed to short-term desires for liquidity or other effects." *Id.* at 285.

102. Circular A-4, *supra* note 5, at 33 (emphasis added). Circular A-4 further notes that "[i]n a recent analysis, OMB found that the average rate of return to capital remains near the 7 percent rate." *Id.*

acknowledges uncertainty in calculating the social rate of time preference and notes that the recommended discount rate of three percent represents what "this rate has *averaged*" over the past thirty years.[103]

For example, assume there is a hypothetical scenario in which half of the relevant indicators suggest a discount rate of two percent whereas the other half suggest a discount rate of four percent. Here, regulators following historical precedent are likely to apply a discount rate of three percent—which represents the average value of two and four percent. The Working Group applied this averaging method to arrive at its median discount rate of three percent representing the social rate of time preference. Specifically, the Working Group explained that this value represents "the *average* real return from Treasury notes over the longest time period available."[104] While not explicit in its analysis, it also seems likely that the Working Group applied averaging to arrive at the discount rate of five percent reflecting market returns, since calculations of the private rate of return typically involve averaging.[105] Thus, two of the three discount rates used by the Working Group to calculate the SCC ostensibly were determined through the averaging method.

While this method of averaging rates has an intuitive appeal, it should not be applied to regulatory initiatives when their effects occur over long time horizons, such as regulatory measures intended to impact greenhouse gas emissions. In this regulatory context, the averaging method produces a "radical foreshortening" of long-term benefits; it drastically reduces the expected value of benefits accrued in the distant future.[106] To help illustrate this point, let us assume that there is a proposed regulation that would produce $1 million in net benefits, with all of these benefits accruing in one hundred years. Let us further assume that, like in the example above, half of the indicators point to a discount rate of two percent while the other half point to a discount rate of four percent. The present value of the proposed benefit is approximately $130,000 at a discount rate of two percent and around $17,000 when a discount rate of four percent is applied. Yet, applying a discount rate of three percent—the average of the two possible discount rates—yields a present value of just $47,500. Instead of repre-

103. *Id.* (emphasis added). Circular A-4 also states that the discount rate of three percent represents "the rate that the average saver uses to discount future consumption as our measure of the social rate of time preference." *Id.*

104. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 20 (emphasis added). The Working Group adjusted this calculation to account for federal taxes. *Id.*

105. *See supra* note 52 and accompanying text.

106. Farber, *supra* note 7, at 294.

senting the average benefit that would be attained under the two possible discount rates, the resulting present value is significantly skewed toward the value that we would expect using the higher discount rate of four percent.[107]

This effect is magnified—with increasing uncertainty—when the disparity between possible discount rates is greater, and the timeframe lengthier. In the context of the SCC, for instance, possible long-term discount rates range from approximately one to seven percent.[108] Let us simplistically assume that climate change will reap $1 trillion in damages in exactly two hundred years without causing any damage during the intervening period. A discount rate of seven percent yields a present value for these damages of $1.3 million, whereas a discount rate of one percent yields a present value of nearly $13.4 billion. The average of these two values is approximately $6.7 billion; however, the present value using a discount rate of four percent—the average of one and seven percent—yields a present value of just $4.2 million, which is more than 1500 times less than the $13.4 billion produced using a discount rate of one percent.

As these hypothetical examples illustrate, using an average discount rate drastically undervalues long-term regulatory benefits. By doing so, the averaging method can depress public spending on long-term regulatory initiatives and thereby lead to severe under-regulation.

B. A Promising Alternative: Hyperbolic Discounting

Hyperbolic discounting is a series of recently developed approaches that overcome the distortions that are produced by averaging possible discount rates. Rather than averaging discount rates in the future, hyperbolic discounting applies multiple possible discount rates to future years and then averages their respective *discount factors*, or the expected values that the discount rates produce.[109] This approach avoids the problem of severely undercounting long-term benefits, as it produces a declining marginal discount rate that approaches the lowest

107. This effect derives from the compounding nature of discounting over multiple years. Recall that we determine the present value by multiplying the future value by $(1–X)^Y$, with X equaling the discount rate and Y equaling the number of years in the future at which the benefit accrues. Exponential functions of fractions produces lower fractions approaching zero, with lower fractions approaching zero at a more rapid rate. Therefore, the average value of two fractions to a certain exponent will be higher than the average of those two fractions taken to the same exponent.

108. *See supra* notes 78, 101 and accompanying text.

109. Weitzman, *supra* note 77, at 206 ("The key insight here is that what should be averaged over states of the world is not discount rates at various times, but discount factors.").

possible rate over time.[110] Thus, hyperbolic discounting abandons the maxim that a constant discount rate must be applied over time.[111]

Table 1 illustrates this principle. Here, I have modeled a scenario similar to the one above in which there are two possible discount rates of equal probability: one percent and seven percent. I show the present value of $1 million at different times in the future under each of these discount rates, and then average these discount factors to calculate the expected value produced by hyperbolic discounting. In the final column, I present the effective discount rate or, put differently, the marginal percentage decline in present value from the benefit accruing one additional year in the future.

TABLE 1.
THE VALUE OF $1 MILLION OVER 100 YEARS AT 1% AND 7% DISCOUNT RATES

Years in Future	Present Value at 7% Discount Rate	Present Value at 1% Discount Rate	Average Present Value	Marginal Discount Rate
1	$930,000	$990,000	$960,000	4.00%
2	$864,900	$980,100	$922,500	3.90%
3	$804,357	$970,299	$887,328	3.81%
18	$270,828	$834,514	$552,671	2.54%
19	$251,870	$826,169	$539,020	2.47%
20	$234,239	$817,907	$526,073	2.40%
48	$30,703	$617,290	$323,997	1.30%
49	$28,554	$611,117	$319,836	1.28%
50	$26,555	$605,006	$315,781	1.27%
98	$815	$373,464	$187,139	1.015%
99	$758	$369,730	$185,244	1.013%
100	$705	$366,032	$183,369	1.012%

This example clearly illustrates the fact that the marginal discount rate declines every year under hyperbolic discounting. Under this simplified hypothetical, the marginal discount rate nears one percent—the lowest possible long-term rate—before the fiftieth year and is practically at one percent by the hundredth year.

110. *Id.* ("[T]he properly averaged certainty-equivalent discount *factor* corresponds to the *minimum* discount rate.").

111. Revesz & Shahabian, *supra* note 91, at 1113 ("Since we are not sure what the discount rate will be in the very-distant future, by averaging discount factors, over time the lower discount rate will dominate, leading to a declining rate.").

Hyperbolic discounting was first described in a highly influential 1998 paper by the economist Martin Weitzman.[112] Five years later, Richard Newell and William Pizer offered a variation on Weitzman's method that produced an even sharper decline in effective discount rates. Rather than averaging discount factors each year, Newell and Pizer's model randomly applies a different discount rate each year among the possible options, mimicking the "random walk" that frequently characterizes economic activity.[113] This model reflects the fact that future discount rates are likely to unpredictably fluctuate over time as economic conditions change.[114] This technique produces an even starker contrast from traditional, flat discounting than does Weitzman's proposal: while Weitzman's hyperbolic discounting produces a present value that is approximately 130 times higher after four hundred years than would be produced through traditional discounting practices, the "random walk" variation increases present value by a factor of more than 4000.[115]

Further research is required to assess whether the Weitzman or Newell/Pizer model is more accurate.[116] Nonetheless, both models clearly demonstrate that traditional discounting significantly undervalues the future, particularly with respect to issues like climate change that involve considerable uncertainty in the distant future. Unfortunately, these more traditional principles underlie the SCC estimates based on discount rates of three and five percent. This is despite the fact that hyperbolic discounting has gained prominence among the economic community in recent years. A 2009 survey on the economics of climate change found nearly even support for hyperbolic discounting and traditional discounting among economists.[117] Likewise, sev-

112. Weitzman, *supra* note 77, at 202.

113. *See* Newell & Pizer, *supra* note 60, at 525.

114. *See supra* notes 69–76 and accompanying text.

115. *See* Newell & Pizer, *supra* note 60, at 526.

116. The Working Group declined to endorse one model over the other, selecting the discount rate of 2.5% by taking "the average certainty-equivalent rate using the mean-reverting and random walk approaches from Newell and Pizer." INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 23.

117. *See* J. SCOTT HOLLADAY ET AL., INST. FOR POLICY INTEGRITY, ECONOMISTS AND CLIMATE CHANGE: CONSENSUS AND OPEN QUESTIONS (2009), http://policyintegrity.org/files/publications/EconomistsandClimateChange.pdf. The survey of more than 150 leading economists found that 37.5% support discounting at a constant rate versus 36.8% for "alternative discounting methodologies (such as hyperbolic discounting)." *Id.* at viii. An additional 16.7% of respondents believed that benefits to future generations should be evaluated "by reference to moral inquiries unrelated to discounting." *Id.* The survey did not specify what this third choice might entail, though presumably many economists who selected this option were motivated in part by the normative approach presented in Section II.B.2.

eral organizations that support greater regulation of greenhouse gas emissions advocated for the Working Group to apply hyperbolic discounting in calculating the SCC.[118] Despite acknowledging that "ideally . . . [it] would formally model this uncertainty" in the discount rates—and citing the Weitzman and Newell/Pizer models as possible methods for doing so—the Working Group did not formally apply hyperbolic discounting to calculate the SCC.[119]

Nonetheless, the Working Group selected the 2.5% discount rate—the lowest discount rate used among the menu of the SCC values—based on the principles of hyperbolic discounting. Specifically, the Working Group explained that this value equaled the average "certainty-equivalent rate" corresponding to the present-value estimates of damage caused by carbon emissions generated by the Weitzman and Newell/Pizer models.[120] The Working Group effectively calculated the SCC using hyperbolic discounting, and then reverse-engineered the 2.5% discount as a flat, annual discount rate producing roughly the same SCC value.[121] As expected, this produced a significantly higher SCC estimate than the other estimates using traditional discounting practices.[122]

C. The Working Group's Folly

The Working Group deserves recognition and applause for applying hyperbolic discounting in calculating one of the SCC values. This appears to be the very first use of hyperbolic discounting in federal

118. *See, e.g.*, Letter from Envtl. Def. Fund to Angela Jackson, Fuel Econ. Div., NHTSA Office of Int'l Policy, Fuel Econ. & Consumer Standards 5 (June 9, 2011) (noting that "an alternative to constant rate discounting, including hyperbolic discounting, should be considered" for the SCC).

119. INTERAGENCY WORKING GRP. ON SOC. COST OF CARBON, *supra* note 14, at 22.

120. *Id.* at 23 ("The low value, 2.5 percent, is included to incorporate the concern that interest rates are highly uncertain over time. It represents the average certainty-equivalent rate using the mean-reverting and random walk approaches . . . starting at a discount rate of 3 percent. Using this approach, the certainty equivalent is about 2.2 percent using the random walk model and 2.8 percent using the mean reverting approach. Without giving preference to a particular model, the average of the two rates is 2.5 percent." (citations omitted)).

121. The Environmental Defense Fund argued in public comments that hyperbolic discounting could produce a certainty-equivalent discount rate of two percent or lower, but this appears to reflect a disagreement with the underlying assumptions about the range of potential discount rates rather than the mathematical technique. *See* Letter from Inst. for Policy Integrity & Envtl. Def. Fund to Lisa P. Jackson, Adm'r, EPA (Nov. 27, 2009), http://policyintegrity.org/documents/SCC_Comments_EPA FINAL.pdf.

122. Existing SCC estimates using the discount rate of 2.5% derived from hyperbolic discounting are significantly higher than the two estimates relying on traditional discounting methods. *See supra* note 20 and accompanying text.

regulatory cost-benefit analysis,[123] which is a significant development for two critical reasons. First, it provides an SCC value based on strong discounting principles that do not significantly undervalue long-term events. Second, it provides a potential basis for the more frequent use of hyperbolic discounting in federal regulatory analysis, particularly for regulations with long time horizons spanning decades or centuries, which involve a greater likelihood that regulators will undervalue long-term benefits through traditional discounting practices.

Despite its laudable use of hyperbolic discounting in calculating one of the SCC values, the Working Group erred by including additional SCC values that fail to adequately account for the significant uncertainty surrounding the discount rates to apply in the distant future. As detailed above, there is considerable uncertainty and disagreement about what discount rate should apply to the SCC. This uncertainty is magnified for the distant future due to the imprecision of long-term economic forecasts and concerns for the equality of future generations.[124] As a result of such deep uncertainty about the discount rate for the distant future, there is a real possibility that the long-term effects of reductions in carbon emissions will have a significant present value.

By applying a flat discount rate representing an average of different possible rates, the SCC values calculated using discount rates of three and five percent fail to account for the benefits that would be accrued should long-term discount rates in fact be on the low end of the spectrum. Rather, they drastically diminish these potential long-term benefits by applying a higher discount rate that reduces them practically to zero.[125] The SCC values that reflect discount rates of three and five percent thereby devalue potential long-term benefits and, by doing so, violate the central tenet of cost-benefit analysis that benefit and cost computations should "reflect the full probability distribution of potential consequences."[126] Moreover, these estimates undervalue the SCC, providing for the possibility of under-regulation due to artificially deflated benefit calculations.

Two of the three discount rates applied by the Working Group to calculate the SCC were based on faulty methods that significantly un-

123. A search for the phrase "hyperbolic discounting" on Regulations.gov yielded only a few dozen results, none of which involved the application of this technique in agency rulemaking.

124. *See supra* Section II.B.

125. *See supra* notes 104–05 and accompanying text.

126. *See* CIRCULAR A-4, *supra* note 5, at 18.

dervalue potential long-term benefits. Only the 2.5% discount rate, which was based on principles of hyperbolic discounting, accurately accounts for these benefits. By applying hyperbolic discounting, this discount rate avoids the problems that plague the other two because it allows for the consideration of potential long-term benefits should discount rates applied to the distant future be low.[127]

The SCC estimate applying a discount rate of 2.5% represents the most accurate SCC calculation among the Working Group's various options and should be exclusively used in regulatory cost-benefit analysis. When the Working Group revisits its estimates in the future, it should provide only a single SCC value based on the principles of hyperbolic discounting.

IV.
The Practical Benefits of Providing a Single SCC Value

The SCC value based on hyperbolic discounting should be exclusively applied in agency rulemaking because it is the only estimate that properly accounts for long-term uncertainty in the discount rate. Providing other SCC values based on traditional discounting practices obscures this fact by providing agencies with a range of options. Also, it may provide a useful tool to antiregulatory policymakers seeking to weaken environmental regulation. Political considerations often play a significant role in cost-benefit analysis and regulatory decision-making.[128] It would be unfortunate for political considerations to overshadow science with regard to the plight of future generations.

In this Part, I argue that the best method to ensure that the long-term benefits of carbon mitigation are given proper consideration is to provide a single SCC value based on hyperbolic discounting. I argue that providing a single SCC estimate may limit political influence in future climate regulation and thereby prevent a severe undervaluation of future benefits.

A. The Infusion of Politics into Cost-Benefit Analysis

There is disagreement in the legal and political science literature over whether White House review of agency rulemaking—and the widespread implementation of cost-benefit analysis that accompanied it—was intended to broaden or limit the importance of technical ex-

127. *See supra* Section III.B and accompanying text.

128. *See* Stuart Shapiro & John F. Morrill III, *The Triumph of Regulatory Politics: Benefit-Cost Analysis and Political Salience*, 6 Reg. & Governance 189 (2012) (finding that regulations with the least political salience have the highest net benefits).

pertise relative to political considerations in agency rulemaking.[129] Nonetheless, there is widespread agreement that politics play a significant role in agency rulemaking and cost-benefit analysis. The only debate is whether cost-benefit analysis and White House review have added another dimension of politics by aligning rulemaking with the President's agenda[130] or served to help counterbalance the effects of agency capture and bias.[131] Politics plays a substantial role under both accounts.

Implicitly "value-laden" aspects of cost-benefit such as discount rates may be particularly subject to manipulation in order to justify regulatory initiatives that fulfill political agendas.[132] Indeed, policymakers have sometimes selected discount rates based on regulatory or legislative goals rather than sound economics.[133] In response to this perceived misuse, the OMB recommended a ten-percent discount rate to apply to all future benefits and costs through the publication of Circular A-94 in 1972.[134] Yet this document, as well as subsequent OMB guidance that gradually reduced the recommended discount rate,[135] failed to completely rein in political discretion over discount rates. A 2000 survey concluded that more than one quarter of agency cost-benefit analyses deviate from OMB guidance.[136] Certain agencies

129. *See, e.g.*, Michael A. Livermore, *Cost-Benefit Analysis and Agency Independence*, 81 U. CHI. L. REV. 609 (2014); Nina A. Mendelson, *Disclosing "Political" Oversight of Agency Decision Making*, 108 MICH. L. REV. 1127 (2010); Matthew C. Stephenson, *Bureaucratic Decision Costs and Endogenous Agency Expertise*, 23 J.L. ECON. & ORG. 469 (2007).

130. *See* Christopher C. DeMuth & Douglas H. Ginsburg, *White House Review of Agency Rulemaking*, 99 HARV. L. REV. 1075, 1076 (1986) (acknowledging the controversy surrounding White House review programs).

131. Cass R. Sunstein, *Cognition and Cost-Benefit Analysis*, 29 J. LEGAL STUD. 1059, 1059 (2000) (arguing that "[c]ost-benefit analysis serves as a corrective to . . . cognitive problems").

132. Thomas O. Sargentich, *The Emphasis on the Presidency in U.S. Public Law: An Essay Critiquing Presidential Administration*, 59 ADMIN. L. REV. 1, 33 (2007); *see also* Jennifer Nou, *Agency Self-Insulation Under Presidential Review*, 126 HARV. L. REV. 1755, 1792 (2013).

133. *See* Lisa Heinzerling, *Discounting Our Future*, 34 LAND & WATER L. REV. 39, 44 (1999).

134. CIRCULAR A-94, *supra* note 56, at 4.

135. In 1992, the OMB reduced the recommended discount rate from ten percent to seven percent. *See* Benefit-Cost Analysis of Federal Programs; Guidelines and Discounts, 57 Fed. Reg. 53,519, 53,522–23 (Nov. 10, 1992). The current Circular A-4 introduced a social discount rate of three percent while maintaining the discount rate of seven percent for regulations predominantly affecting the allocation of private capital. *See* CIRCULAR A-4, *supra* note 5.

136. Robert W. Hahn et al., *Assessing Regulatory Impact Analyses: The Failure of Agencies to Comply with Executive Order 12,866*, 23 HARV. J.L. & PUB. POL'Y 859, 876–77 (2000).

have also exhibited stark inconsistencies in their application of discount rates without providing much explanation for these disparities.[137]

The political backlash against regulation to mitigate climate change makes it a likely candidate for under-regulation.[138] This would be reminiscent of attempts by the George W. Bush administration to weaken environmental regulation based on politically motivated intervention in cost-benefit analysis. In one of the highest-profile examples of manipulation of cost-benefit analysis, the Bush administration drastically deviated from widely accepted practices to calculate the VSL in an effort to inflate the benefits of the Clear Skies initiative, a series of deregulatory environmental measures.[139]

If handed the option, antiregulatory policymakers may similarly select the highest possible discount rate for the SCC in support of less stringent regulation. Antiregulatory interest groups have already gone on the offensive to limit the use of SCC estimates in regulatory cost-benefit analysis, citing the Working Group's failure to calculate SCC estimates at higher discount rates. In September of 2013, several anti-reform lobbying organizations including the U.S. Chamber of Commerce, the American Chemistry Council, and the American Petroleum Institute filed a Petition for Correction requesting that the SCC estimates "be withdrawn and not used in rulemaking."[140] In public comments supporting this petition, these and numerous other lobbying groups stressed that the Working Group should have provided an SCC estimate using a discount rate of seven percent.[141] Other interest groups such as the Edison Electric Institute also submitted comments

137. Edward R. Morrison, *Judicial Review of Discount Rates Used in Regulatory Cost-Benefit Analysis*, 65 U. CHI. L. REV. 1333, 1336 (1998).

138. *See supra* notes 1–4 and accompanying text.

139. *See* Laura J. Lowenstein & Richard L. Revesz, *Anti-Regulation Under the Guise of Rational Regulation: The Bush Administration's Approaches to Valuing Human Lives in Environmental Cost-Benefit Analysis*, 34 ENVTL. L. REP. 10,954 (2004). Despite a strong push by the Bush administration, the Clear Skies Act was not adopted, due to political backlash.

140. Letter from Am.'s Nat. Gas All. et al. to the Office of Mgmt. & Budget 2 (Sept. 4, 2013), https://www.uschamber.com/sites/default/files/legacy/hill-letters/090413_IQA%20Petition%20on%20Social%20Cost%20of%20Carbon.pdf (petition for correction submitted by America's Natural Gas Alliance, the American Petroleum Institute, the National Association of Manufacturers, the U.S. Chamber of Commerce, the American Chemistry Council, the National Association of Home Builders, and the Portland Cement Association).

141. Letter from Am.'s Nat. Gas All. et al. to Howard Shelanski, Adm'r, the Office of Info. & Regulatory Affairs (Feb. 26, 2014), https://www.uschamber.com/sites/default/files/documents/files/2.26.14-%20Comments%20on%20the%20Social%20Cost%20of%20Carbon.pdf (public comments from America's Natural Gas Alliance, the American Chemistry Council, the American Petroleum Institute, the National Associ-

requesting the use of a higher discount rate in calculating the SCC, without offering a serious economic defense of this approach.[142]

Applying the SCC estimate using a discount rate of five percent would limit the SCC to just $12 per ton, only twenty-one percent of the value provided through hyperbolic discounting.[143] If an agency chose to apply a discount rate of seven percent, the SCC value would be even lower—perhaps significantly so.[144] Utilizing either of these discount rates would significantly undervalue the long-term benefits of reducing carbon emissions and thereby produce significant underregulation.

B. The Benefits of Providing a Single SCC Estimate Based on Hyperbolic Discounting

While antiregulatory policymakers may attempt to limit regulation by applying an artificially high SCC, the Working Group can preemptively defend against this tactic by providing only a single SCC estimate, one that is based on hyperbolic discounting. While far from foolproof, recommending a lone SCC estimate may limit political manipulation of climate regulation in several respects. For example, it enhances the likelihood of judicial review. It also enhances the likelihood of backlash against politically motivated intervention.

1. Judicial Review

An agency rulemaking will be vacated as "arbitrary and capricious" if the agency "entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise."[145] On this basis, the Ninth Circuit has held that an agency must monetize the effects on climate change when a rulemaking signifi-

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ation of Home Builders, the National Association of Manufacturers, the Portland Cement Association, and the U.S. Chamber of Commerce).

142. Letter from Quinlan J. Shea, III, Vice President, Env't, Edison Elec. Inst., to the Hon. Howard Shelanski, Adm'r, the Office of Info. & Regulatory Affairs 9 (Feb. 26, 2014), http://eei.org/issuesandpolicy/testimony-filings-briefs/Documents/140226SheaOmbSocialCostCarbon.pdf (public comment).

143. *See supra* note 20 and accompanying text.

144. Without more data, it is difficult to assess what the SCC value would be using a seven-percent discount rate. SCC values cannot be easily translated from one discount rate to another because long-term benefits are spread out over many years and do not take place at a single point in time, as they have with every hypothetical example I have used in this Note.

145. Motor Vehicles Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43 (1983).

cantly impacts carbon emissions.[146] However, no court to date has opined on the sufficiency of an agency's monetization of carbon emissions. While agencies may need to monetize the costs of carbon during rulemaking, there is no guidance on how high or low such a cost estimate may be.

In the few decisions in which the issue has been raised, courts have been hesitant to remand an agency rulemaking based on the agency's choice of discount rate. Typically, the court first asks whether the agency was legally justified in discounting future benefits and costs under the governing statute. The D.C. Circuit has explained that the selection of discount rates is entitled to judicial deference because it is "first and foremost a policy choice."[147] In another case, the D.C. Circuit carefully assessed whether the social or private discount rate was appropriate, but then declined to second-guess the agency's determination that the social rate of time preference stands at fifteen percent.[148] In short, it seems highly unlikely that a rulemaking would be remanded based simply on the agency's selection of discount rate for the SCC.

Nonetheless, a court may choose to strike down an agency's rulemaking if its SCC estimate deviates significantly from economic consensus and standard practice. In *Corrosion Proof Fittings v. EPA*, the Fifth Circuit struck down an Environmental Protection Agency ("EPA") rule that relied on an abnormally high VSL estimate in banning asbestos products.[149] While most VSL estimates at the time fell between $3.8 and $9 million,[150] the rulemaking could only be justified under the EPA's own cost-benefit analysis using a minimum VSL value of between $43 and $76 million.[151] In striking down the rule,

146. *See* Ctr. for Biological Diversity v. NHTSA, 538 F.3d 1172, 1203 (9th Cir. 2008); *see also supra* note 42 and accompanying text; *cf.* WildEarth Guardians v. Jewell, 738 F.3d 298, 309 (D.C. Cir. 2013) (holding that the Bureau of Land Management did not have to consider the impacts of greenhouse gas emissions in its final environmental impact statement for a proposed coal-mining lease, since "[g]iven the state of the science, it is not possible to associate specific actions with the specific global impacts such as potential climate effects").

147. Ohio v. U.S. Dep't of the Interior, 880 F.2d 432, 465 (D.C. Cir. 1989). The D.C. Circuit has upheld this rationale in recent years, albeit in dicta. *See* Am. Trucking Ass'ns v. Fed. Motor Carrier Safety Admin., 724 F.3d 243, 254 (D.C. Cir. 2013).

148. *See* N. Cal. Power Agency v. Fed. Energy Regulatory Comm'n, 37 F.3d 1517 (D.C. Cir. 1994).

149. *See* Corrosion Proof Fittings v. EPA, 947 F.2d 1201, 1218, 1222–23 (5th Cir. 1991).

150. W. Kip Viscusi & Joseph E. Aldy, *The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World*, 27 J. RISK & UNCERTAINTY 5, 18 (2003).

151. *Corrosion Proof Fittings*, 947 F.2d at 1222.

the court noted that "such high costs are rarely, if ever, used to support a safety regulation."[152] The fact that there was broad economic consensus and fairly uniform practice across regulatory agencies in applying VSL estimates appeared to embolden the court to declare the EPA's inflated estimate an unreasonable outlier.

Should the Working Group provide a single SCC estimate based on hyperbolic discounting, a court may be willing to strike down a regulation relying on an SCC estimate with a higher discount rate on the basis that it drastically deviated from standard practice. Currently, however, such judicial intervention is unlikely because the Working Group has sanctioned a wide range of SCC values. A court is likely to permit the application of an SCC value several dollars lower (applying a discount rate of seven percent) than the $12 value obtained using a five-percent discount rate.[153] By endorsing a single SCC estimate based on hyperbolic discounting, the Working Group would increase the likelihood that a court would invalidate a lower SCC estimate that greatly undervalues the long-term future.

Nonetheless, the possibility of judicial review remains slim under any scenario. *Corrosion Proof Fittings* is often regarded as an example of judicial overreach, and in practice, courts rarely challenge VSL estimates or other technical valuations on substantive grounds.[154]

2. Precedent and Political Backlash

While it may be unlikely for courts to intervene when an agency has adopted a low SCC value based on a high discount rate in promulgating a rule, providing a single SCC value based on hyperbolic discounting may force agencies to apply a fair value for the SCC due to the effects of political and public pressure.

Public pressure has previously forced antiregulatory policymakers to refrain from infusing politics into cost-benefit analysis. The clearest example of this effect involved VSL calculations and the Clear Skies initiative, discussed *supra*.[155] The EPA had a longstanding policy of applying revealed preference studies to calculate the VSL, which it estimated at $6.3 million through a review of more than

152. *Id.* at 1223.

153. *See* Am. Dental Ass'n v. Martin, 984 F.2d 823, 825 (7th Cir. 2003) (finding the agency's VSL valuation to be "high . . . but not so astronomical, certainly by regulatory standards . . . as to call the rationality of the rule seriously into question").

154. *See* Mark Seidenfeld, *Demystifying Deossification: Rethinking Recent Proposals to Modify Judicial Review of Notice and Comment Rulemaking*, 75 TEX. L. REV. 483, 492–94 (1997).

155. *See supra* note 139 and accompanying text.

twenty independent economic studies.[156] To justify proposed air-quality standards that would generally have reduced regulation, the EPA scrapped its longstanding approach and instead calculated VSL using a new and highly controversial methodology based on years of life saved. This methodology effectively reduced the benefits of prolonging the lives of senior citizens.[157] It produced an eighty-eight percent decrease in the VSL, which supported significantly less stringent regulation.[158]

This change in regulatory policy not only sparked academic criticism,[159] but also produced considerable political backlash from senior-citizen advocacy groups, environmental organizations, and the regulatory community.[160] For instance, former EPA Administrator Carol Browner publicly criticized the adjustment to longstanding VSL methodology as a political ploy aimed at reducing regulation, asserting that Agency leadership was "adjusting the calculations to say that the benefits of less pollution are much lower."[161] The fact that the new VSL methodology represented such a sharp break from established practice helped fuel political backlash, which ultimately led the EPA to revert to traditional VSL methods and ultimately abandon the Clear Skies initiative altogether.[162]

The EPA's attempt to revise established methodology for calculating the VSL was unsuccessful largely because there was a preexisting consensus as to how the VSL should be calculated. If the Working Group provided a single SCC value based on sound cost-benefit principles, this would suggest a similar consensus that could produce uniform application of the SCC in regulatory cost-benefit analysis over many years. Any attempt to revise the SCC downward based upon discounting practices that severely undervalue long-term benefits would likely be perceived as a sharp, politically motivated break from

156. *See* Lowenstein & Revesz, *supra* note 139, at 10,959.

157. *See id.* at 10,964–67.

158. *Id.* at 10,974.

159. *See, e.g.*, *id.* Some noted economists favor the years-saved approach, while not necessarily agreeing with the Bush administration's figures. *See* Joseph E. Aldy & W. Kip Viscusi, *Age Differences in the Value of Statistical Life: Revealed Preference Evidence*, 1 REV. ENVTL. ECON. & POL'Y 257 (2007).

160. *See* Katherine Q. Seelye & John Tierney, *E.P.A. Drops Age-Based Cost Studies*, N.Y. TIMES (May 8, 2003), http://www.nytimes.com/2003/05/08/us/epa-drops-age-based-cost-studies.html; Cindy Skrzycki, *Under Fire, EPA Drops the "Senior Death Discount,"* WASH. POST (May 13, 2003), https://www.washingtonpost.com/archive/business/2003/05/13/under-fire-epa-drops-the-senior-death-discount/e14279ed-9109-40e5-998b-fd3a1620799c/.

161. Seelye & Tierney, *supra* note 160.

162. *Id.*

established methodology. This may once again provide environmental groups with significant leverage to mobilize public and political opposition and could lead to considerable backlash against attempts to devalue long-term regulatory benefits by applying a lower SCC value.

Conclusion

Discount rates are not a purely technical determination. They reflect value-laden judgments about human progress and the value of future generations. Any long-term analysis of discount rates must be sensitive to these considerations and recognize that discount rates in the distant future are severely uncertain.

By applying a fixed discount rate based on present conditions in calculating three of its four SCC values, the Working Group failed to adequately account for long-term uncertainty in future conditions and, as a result, severely undervalued future benefits. Hyperbolic discounting solves this problem by mathematically accounting for long-term uncertainty. By presenting this approach as simply one in a range of acceptable methods for long-term discounting, the Working Group violated sound cost-benefit principles and provided a historical basis for severe under-regulation of carbon emissions. When the Working Group next updates its SCC estimates, it should propagate just one SCC estimate based on hyperbolic discounting.

Providing a single SCC value, based on hyperbolic discounting, would better account for long-term uncertainty and reduce the likelihood of shortsighted regulation that devalues the future. And, perhaps just as importantly, it would provide a basis for the more widespread use of hyperbolic discounting in regulatory cost-benefit analysis. As the only method that accurately accounts for uncertainty in future discount rates, hyperbolic discounting should replace traditional discounting principles throughout regulatory analysis.