Comment on "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances"

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1. Introduction

On November 11, 2022, the US Environmental Protection Agency solicited public comments on its external review draft titled, "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances." The draft report proposes a new set of estimates for the social cost of carbon (SC-CO2), social cost of methane (SC-CH 4), and social cost of nitrous oxide (SC-N2O), collectively called the social cost of greenhouse gases (SC-GHGs). The EPA requested public comment on the underlying methodology of its report and on its new proposed estimates.

The proposed new estimates represent worldwide damages each year through the year 2300. The estimates are significantly higher than those in earlier documents and rise more rapidly over time, thereby increasing the present value of GHG damages. For example, the proposed SC-CO2 estimates range from $120 to $340 per metric ton of carbon dioxide emitted in 2020. These estimates compare to the $50 per ton figure now in use, which is based on methodology developed during the Obama administration.

Future climate changes and their socioeconomic effects are enormously uncertain, and century-long intergenerational welfare comparisons raise profound philosophical questions. Given these policy challenges, it is essential that the guidelines are transparent about uncertainties and the implications of methodology choices. To acknowledge the epistemic uncertainties inherent in the policy context, it also imperative to represent a relatively broad range of parameter values for key parameters like the discount rate, rather than using a narrower range tied to a particular school of thought or academic point of view. Our comment elaborates upon these points. We first discuss the uncertainty associated with the SC-GHG estimates, and the implications for reporting transparency. We then focus on two areas that deserve particular attention: the

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accounting perspective for reporting SC-GHG estimates, and the choice of the discount rate. A final section summarizes and presents our recommendations.

2. Representing Uncertainty

EPA's modeling of benefits of emissions reductions goes to the year 2300, roughly 275 years in the future, and a date as distant temporally from us as 1750. In 1750, the Little Ice Age was peaking and the first water-powered cotton mill was less than a decade old. A steam engine was commercially successful, but James Watt's innovation of a separate condensation chamber was still a decade in the future. Microorganisms were visible in microscopes, but germ theory was new. Still undiscovered were carbon dioxide and oxygen, chronometers to measure longitude, electricity, railroads, steamships, hot air balloons, powered flight, and antibiotics. Economical jet travel, moon walks, genetically engineered plants and animals, and smart phones for (nearly) everyone, were all likely unimaginable in 1750. Assessing benefits from GHG controls all the way to the year 2300 seems as difficult as imagining the year 2020 while watching the dawn of the industrial revolution.

After publication of the first federal SC-CO2 estimate in 2010, substantial government and private sector efforts wrestled with the challenge of improving and refining GHG damage estimates. Notwithstanding the progress made, EPA's External Review Draft (hereafter EPA-ERD) discusses extensive deficiencies and difficulties associated with the new proposed global SC-GHG estimates (p. 70-77). Because of the daunting nature of this calculation, some prominent economists (Stern, Stiglitz, and Taylor 2022; Pindyck, 2013, 2017, 2019) and decision analysts (Morgan et al., 2017) argue for abandoning the SCC approach and instead using an approach that emphasizes the cost-effectiveness of different policies, without assigning a dollar value to the damages from GHG emissions. The U.K. and France employ this approach (sometimes labeled the "target consistent" method) for pricing carbon emissions (US GAO, 2020). There are also doubts about the suitability of the Monte Carlo simulation approach used in the guidelines for the climate-modeling context, e.g., Pindyck (2017), Morgan et al, (2017), Stern, Stiglitz, and Taylor (2022). Some researchers believe that methods like "robust decision-making" are more appropriate to address fundamental uncertainties (Kwakkel et al, 2016; Lempert et al 2003; Lempert et al 2013).

These differences of opinion call out for clarity about the implications of methodology choices and transparency in the representation of SC-GHG estimates. The EPA-ERD does present distributions for uncertain input parameters like population size, economic growth, discount rates, surface temperatures and the like. But the assumptions underlying the modeling are not well justified, e.g., with respect to the social discount rate (discussed below). Moreover, uncertainties around the input distributions are not traced through to the output side to show the distributions of the SC-GHG estimates except for one illustrative year, 2030, for each of the SC-GHG estimates, i.e., Figure 3.1.1 in the text for SC-CO_2, and Figure A.5.8 for SC-CH_4 and A.5.9 for SC-N_2O in the Appendix. Looking at these figures, the 90% confidence interval for the estimates from the DSCIM based-damage modules include zero for any of the SC-GHG estimates, suggesting that extracting the damage signal of a one-ton pulse in GHG emissions above a baseline of billions is challenging.

Given the input uncertainties that the EPA-ERD documents, it is not credible to present SC-GHGs as point estimates for the years beyond 2030. The SC-GHG estimates in all years should be presented as distributions that are published for use in RIAs. This reporting format would make Monte Carlo simulation a routine part of the RIA process, as has been proposed for addressing other uncertainties, e.g., those regarding the estimates of PM 2.5 concentration response coefficients (Fraas and Lutter, 2013; Krutilla et al, 2015).

The SC-GHG guidelines should also separately report distributions for the fraction of SC-GHG values associated with the present to 2100; from 2101 to 2200; and from 2201 to 2300. This representation would reveal the greater uncertainties for periods occurring further into the future. Additionally, the credibility of the assumptions underlying the Ramsey discounting formula proposed in the EPA_ERD -- exogenous growth, exogenous preferences, and utility function stability -- become increasingly tenuous in the longer-term.

Temporally disaggregating the distributional effects of the SC-GHG estimates would also give policy-relevant information. It is appropriate for the public, who is bearing the cost of the regulatory actions, to see how the benefits of climate policies are distributed among different generations.

We elaborate upon the need for reporting clarity and justifying methodology choices in the following two sections. In the next section we turn to the accounting perspective that the EPA-ERD proposes for SC-GHG estimates. We then consider the assumptions underlying the social discount rate choices that the EPA-ERD recommends.

3. The Scope of GHG Damage Estimates

The proposed GHG damage estimates are based on a global accounting perspective, a return to the methodology used during the Obama administration. EPA justifies this scope for several reasons, among others, to encourage global cooperation in climate policymaking; to reflect climate damages on US businesses and military infrastructures located in other countries; and to address the impacts of climate change on international supply chains that affect US welfare.

We agree with EPA's justification for using global SC-GHG estimates. However, we oppose returning to the adoption of global damages as the only measure of the SCC. Providing both global and country estimates will increase transparency about who receives the benefits, will foster policy discussions about fairness and equity, will furnish agencies with the flexibility to prepare analyses consistent with their statutory mandates, and will provide important distributional information to help in international negotiations.

The EPA-ERD reports that models having both sub-national and country-scale damage functions are used to generated SCC estimates, in combination with a damage function derived from a meta-analysis. Using the disaggregated DSCIM and GIVE damage modules, Section 3.3 provides estimates for climate impacts physically occurring within the US for a limited set of damage categories. These estimates are accompanied with the caveats that they only cover a subset of damages, do not capture spillovers or indirect effects, and that these estimates are not equivalent to benefit estimates for US citizens and residents. These caveats are given as major reasons for presenting only global damage estimates.

This argument is unpersuasive. A rich set of economic and environmental data is available to support improved estimates of damages to the U.S. As the science improves further, we would also support developing and reporting damage estimates for states, regions, and counties in the United States. Modeling at regional scales could be "soft-linked" into the IAM -- an increasingly common approach for combining complex models in the energy and climate areas (Krook-Riekkola et al., 2017). A scientific advisory panel to the EPA recommended soft-linking as an option for incorporating disaggregated spatial environmental information into EPA's SAGE model (EPA, 2017).[2]

Presenting a disaggregated picture of climate-control benefits is consistent with commitments to consider the equity impacts of environmental policies. An exclusive focus on the global SCC is at odds with President Biden's Modernizing Regulatory Review memorandum calling for more distributional analysis regarding "disadvantaged, vulnerable or marginalized communities" in the U.S. The development of a domestic SCC estimate is a prerequisite for being able to develop a distributional analysis of the effects on such communities in the U.S.

In the draft EPA-ERD, EPA asserts that the global nature of GHG emissions "requires" consideration of how U.S. emissions controls will affect controls by other countries, and that use of a global estimates allows the U.S. to actively encourage other nations to reduce emissions. We agree that that global SC-GHG estimates might help to promote future international cooperation and indicate the future scale of international cooperation that fighting climate change may require.

But, international cooperation and reciprocity must be appraised in terms of emissions reductions — that is, which countries can be expected to cut their emissions, by how much, and by what dates due to U.S. action — and an objective look at the likelihood of projected cuts. After all, most countries are failing to meet their commitments under the 2015 Paris Agreement, which did not establish legally binding emissions limits. Longstanding practice in regulatory analyses is to incorporate only those changes in behavior that are required by current law. In the international context, a comparable approach would credit only reductions associated with binding agreements, not goals or pledges.

The exclusive focus on the global SCC also presumes that U.S. policymakers are indifferent about whether climate-control benefits occur in the U.S. versus elsewhere in the world — a perspective inconsistent with basic notions of nationalism and U.S. laws, such as the Clean Air Act, that specify that relevant "benefits" are those to the "Nation" and not the world. It is also inconsistent with President Clinton's 1993 Executive Order on regulation, which is still in effect and seeks a regulatory system that serves the American people. Moreover, development and use of a domestic SCC in estimating damages would increase transparency by providing information about reductions in domestic GHG-related damages from climate change initiatives to members

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[2] A description of the SAGE model can be found here. Carbone et al., (2022) discuss disaggregation issues in large computational models.

of Congress, and to U.S. taxpayers and voters, who have a right to know the projected effect of policy decisions in the U.S.

Looking to the long run, developing both a domestic and global SCC for use in policy analyses is likely to promote stability in analytic practices at EPA and other agencies. Reporting both the global SCC and the domestic SCC may therefore reduce disruptive whipsawing of carbon policy analyses across administrations.

EPA's decision on this matter may also affect the future course of research and development. The choice to develop a domestic and/or global SCC estimate is akin to an "on-off" switch regarding additional research--it provides a signal and affects incentives for both EPA and the outside academy to improve these estimates. EPA has chosen to develop a global SCC estimate--a summary measure of a dauntingly complex reality to provide an operational estimate of the long-term global damage caused by a one-ton increase in global carbon emissions. EPA could also provide a domestic SCC estimate along with a discussion of the inherent uncertainties — which would be no greater than that associated with EPA's global SCC estimate. EPA's failure to provide a domestic SCC estimate might effectively chill efforts to improve the technical quality of such estimates.

For these reasons, we believe EPA should report estimates of the benefits to the U.S. from greenhouse gas emissions reductions. Focusing solely on global costs of greenhouse gas emissions without considering costs to the U.S. provides inadequate transparency to US citizens who will bear most of the costs of carbon emissions restrictions adopted by the U.S. EPA.

3. The Social Discount Rate

The social discount rate (SDR) is the discount rate used to evaluate regulations or public projects. It is based on an appropriate weighting between the opportunity cost of capital and the consumption rate of interest that reflects the specific regulatory context.

One of the most important judgments underlying the EPA's proposed social cost of carbon is the choice of a SDR for discounting damages that occur in the distant future. The SDR matters because the time scale to realize the benefits of greenhouse gas emission controls is so long, and much longer than conventional financial contracts.

EPA's recommended discounting procedure departs from practices in past guidelines in significant ways. A consumption discount rate is given priority in the analysis over the opportunity cost of capital. The Ramsey discount formula is adopted for calibrating the consumption discount rate, with the growth rate (g) taken as stochastic. The growth rate uncertainty makes the discount rate a random variable, and causes the discount rate to decline over time (Gollier, 2013). The p and η parameters in the Ramsey formula are calibrated so that the average of the certainty-equivalent discount rates over the first ten years matches a short-term consumption rate. Uncertainty about short-term consumption rates is bracketed using the rates of 1.5%, 2%, and 2.5%.

Our comments address the use of the Ramsey rule, the parameter values for consumption discount rates, and the need for including the social cost of capital in the SDR when regulations displace capital investment, and plausible parameter values. We also consider the implications of declining discount rates.

3.1 The Ramsey Formula

The Ramsey equation reflects the optimal solution to a benevolent social planner's problem to maximize the present value of utility (or welfare) assuming an infinite time horizon, given that utility depends only on consumption and consumption can grow only through savings. The equation is $r = \eta g + \delta$, where r is the discount rate, η is the elasticity of marginal utility of consumption, g is the growth rate of consumption, and δ is the pure rate of time preference. This relationship implies that the optimal (consumption) discount rate is above the pure rate of time preference only by the product of consumption growth g and the elasticity of marginal consumption with respect to consumption.

It is unclear whether the EPA's application of the Ramsey equation is appropriate. First, EPA's draft does not discuss the implications of increases in longevity for the use of the Ramsey equation in climate policy. Improvements in health—particularly increases in longevity—have been roughly as valuable as the gain in consumption, conventionally measured (e.g., Cutler and Richardson 1997, Nordhaus, 2002). Put differently, gains in welfare driven by health improvements and consumption of goods and services over the decades from 1950 through roughly 2000 appear to be twice the growth in consumption of goods and services alone. If the future looks like the past, our grandchildren's generation will be better off than our own, but not only because their consumption of goods and services will exceed ours by nearly a factor of 5, assuming that past trends in median consumption and income growth in the U.S. continue to hold and that parents have kids at age 20. [Note that $4.6 = (1.02)^{40}$.] In addition, assuming past gains in longevity hold, future generations can be expected to be better off because of these longevity and health gains by roughly the same amount as from the gains in consumption alone.

The rapidly changing composition of consumption over time itself raises utility, a fact ignored in the Ramsey formulation. Technological change increases the scope for consumption choices, raising utility for the same dollar of income. Smart phones came to dominate personal communications only in the past 15 years (the iPhone was introduced in 2007); yet, considerable income would now be necessary to compensate users to give up this technology.

The Ramsey model is also based on an outmoded view of economic growth—that consumption can increase only by deferring consumption of current output and increasing investment in productive capital. Paul Romer (who shared the 2018 Nobel prize in economics with William Nordhaus) showed that generation of human capital and ideas (e.g., blueprints and recipes) could lead to competitive markets and sustainable growth (Romer, 1986; Romer, 1990).

Importantly some of the health improvements enjoyed by Americans and others come from ideas and recipes, not capital investments per se. Most important, new pharmaceuticals, vaccines, new diagnostic devices, epidemiologic research about smoking, and basic science such as the findings that enabled accelerated development of the mRNA COVID-19 vaccines all involve ideas such as those studied by Paul Romer.

The broader question is how endogenous growth, improvements in health and longevity, and increasing consumption efficiency over time affect the choice of the social discount rate for climate control policy. EPA needs to address this before embracing the Ramsey model to derive a discount rate for calculating the social cost of carbon.

3.2 Consumption Discount Rates

The EPA-ERD implicitly assumes that the costs of complying with EPA climate regulations will be borne by the public in the form of reduced consumption. This assumption may not be valid for all EPA climate regulations. For those regulations for which the assumption is valid, the consumption discount rates proposed in the EPA-ERD have two limitations. First, returns on Treasury notes are used to calibrate the initial discount rates. Secondly, the statistical properties of the growth process used in the Ramsey formula are not well enough described for the reader to understand which uncertainties are represented. In combination, the treatment of these issues in the EPA-ERD is likely to bias downward the proposed consumption discount rate.

Calibration and Estimation

The target consumption discount rates to which the Ramsey parameters are calibrated are the average real return on 10-year Treasury securities in recent decades. EPA cites other studies and surveys to support the selected range, including surveys by Drupp et al. (2018) and Pindyk (2019). This selected range is markedly lower than the Obama-era range of discount rates.

The justification for the low rates is a substantial and persistent decline in the average real return for Treasuries in recent decades. However, there is no discussion of the effect of the remarkable monetary policy pursued by the Federal Reserve over the last several decades, which have kept interest rates on Treasuries artificially low, or that fiscal policy is now becoming more expansionary.[3] (Kashyap and Stein (2023) Moreover, when the forecasting horizon is several hundreds of years, interest rate behavior in recent decades is not necessarily more relevant than in earlier historical periods when interest rates were higher.

Looking more closely at the Pindyck (2019), Drupp et al. (2018), and Howard & Sylvan (2020) studies, Pindyk reports the mean estimates range from 2.6% for European experts to 2.73 % for economists to 2.94% for North American experts to 4.14% for experts from developing countries. All of these estimates are above EPA's upper end near-term target rate. Drupp et al. report mean and median estimates of 2.27% and 2%, respectively, with a mean upper bound of 4.14% and median of 3.5%. Howard & Sylvan report mean and median estimates of 3.1% and 2%, respectively [with trimmed mean and median estimates of 2.3% and 2%]. They report that the 90th percentile estimate was 4.5%. The response rate for the surveys ranged from 10%

[3] There was a substantial benefit of the seigniorage effect offered by US financial instruments over these decades. The future development of alternative instruments by other nations and the private sector will likely erode this advantage in future years.

(Pindyck w/ 534 responses) to 20% (Howard & Sylvan w/ 216 responses) to 30% (Drupp et al. w/ 183 responses).

Moreover, Polasky and Dampha (2021), in their survey article suggest values between 1.35 and 2.65 for prescriptive versions of the Ramsey rule, while the descriptive approaches from Nordhaus and Weitzman give values between 5.5 and 6.

Using Treasury securities as the basis for the consumption discount rate also poses the problem that only a small minority of consumers own them (CEA, 2017). Credit rationing is pervasive in the economy, leading to segmentation of the capital market and a range of markets for consumption smoothing (Stern, Stiglitz, and Taylor, 2022). The EPA-ERD points to this issue on page 59:

"Further, a concern about discount rates developed using both the descriptive and prescriptive approaches is that they tend to obscure important heterogeneity in the population. For instance, many individuals smooth consumption by borrowing with credit cards that have relatively high rates. Some are unable to access traditional credit markets and rely on payday lending operations or other high-cost forms of smoothing consumption. This behavior may reflect rational intertemporal preferences, or it may reflect other factors such as present bias, lack of financial literacy, and other distortionary effects of poverty (Haushofer and Fehr 2014; Lusardi and Mitchell 2014). *Nevertheless, whether one puts greater weight on the prescriptive or descriptive approach, the high interest rates that credit-constrained individuals accept suggest that some account should be given to the discount rates revealed by their behavior*." (emphasis added)

Studies have documented that consumers have high marginal rates of time preference. Nominal discount rates for US military personnel making choices about compensation packages varied between 10% and 54% (Warner and Pleeter, 2001). A field study of consumers in Denmark found a mean nominal rate of 27% (Harrison et al., 2002). A study of private energy investment in Greece yielded a mean nominal discount rate of 77%, with a required payback period of 3.7 years (Damigos et al., 2021). Such high discount rates provide one explanation for the so-called "energy efficiency paradox" that sometimes arises in EPA's rulemakings. From a private perspective, the calculated NPVs of EPA's energy efficiency regulations can be positive at 7%, the upper bound discount rate recommended in Circular A-4. Yet, if the private sector was voluntarily pursuing this payoff there would be no need for the regulation. Higher discount rates than those suggested in BCA guidelines is likely to be part of the explanation for why the market is not supplying and consumers are not pursuing energy efficiency options that EPA's analysis indicates provides benefits to the private sector (Gillingham and Palmer (2014) and Helfand and Dorsey-Palmateer, 2015).

<u>Uncertain Growth</u>

The EPA-ERD does not describe the statistical process that generates the growth rate estimates, making it unclear what uncertainties the forecasts include.

Starting with Dasgupta and Heal (1979), it has been common to add a discounting component to account for the possibility of catastrophic societal risks that pose an existential threat to humanity, e.g., the risk of human extinction from an event like an asteroid strike. Stern (2008) recommended adding a risk premium of 0.1%, representing a 1 in 1000 annual risk of complete societal collapse. This adjustment would marginally affect the discount rate used in the analysis by adding a risk premium of 0.1% to the discount rate.

An important uncertainty is the possibility of major economic disruptions (unrelated to climate damages), such as those associated with economic depressions, wars, financial crises, or pandemics (Pindyck & Wang (2013), Martin & Pindyck (2015), Martin & Pindyck (2020)). The last two decades provide ample illustrations of such events that could reoccur in future decades. Freeman et al., (2018) suggest adding a risk premium to account for this category of uncertainty.

An alternative would be to model such events explicitly, e.g., as a sharp initial decline in the growth rate, followed by higher-than-trend growth rates over a long convergence period that would return the economy back to the average. The effects of this perturbation would carry through to the discount rate and damage estimates, given their dependency on economic growth. The modeling should reflect both the past and expected future frequencies of catastrophic economic disruptions; for example, by calibrating the value of a time-varying lambda parameter in a Poisson distribution to match historical and projected occurrences.

In summary, we believe there are three reasons that the discount rate range used in the draft guideline understates the target consumption discount rates (1) they are inappropriately calibrated to short-run market rates and ignore the credit-rationing in capital markets, (2) the review of the literature of consumption discount rates shows higher plausible upper bounds than the 2.5% used in the EPA-ERD and (3) uncertainties about the growth rate and the possibility of catastrophic damages suggest additional risk premia that are not reflected in the statistical process that generates the growth forecasts.

For these reasons, we recommend 3% and 5% as conservative estimates for the mid and upper bound consumption discount rates for use in SC-GHG estimates.

3.3 Cost of Capital

The low consumer discount rates cited by EPA in the EPA-ERD are not appropriate for use in evaluating regulations that will displace corporate investment. The seminal theoretical contributions in economics that support use of the consumer discount rates acknowledge that a different approach must be used if capital investment in the economy will be displaced (e.g., see Bradford, 1975, Case 2, 891, Li & Pizer, 2021). We do not address here whether EPA climate regulations will reduce consumption, investment or both, except to say that it seems likely that both effects will occur.

One of the key arguments for incorporating the opportunity cost of capital in regulatory analysis is that it ensures that there are no other uses of investment capital that would enable everyone to be even better off, thereby giving a Pareto improvement. This logic applies both intra- and inter-generationally. See Viscusi et al. (2019), Kaplow (2006), Lind (1995); Liu et al., (2021), Weisbach and Sunstein, (2008); Weyant, J.P., (2008).

OMB's Circular A-4 states that: "the analytically preferred method of handling temporal differences between benefits and costs is to adjust all the benefits and costs to reflect their value in equivalent units of consumption and to discount them at the rate consumers and savers would normally use in discounting future consumption benefits." (OMB 2003).

However, estimating the shadow price of capital is challenging (OMB 2003). Li & Pizer (2021) most recently addressed this task. The adjusted discount rate in this approach is time dependent, with SDR declining in the long run to the consumption rate, e.g., after 50 years or more depending on parameter values. The fact that it is only in the longer run that the social discount rate declines to the consumption rate suggests an important insight: *the target discount rates used to start off the temporal discount rate path should not be based on a consumption rate, as is suggested in the EPA-ERD, when regulatory compliance displaces capital investment.* On this point, the EPA draft commits an analytic error that is readily fixed, as we explain below.

While the Li and Pizer analysis focuses on longer timeframes, they suggest a wide range for the shadow price for near-term analysis. Most capital investment required by regulation represent near-term projects--technological innovation typically results in obsolescence of reproducible capital within a few decades.

As an alternative approach to the shadow price of capital, EPA considers converting capital costs to an annual stream over the life of the project using the opportunity cost of capital and then discounting that stream of capital costs back (for present value estimates) using the consumption rate of interest. This approach would discount both the benefit and resulting cost stream(s) with the same discount rate. We encourage EPA to focus on this approach in its final guidelines since it will correct the analytic error noted above.

Both the shadow price of capital and this alternative approach require an estimate of the opportunity cost of capital. The estimates of the social opportunity cost of capital using data from the National Income Accounts have been remarkably stable. OMB has calculated a long-term, real, pre-tax opportunity cost of capital of 7 percent for periods beginning with the early years of the last century.[4] Using a similar approach, the CEA (2017) reported stable estimates over the last 50 years for the annual rate of return to capital, with the rate centering around 7 percent (CEA, 2017, 10).[5] Gomme reports pre-tax returns on business capital since 1950 have generally exceeded 8 percent.[6] Further, Damodaran (2022) reports equity risk premia for US business have generally ranged from 4.5 to 6 percent since 1960.[7] Fernandez et al. (2022) report a corporate equity premium on the order of 5.5 percent for the U.S. over the last decade. These several estimates suggest a private cost of capital of 7 percent or higher.

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[4] OMB's estimate included the lower return on land which is not reproducible capital and arguably not relevant to this calculation. ~~On the other hand, CEA also noted that this approach may be subject to measurement error leading to an overestimate of the return to capital.~~

[5] CEA also noted that this approach may be subject to measurement error leading to an overestimate of the return to capital.

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[6] https://paulgomme.github.io/#data

[7] https://pages.stern.nyu.edu/~adamodar/

A different approach would be for EPA to use sector-specific returns on capital investment since EPA regulations can be expected to displace capital in specific sectors. OMB or EPA could publish sector-specific rates of return and adjust them over time based on new information. Only regulations that are economy wide – rare for EPA regulations – would use the average economy-wide rate of return. We believe this approach is also defensible.

Looking forward, we believe it would be appropriate for the US federal government to review alternative estimates of the return to capital and propose an appropriate range for use in BCA. Those estimates should be made available for public comment and should be subject to independent peer review by qualified experts. We would expect such a review to place the appropriate values in the range from 5% to 10%.

3.4 Declining Discount Rates

We do not object to reporting some benefit estimates using a declining rate of discount. However, we believe it is unwise to completely abandon constant discounting and rely entirely on benefit estimates that assume a declining rate. Some analyses should be performed with a conventional constant discount rate to avoid temporal inconsistencies that we explain below.

One of the discounting issues identified by the NAS report is how the SC-CO2 estimates should be combined with other cost and benefit estimates that may use different discount rates in regulatory analysis (EPA Supp22, 9). Where the time frame for the analysis is "moderate" (e.g., within 30 years), EPA states that there will be only a small difference between discounting from the year of emissions to the year of analysis using a constant discount rate--the consumption rate of interest--equal to the near-term target rate and discounting using the certainty-equivalent discount factor. Thus, EPA advises that using a constant discount rate equal to the near-term target rate provides a close approximation for regulatory analysis of projects within the current generation. (EPA Supp22, 83).

When a declining discount rate is used over long time periods, a mismatch can occur between the within-generation intertemporal preferences of the future generation and the forward intertemporal preferences of the future generation that the current generation assigns to them (Viscusi 2022). The declining discount rate reflects the weighting by current generations of impacts on future generations. The decisions made by the current generation may have different effects, or effects that occur at different times in the future, relative to the choices of future generations.

Future generations will likely live longer—e.g., the generation born in the U.S. in 2080 might live to 85 or even 90 years. Within that future generation, use of a declining discount rate rather than a constant discount rate would place a greater weight on benefits in the latter part of the generation than the early years. The future generation may prefer a different trajectory of benefits that is more front-loaded within that generation than would result from the forward-looking preferences associated with the declining discount rate. In this instance, future generations will not thank us for low-balling the discount rate in assessing intergenerational projects. For similar reasoning, refer to Birdsall and Steer (1993) and Wildavsky (1988), among others in the literature.

4. Summary and Conclusions

Estimating the economic cost of global damages over the next several centuries poses daunting challenges. For the present value of these estimates to be informative for regulatory benefit-cost analysis, transparency about the uncertainties is essential. Moreover, understandable differences of opinion about methodology and in philosophical approaches to intergenerational welfare comparisons suggest public decision-makers should remain eclectic in their analytic approaches and the assumptions they use to calibrate important inputs, such as the social rate of discount.

We believe that the EPA-ERD is not transparent enough about the implications of methodological choices and uncertainties, or expansive enough in representing the range of views in the economics literature about relevant methodology issues and parameter values. To remedy these deficiencies, we make the following recommendations:

1. The SC-GHG estimates should be presented as distributions that trace through the distributions around the input parameters described in the EPA-ERD. It is not credible to show the input uncertainties while muting their reflection in the SC-GHG estimates.

2. The SC-GHG guidelines should separately report distributions for the part of SC-GHG values associated with the present to 2100; from 2101 to 2200; and from 2201 to 2300. This decomposition would indicate the greater uncertainty of future estimates and the distribution of benefits falling on different generations. The intergenerational distribution of benefits is policy relevant.

3. The guidelines should provide both global and domestic SCC estimates. Providing both estimates will increase transparency about who receives the benefits, will foster policy discussions about fairness and equity, will furnish agencies with the flexibility to prepare analyses consistent with their statutory mandates, and will provide important distributional information to support international negotiations.

4. The EPA needs to justify the use of the Ramsey discounting formula, which is deficient in several respects. Among other issues, the Ramsey formula ignores the role of human capital and technological developments in wealth generation and utility, and the role of increasing longevity and expanding product variety on the standard of living over time. Intertemporal welfare comparisons that do not take into account these quality-of-life improvements will bias the discount rate downward.

5. The range of the proposed initial discount rates (1.5% to 2.5%) is narrower than the ranges used in the studies that EPA cites to justify them, and significantly narrower than the range for consumption discount rates found in the economics literature. These rates also ignore a point the EPA-ERD itself makes, that the effects of capital rationing on consumer discount rates should be reflected in the social discount rate. To better reflect

this broader landscape, we recommend 3% and 5% as quite conservative estimates for the mid and upper bound consumption discount rates to use in SC-GHG estimates.

6. The social cost of capital is also relevant for climate regulations that displace investment. Li & Pizer (2021) propose a capital shadow pricing approach in which the SDR declines to the consumption rate in 50 years or more depending on parameter values. This implies that the initial discount rates used to start off the temporal discount rate path should not be based on a consumption rate, as is suggested in the EPA-ERD. For the social cost of capital in the nearer term, the appropriate values are likely to range from 5% to 10%.

7. The EPA-ERD propose a declining discount rate schedule that begins to significantly depart from the constant rate after 30 years or so. Temporal inconsistencies can arise with declining discount rates in the longer term, as discussed in the preceding section. We recommend that the SCC be computed using both a constant discount rate to avoid temporal inconsistencies, as well as declining rates such as those recommended in the EPA-ERD.

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