May 12, 2020

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Subject: First Batch of Additional Comments to the Science Advisory Board Economic Guidelines Review Panel, Covering Chapters 1–7

The Institute for Policy Integrity ("Policy Integrity") at New York University School of Law[1] submits the following additional comments to the Science Advisory Board's Economic Guidelines Review Panel. Policy Integrity is a non-partisan think tank dedicated to improving the quality of government decisionmaking through advocacy and scholarship in the fields of administrative law, economics, and public policy. These comments build on, and incorporate, our initial written and oral comments.[2]

Given the short time between the May 1 notice of the SAB panel's additional meetings and the May 12 deadline set for written comments, these comments focus on the first seven chapters of the draft *Guidelines*, which the SAB panel plans to review during its first two meetings. Policy Integrity will submit additional comments on chapters eight through eleven in advance of the panel's third meeting. This first batch of comments will proceed in chapter order, rather than in order of issue importance, to facilitate the panel's review.

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[1] This document does not purport to present New York University School of Law's views, if any.

[2] Policy Integrity, Initial Written Comments (Apr. 15, 2020), https://policyintegrity.org/documents/SAB_Econ_Guidelines_Review_Panel_Initial_Comment_2020.04.15-signed_.pdf; Policy Integrity, Transcript of Oral Comments Presented on April 23, 2020, https://policyintegrity.org/documents/SAB_Econ_Guidelines_Review_Panel_Oral_Comment_2020.04.22.pdf.

Comments on the Glossary

Additions: The SAB should encourage EPA to include additional definitions for key terms. For example, "breakeven analysis" is a key concept for the proper consideration of unquantified effects, but neither the draft *Guidelines* nor *Circular A-4* provides a concise definition of the term. Other missing terms worthy of a definition in the glossary include: sensitivity analysis, bounding analysis, and ecosystem services.

Revisions: EPA should consider whether to add the concept of international trade effects to the definition of "economic impact analysis." Note that international trade is listed as a "relevant group" in EPA's Table 9.2 on examples for analyzing the economic impacts of regulations.[3]

While the definition of "elasticity of supply" appropriately notes that most goods are increasingly price elastic over time, the definition of "elasticity of demand" lacks that broader statement, instead only giving as one example that gasoline will be more price elastic in the long term. The definition for "elasticity of demand" should echo the broader statement on the long-term elasticity of most goods.[4] Additionally, EPA might consider defining what "short term" means, especially in an important context like fuel prices, but also more generally for elasticities. For example, a study relied upon by the Bureau of Ocean Energy Management found that "90 percent of the long run response" to a change in the relative price between traditional fuels had already occurred before the eleventh year following a price change, suggesting that the line between "short run" versus "long run" may be considerably less than ten years.[5]

In the definition of "non-use value," EPA should delete the words "mere" (page i-11, line 18) and "paternalistic" (*id.* line 19), as they have an unnecessarily pejorative connotation.

VSL: In the definition of "value of statistical life," EPA should replace the example ("if 10,000 individuals are each willing to pay $500 for a reduction in risk of 1/10,000, then the value of saving one statistical life equals $500 times 10,000—or $5 million") with numbers that actually reflect EPA's current VSL, and to be consistent with the example EPA uses on its website on "Mortality Risk Valuation."[6] Starting at page i-12 line 40, the text should read: "For example, if 100,000 individuals are each willing to pay $100 (2016$) for a reduction in risk of 1/100,000, then the value of saving one statistical life would equal $100 times 100,000—or $10 million." The definition should also make clear that the value must be updated for inflation and income growth.

Comments on Chapter 1

Highlight Unquantified Effects: Text Box 1.1 purports to represent OMB's *Agency Checklist for Regulatory Impact Analysis*, and yet includes no reference to unquantified or qualitative effects—which, as the *Guidelines* otherwise do acknowledge, is a key part of any complete regulatory analysis. OMB's checklist refers to qualitative in each of the last two bullet points.[7] EPA should similarly include

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[3] *See generally* Michael Livermore & Jason Schwartz, "Regulating Regulation: Impact Assessment and Trade" in *Megaregulation Contested: Global Economic Ordering After TPP* (2019, Kingsbury, Benedict et al., eds.) (explaining how to appropriately incorporate international trade effects into regulatory impact analysis).

[4] N. Gregory Mankiw, Principles of Economics at 91 (2009, 5th ed.) ("Goods tend to have more elastic demand over longer time horizons.").

[5] *See* Policy Integrity Comments to BLM on Errors and Omissions in the Substitution Analysis in the Wright Area Coal Leasing Remand Environmental Assessment, at 3 n. 18 (Oct. 4, 2018), https://policyintegrity.org/documents/Wright_Area_Remand_EA_Comments_on_Substitution-final.pdf (citing Clifton Jones, *The Role of Biomass in U.S. Industrial Interfuel Substitution*, 69 Energy Policy 122, 124 (2014)).

[6] https://www.epa.gov/environmental-economics/mortality-risk-valuation.

[7] https://www.whitehouse.gov/sites/whitehouse.gov/files/omb/inforeg/inforeg/regpol/RIA_Checklist.pdf.

references to unquantified effects in appropriate places in the text box. For example, EPA could make these redline additions:

- Does the RIA explain and support a reasoned determination that the benefits (including unquantified benefits) of the intended regulation justify its costs (including unquantified costs)?
- Does the preferred option have the highest net benefits (considering unquantified effects as well as quantified effects)—unless a statue requires a different approach?

A separate bullet point specifically on unquantified effects is also warranted, such as:

- Does the RIA characterize the likely magnitude and significance of any important unquantified effects to the extent feasible, such as through breakeven analysis?

Comments on Chapter 2

Reaffirm Best Analytical Practices: While the draft *Guidelines* assert that specific statutes may "mandate specific economic analyses" that are "not discussed here" (page 2-1), the *Guidelines* also elsewhere emphasize that good economic analyses aim to inform the public, Congress, and decisionmakers of all the effects of policy options and so "should identify those options that are more efficient or cost-effective *even if the regulatory approaches may be prohibited by statutory or judicial requirements (OMB 2003)*" (page 3-4; emphasis added). The SAB should encourage EPA to make similar statements with respect to the entire economic analysis, such that analysts include full estimates of all important costs and benefits, consistent with best economic practices, even if some decisionmakers may feel that they are not permitted by statute to fully consider those effects in selecting between regulatory alternatives. Chapter 2 would be an appropriate place to reemphasize that distinction.

Comments on Chapter 3

Alternative stringencies: On page 3-1, at line 14, EPA should change "may" to "should," reflecting the fact (as acknowledged elsewhere in the *Guidelines*) that regulatory alternatives *should* always include different level of stringency.

Market failures and other regulatory goals: On page 3-2 at lines 10-11, EPA incorrectly states that "For pollution problems, the social purpose *is* to correct a 'market failure.'" (emphasis added). While classic externalities and other market failures are surely the most common and often driving reasons for federal environmental regulation, it is not true that the only social purpose for addressing pollution problems "is" correcting market failures. Distributional equity, for instance, could also be the supplemental or even primary goal in addressing pollution. This sentence should be revised as follows: "For pollution problems, the social purpose often is to correct a 'market failure,' though distributional equity and other goals may also be motivating factors."

On page 3-2 at footnote 48, EPA should add a citation to the growing literature on internalities and behavioral market failures. One such source would be Hunt Allcott & Cass R. Sunstein, *Regulating Internalities*, 34 J. Policy Analysis & Mgmt. 698 (2015). As the draft *Guidelines* already acknowledge at page 4-16, externalities are not the only ways that markets can fail, and it is important to pay attention to behavioral market failures in the design of an efficient regulatory solution. EPA should therefore acknowledge this literature in the section on market failures in Chapter 3 as well.

On page 3-2 at line 33, EPA should add a footnote after the phrase "perfect markets with full information," to clarify that, in fact, labor markets are rarely perfectly competitive and the workers who seek high-risk jobs may not have perfect information or equal bargaining power—and, further, that such

imperfections may cause an underestimation of the value of statistical life when based on labor market studies. Moreover, such workers may not be representative of average rational attitudes toward risk, since employers offer wage premiums not to attract the average person, but instead to attract the last person needed to fill a job.

Do Not Presume a "Preferred" Option: On page 3-4, at line 26, as well as elsewhere in the *Guidelines*, EPA talks about the need to analyze both a "preferred option" and more stringent and less stringent options. This language presumes that the agency has settled on a "preferred option" even before any analysis has taken place. There may be times when statutory factors, like technological feasibility, point toward a particular option as a starting place, but no option should be presumptively "preferred" before any economic analysis has been completed. The SAB panel should consider and advise EPA on more appropriate terminology to use, to encourage analysts to approach a suite of reasonable regulatory alternatives without having already identified one as the "preferred" option.

Use More Balanced Language on Variations by Firm Size: On page 3-6, lines 12-15, the description of considering regulatory alternatives by firm size is overly focused on the potential differences in costs. This discussion should also remind analysts of the importance of weighing the forgone benefits from any relaxation of regulatory requirements for certain sized firms, and of the efficiency in equalizing marginal compliance costs across firms.[8] *Circular A-4*'s language on this same point, for example, is more balanced: "The balance of benefits and costs can shift depending on the size of the firms being regulated. Small firms may find it more costly to comply with regulation, especially if there are large fixed costs required for regulatory compliance. On the other hand, it is not efficient to place a heavier burden on one segment of a regulated industry solely because it can better afford the higher cost."

Problematic Language on "Statutory Objective": In general, the *Guidelines* appropriately continue to remind analysts (e.g., at page 5-3) that "when calculating net benefits all welfare effects should be included, as it is the total willingness to pay for all changes induced by a regulation that determinates economic efficiency." However, some of the specific language and approaches the *Guidelines* applies to indirect effects are potentially problematic.

Footnote 62, at page 3-6, reads: "The statutory objective of the regulation is the specific objective of the statutory provisions under which the regulation is promulgated." First, that sentence is somewhat of a tautology and does not offer analysts much guidance. Second, the statement seems to assume a single, knowable statutory objective. In fact, a regulation can have multiple statutory authorities. A statute can also have multiple objectives. Legislative objectives may not always be clear. A specific statutory provision's objectives may be informed by the broader objectives of the entire act. Policy Integrity's prior written and oral comments already flagged the difficulty of trying to distinguish between pollutants that are the "statutory objective" versus those that are "other" contaminants, and the problems with relegating "other" effects to some secondary status. If footnote 62 is kept, it should include more useable guidance for analysts and should acknowledge the complexities in identifying a statutory objective. The footnote should also clarify that analysts should not assume, absent explicit statutory language, that any statute has the objective of barring consideration of important indirect effects. For example, any broad statutory language, like "reasonable" or "appropriate," should be read broadly to authorize consideration of all important effects, whether direct or indirect.

Page 3-6 at lines 33-34, raises the possibility of considering options to separately or simultaneously regulate "other" contaminants "directly." As Policy Integrity noted in our prior written and oral comments, undertaking multiple regulations, each focused on individual pollutants rather than a unified,

[8] *See* Policy Integrity, Letter to U.S. Small Business Admin. on Suggested Improvements to the Implementation of the Regulatory Flexibility Act, Feb. 24, 2012, https://policyintegrity.org/documents/Policy_Integrity_Letter_to_SBA_on_RFA.pdf.

multi-pollutant regulatory strategy, may carry additional costs: administrative costs from designing and issuing multiple regulations; paperwork costs from implementing and complying with multiple regulations; and any lost efficiencies that a multi-pollutant compliance strategy may achieve that distinct pollutant-specific rulemakings might preclude. Additionally, any analysis of a regulatory alternative that requires a separate rulemaking would have to consider the realistic probability of whether such alternate or separate rulemakings could actually occur, as well as the forgone benefits during any delay in waiting for the additional rulemakings. Such an analysis could prove vexing if not impossible for an administration, especially when different authorities span across different agencies or different offices within an agency, each with their own rulemaking and enforcement capacities. Indeed, the *Guidelines* generally do not permit EPA to consider separate rules that have not yet even been proposed let alone finalized in either the baseline or policy scenarios of a cost-benefit analysis (*see* page 5-10). Moreover, as courts have repeatedly reminded agencies, the existence of overlapping authorities does not excuse an agency from rationally implementing all of its statutory mandates: "The two obligations may overlap, but there is no reason to think the two agencies cannot both administer their obligations"[9]; "Just as EPA lack authority to refuse to regulate on the grounds of [the existence of another] statutory authority, EPA cannot defer regulation on that basis."[10] As the *Guidelines* already acknowledge, the rational implementation of rulemaking authorities requires the consideration of net social benefits including from reductions of other environmental contaminants. The SAB should object to any proposal to consider separate or simultaneous rulemakings without sufficient attention to the practical and economical challenges posed by such an undertaking.

Comments on Chapter 4

Equity in Evaluating Environmental Policy: At page 4-1, lines 25-26, the *Guidelines* delineate "economic efficiency" and "cost-effectiveness" as "two economic concepts useful for framing the discussion and comparing [policies]." However, distributional equity is another concept useful for framing the discussion and comparing policies. Standard economic tools, such as the Gini Coefficient, exist to evaluate the distribution of an economic feature (such as income, benefits, or costs). The *Guidelines* should go further to emphasize equity and distributional burden as an economic concept useful for "framing the discussion and comparing [policies]"—not just in Chapter 10, but upfront in Chapter 4, and throughout.

Co-Benefits in Economic Efficiency: At page 4-2, line 4, the *Guidelines* state that "The socially optimal level of pollution is determined by reducing emissions until the benefit of abating one more unit (i.e., the marginal abatement benefit)—measured as a reduction in damages—is equal to the cost of abating one more unit (i.e., the marginal abatement cost)." The phrase "one more unit" could be read to refer to a unit of a particular pollutant. This formulation, however, is only true if there are no other market failures. In the case of positively correlated externalities (for example, how particulate matter emissions are often correlated with carbon dioxide emissions), it is possible that the socially optimal level of pollution occurs when the marginal abatement cost exceeds the marginal abatement benefits of a particular targeted pollutant. Especially given EPA's attempts to distinguish between target pollutants versus other contaminants (though note the comments above and below for critiques of that distinction), this point should be further clarified in a footnote.

Certainty Benefits in Prescriptive Regulations: One potential benefit of prescriptive policies is increased certainty over the quantity of emissions reductions. This increased certainty can be important when

[9] *Massachusetts v. EPA*, 549 U.S. 497, 532 (2007).
[10] *Coalition for Responsible Regulation v. EPA*, 684 F.3d 102, 127 (D.C. Cir. 2012).

there is uncertainty over the marginal abatement costs or marginal abatement benefits, and when the "slope" of the marginal abatement benefits is large. For example, the certainty benefits can be large when regulating pollutants that are toxic in low dose. The discussion of prescriptive regulations, which starts at page 4-2, should consider discussing this possible advantage.

Grandfathering: The *Guidelines* appear to mention grandfathering only on page 4-3, in the context of discussing prescriptive regulations. Grandfathering is an important issue to consider when designing environmental policies, but its consideration is not reserved to prescriptive policies. It is possible for a market-based policy to "grandfather" older units in the sense of treating them differently than new units: for example, in the context of a cap-and-trade program, by freely allocating emissions credits based on historical emissions of existing units. Though this type of grandfathering raises different issues of inefficiency and inequity than the more classic case of grandfathering in prescriptive regulations—with a free allocation of marketable permits, the concerns are inefficiencies and barriers to entry caused by market power wielded by the existing sources, as well as distributional concerns from granting existing sources a windfall of free, valuable permits[11]—the concerns with grandfathering in this context are no less real.

The inefficiencies of grandfathering should be discussed more generally throughout the *Guidelines*. A broader discussion of grandfathering could be framed together with additional discussion of "incomplete" policies and "regulatory variances"—neither of which is given attention in Chapter 4.

Effects Not Unique to Market-Based Approaches: On page 4-4, at line 35, the *Guidelines* suggest that illegal dumping is a unique possible disadvantage of market-based regulatory approaches. In fact, this type of noncompliance could occur under any type of regulatory approach, whether market-based or prescriptive. Similarly for the comment, in line 36 on page 4-4 and continuing onto page 4-5, that a market-based approach requires special consideration of the distribution of costs, political incentives, and distribution of economic rents: these are important consideration for any regulatory approach, and are not unique market-based approaches. The collection of revenues, mentioned at the top of page 4-5, may be a more salient issue in market-based approaches, though the collection of penalties, registration fees, and the like can also be an issue in prescriptive approaches. The *Guidelines* should not single out market-based approaches as having special considerations when these issues in fact occur in any regulatory context.

Price-Based versus Quantity-Based Approaches: On page 4-5, at lines 8-9, the *Guidelines* suggest that while taxes and other price-based approaches "operat[e] different[ly]" than quantity-based trading systems, the two categories of market-based instruments "put similar incentives in place." In fact, as the *Guidelines* do later explore in section 4.6.4, uncertainty over marginal abatement costs, or marginal abatement benefits, can influence the outcome of different market-based approaches (as well as in comparing between a market-based approach versus a prescriptive approach). A price-based approach may deliver greater certainty about per-unit compliance costs, but at the expense of certainty about the environmental outcome; a quantity-based approach will achieve a target environmental outcome with greater certainty, but with less certainty about total compliance costs.[12] The *Guidelines* should explain in a footnote, at page 4-5 line 10, that "emissions taxes and cap-and-trade systems" may only "achieve the same goal at equivalent cost" if there is no uncertainty over the marginal abatement costs and marginal abatement benefits.

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[11] *See* Jason A. Schwartz, *Report to the Administrative Conference of the United States, Marketable Permits: Recommendations on Applications and Management* at 38-40 (2017), https://www.acus.gov/sites/default/files/documents/Marketable%20Permits%20Report-final.pdf.

[12] *See* Schwartz, Marketable Permits, *supra* at 4.

Problem of Initial Over-Allocation: Somewhere in section 4.3.1.1—perhaps on page 4-5 at line 28 where the efficient level for the cap is discussed, or on page 4-6 at line 25 in the discussion of banking, or at page 4-7 at line 8 in discussing how a cap's initially chosen level can become inefficient over time—the *Guidelines* should add a discussion of initial over-allocation. Many cap-and-trade markets have experienced challenges with setting an initial cap too high or allowing too many banked allowances, leading to persistently low allowance price, little trading, and lower than expected environmental gains.[13] Because it is a recurring problem in policy design and analysis, it deserves special attention in the *Guidelines*.

Role of Price Floors and Collars: Recent research suggests that, given the inelastic nature of supply in a cap-and-trade system, the market price is very likely to be determined by an administratively-set price floor or ceiling.[14] Therefore, some of the discussion about safety-valve systems from section 4.4.1.3 should be subsumed into section 4.3.1.1 on cap-and-trade systems.

Comments on Chapter 5

Standing—Domestic versus International: The discussion of standing at pages 5-1 to 5-2 is insufficient, particularly with respect to climate change effects. As our prior written comments detail, the question of counting domestic-only versus global effects takes on particular importance in the context of climate change. And yet, the section on "standing" in the draft *Guidelines* does not mention climate change. This omission is particularly noticeable when the *Guidelines* insist that "for domestic policy making standing is typically limited to the national level *in order to maximize the welfare of residents*" (page 5-1, emphasis added). However, in the context of climate regulations, ignoring climate effects that occur outside the geographic borders of the United States will *fail to maximize U.S. welfare*. As Policy Integrity has explained in multiple comments to EPA, not only does a domestic-only estimate of the social cost of greenhouse gases fail to consider how international effects will spill over to directly affect U.S. welfare through our globally interconnected economies, health systems, and security, and not only does a domestic-only estimate fail to consider the multiple extraterritorial interests of U.S. citizens and residents, but it also fails to consider the repercussions from foreign reciprocal actions. If all other countries were to likewise consider only their own domestic climate effects and ignore the damages its emissions cause to the United States, U.S. welfare would suffer. Indeed, economic models have shown that for such reasons, the "strategic" social cost of carbon should always be higher than the domestic-only social cost of carbon.[15] The SAB should remind EPA that how the United States treats other countries will directly affect U.S. welfare—especially when it comes to climate change.

The draft *Guidelines* do appropriately note that just because a regulated entity's facilities are located in the United States does not necessarily mean that regulatory effects are limited to domestic citizens if those firms have foreign shareholders, and the *Guidelines* rightly call for a balanced approach to standing between costs and benefits.[16] However, the *Guidelines* never go so far as to suggest that an economic analysis should not count impacts to foreign shareholders, even while they counsel that other

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[13] *See, e.g.*, Lesley K. McAllister, *The Overallocation Problem in Cap-and-Trade: Moving Toward Stringency*, 34 Colum. J. Envtl. L. 395 (2009).

[14] Severin Borenstein et al., *Expecting the Unexpected: Emissions Uncertainty and Environmental Market Design*, 109 Am. Econ. Rev. 3953 (2019).

[15] *See, e.g.*, Policy Integrity et al., Comments on Quantifying and Monetizing Greenhouse Gas Emissions in the Safer Affordable Fuel-Efficient Vehicles Proposed Rule at 6-13 (Oct. 26, 2018), https://policyintegrity.org/documents/Emissions_Standards_PRIA_SCC_Comments_Oct2018.pdf.

[16] *Compare id.* at 14-15 *with 2020 Draft Guidelines* at 5-2.

international effects, like climate effects, should either not be counted or only "report[ed] separately" (page 5-2). Yet it would not be balanced treatment of costs and benefits to relegate certain climate effects to a separate reporting while continuing to group all cost effects together regardless of the shares held by foreign entities. Nor is it clear, in the context of climate change, what it means to report certain effects "separately" from a domestic-only accounting when the existing models cannot produce any accurate estimate of a "domestic-only" social cost of carbon.[17]

The SAB should encourage EPA to take a different, and more balanced, approach to "standing" in the context of climate change.

Indirect Impacts: While the *Guidelines* do appropriately counsel that "all welfare effects" should be counted toward net benefits, much of the terminology, phrasing, and methodologies suggested by the *Guidelines* risk casting unwarranted doubt on important indirect benefits, or risk suggesting that EPA disfavors regulations with large indirect benefits. All important indirect effects should be counted with the same methodological rigor as direct effects, and there is nothing inherently suspect about rules with large indirect benefits.

The draft *Guidelines* avoid using the terms "co-benefits" or "ancillary benefits" because they can be misinterpreted "as having legal or policy meaning that is unintended" (page 5-18, n.129). Instead, the *Guidelines* use phrases like "other environmental contaminants" or "contaminants" that are not "the primary statutory objective" (pages 5-18 to 5-19). While EPA is certainly correct that terms like "co-benefits" have at times led to inappropriately relegating such effects to second-class status, and while the draft *Guidelines* do appropriately reaffirm that all important effects should be calculated in totaling net social benefits, it is not clear that the new terminology adopted by the *Guidelines* will fare much better. In particular, distinguishing between pollutants that are the "statutory objective" and those that are "other" could lead to a similarly inappropriate belittlement of certain key effects.

The *Guidelines* call at page 5-3 to "clearly distinguish between benefits that arise from the statutory objective of the regulation and other welfare effects of the regulation, when it is possible to do so." In theory some distinction could perhaps be discussed in the text of a preamble or regulatory impact analysis. However, drawing such distinctions in a summary table, without providing sufficient context, could lead to the "other welfare effects" being discounted relative to the "benefits from statutory objective." Such a result would be inconsistent with the *Guidelines* policy that "when calculating net benefits all welfare effects should be included, as it is the total willingness to pay for all changes induced by a regulation that determinates economic efficiency." (page 5-3). Moreover, in practice, distinguishing between an effect that meets the "statutory objective" and one that does not is challenging. Take, for example, the benefits that come from reducing particulate matter when regulating mercury and other toxic pollutants: some components of particular matter also meet the definition of hazardous air pollutants.

The SAB should reassess whether language about "other" welfare effects will prevent in inappropriate belittlement of key effects, and the SAB should advise EPA on how to ensure full and balanced treatment of all key effects without making subjective and problematic determinations about which effects meet a "statutory objective" and which do not.

The draft *Guidelines* also include some language that (though the wording is somewhat unclear) seems to suggest that when analysts expect a rule to have large co-benefits, they should consider alternative

[17] *See* Policy Integrity Comments on Monetizing Greenhouse Gas Emissions, *supra*, at 16-20.

ways of "obtaining these unrelated benefits"—presumably referring to options that use other authorities to conduct separate rulemakings to achieve those co-benefits more directly.[18] This suggestion first requires clarification as to what exactly is meant, and then once clarified the suggestion must be carefully reviewed by the SAB and the public. For starters—as already noted above in these comments on similar language in Chapter 3—undertaking multiple regulations, each focused on individual pollutants rather than a unified, multi-pollutant regulatory strategy, may carry additional costs: administrative costs from designing and issuing multiple regulations; paperwork costs from implementing and complying with multiple regulations; and any lost efficiencies that a multi-pollutant compliance strategy may achieve that distinct pollutant-specific rulemakings might preclude. Additionally, any analysis of a regulatory alternative that requires a separate rulemaking would have to consider the realistic probability of whether such alternate or separate rulemakings could actually occur, as well as the forgone benefits during any delay in waiting for the additional rulemakings. Such an analysis could prove vexing if not impossible for an administration, especially when different authorities span across different agencies or different offices within an agency, each with their own rulemaking and enforcement capacities. Indeed, the *Guidelines* generally do not permit EPA to consider separate rules that have not yet even been proposed let alone finalized in either the baseline or policy scenarios of a cost-benefit analysis (*see* page 5-10). Moreover, as courts have repeatedly reminded agencies, the existence of overlapping authorities does not excuse an agency from rationally implementing all of its statutory mandates: "The two obligations may overlap, but there is no reason to think the two agencies cannot both administer their obligations"[19]; "Just as EPA lack authority to refuse to regulate on the grounds of [the existence of another] statutory authority, EPA cannot defer regulation on that basis."[20] As the *Guidelines* already acknowledge, the rational implementation of rulemaking authorities requires the consideration of net social benefits including from reductions of other environmental contaminants. The SAB should ask EPA first to clarify its suggestion on considering other "ways of obtaining these unrelated benefits," and then should carefully review that proposal.

Baselines and Future Regulations: The *Guidelines* seems somewhat inconsistent in their advice for handling other regulatory proposals in setting the baseline for analysis. The *Guidelines* first say that future regulations should not be included in the baseline unless they are "certain" to occur (page 5-6), before indicating that proposed regulations may be included in the baseline if they "are under consideration or nearing completion" (page 5-8), or else that a single baseline should include "only final rules and, in some cases, imminent rules that are expected with a high degree of certainty" (page 5-10). As a further complication, the *Guidelines* counsel the use of multiple baselines "if the impact of other rules currently under consideration fundamentally affects the analysis of the rule being analyzed" (page 5-8); however, "[p]roposed rules should not be in the primary baseline" (page 5-10).

More clarity here would help. In all cases, a degree of certainty and reasonableness should be required before including other rules in any baseline. The *Guidelines* should make those standards clearer, and should help define how well-developed and certain a separate regulatory proposal must be to merit inclusion in a baseline.

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[18] *2020 Draft Guidelines* at 5-19 ("[I]f the regulation is expected to induce large benefits from changes in environmental contaminant(s) beyond those arising from the primary statutory objective of the regulation, an analysis of a policy option where those contaminant(s) are regulated, either separately or simultaneously with the contaminants that are the primary statutory objective of the regulation, it may be useful [sic] to determine whether there are more economically efficient or appropriate ways of obtaining these unrelated benefits.").

[19] *Massachusetts v. EPA*, 549 U.S. 497, 532 (2007).

[20] *Coalition for Responsible Regulation v. EPA*, 684 F.3d 102, 127 (D.C. Cir. 2012).

Additionally, the *Guidelines* should not hold up the 2019 repeal of the Waters of the United States rule as an exemplar of the use of multiple baselines. That repeal adjusted its baselines by alleging "uncertain[ty]" on "the degree to which states would continue to regulate their waters at the 2015 standard." In fact, not only was *any* state action following the repeal extremely uncertain to ever take place, but the assumptions made in the baselines for the analysis of the Waters of the United States repeal were eminently *unreasonable*—including the assumption that the very same states that were vigorously litigating to repeal the Clean Water Rule would turn around and immediately enact similar protections on their own.[21]

Time Horizon: The draft *Guidelines* provide that "the time horizon should be chosen to capture all of the benefits and cost for the policy alternatives analyzed, subject to available resources," but do not specify any recommended ranges (page 5-12). Given that in recent years, some EPA analyses have selected an arbitrarily short time horizon—such as looking at costs and benefits for just 7 years in a rule rolling back standards for methane emissions[22]—the *Guidelines* should offer more concrete advice about appropriate time horizons. For example, a regulatory analysis's time horizon should not end when the annual cost estimates, annual benefit estimates, or annual affected sources are still changing significantly from year to year in ways that could affect the sign of the net benefits calculation.[23]

Rules with Private Cost Savings: While the *Guidelines* clearly acknowledge that the existence of market failures or irrational behaviors (like the internalities discussed above) can result in regulations generating otherwise-unrealized private cost savings, the *Guidelines* set a very high bar for justifying such private cost savings: "empirical evidence specific to the affected market" (page 5-14). That is a needlessly high bar. For example, EPA has (until recently) long cited theoretical and empirical evidence for why consumers of passenger cars and light-duty trucks will fail to achieve valuable energy savings in the marketplace without regulations on vehicle efficiency and emissions. If EPA believes it is justified to also regulate motorcycle emissions and efficiency for similar reasons, would the agency really need motorcycle-specific empirical evidence on top of the broader economic literature? The Science Advisory Board should encourage EPA to be less skeptical of the potential for regulations to help achieve private cost savings, and EPA should be able to base cost-saving regulations on a reasonable theory of market failures informed by relevant literature and evidence, even if no quantitative evidence specific to an individual market yet exists.

Consumer Valuation of Fuel Savings: The *Guidelines* correctly note that analysts should make consistent assumptions about firm and consumer behavior in both the baseline and policy scenarios "unless there is reason to believe the regulation will change underlying behavioral patterns" (page 5-15). Unfortunately, the *Guidelines* then use consumers' under-valuation of fuel economy as an example, saying "if such behavior occurs in the baseline, it is likely to persist regardless of regulatory requirements" (page 5-16). In fact, there are multiple reasons why the best available empirical evidence may detect an undervaluation of fuel economy pre-regulation even though consumers will benefit from fuel savings achieved by regulation. Multiple market failures, including loss aversion, information asymmetries, myopia, supply-side market failures, and the positional nature of competing vehicle

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[21] *See* Policy Integrity, Comments to the SAB on Commentary on the Proposed Rule Defining the Scope of Waters Federally Regulated Under the Clean Water Act at 6-7 (Jan. 10, 2020), https://policyintegrity.org/documents/Policy_Integrity_Comments_to_Chartered_Science_Advisory_Board_on_Clean_Water_Rule_%28signed%29.pdf.

[22] *See* Policy Integrity et al., Comments on Flawed Monetization of Forgone Benefits in the Proposed Rule, Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources Review (Nov. 25, 2019), https://policyintegrity.org/documents/Methane_Rule___Joint_SCC_Comments.pdf.

[23] *See id.* at 2-4.

attributes, mean that consumers' upfront willingness to pay for future fuel savings does not reflect what they would be willing to pay once efficient regulation has addressed those market failures.[24] Other market failures, like manufacturers' market power or their misjudging of consumer preferences, may lead to the undersupply of fuel-efficient vehicle options, leaving consumers unable to actualize their willingness to pay for fuel economy improvements in the market.[25] More generally, the information and experiences that consumers gain from regulations can sometimes change their willingness to pay for goods.[26] Finally, in the particular case of fuel economy, it is important for agency analysts to bear in mind the distinction between *ex ante* measures of consumers' *private* willingness to pay for fuel economy improvements versus the *ex post* economic value of *societal* benefits from fuel savings: regardless of the value consumers appear to place on fuel savings when making vehicle purchasing decisions, when they operate vehicles made more efficiency by regulation, the consumer fewer real economic resources (e.g., barrels of oil, extraction costs, refining, transportation, etc.), and those savings have real benefits to society.[27]

Comments on Chapter 6

Failure to Discuss that the Social Opportunity Cost of Capital Is Biased Upwards: EPA's *Guidelines* on discount rates fail to emphasize that the current social opportunity cost of capital estimate of 7% is likely an overestimate.[28] Despite discussing why social discount rates are appropriate in U.S. government cost-benefit analysis instead private discounting,[29] EPA fails to acknowledge that it is approximating the marginal social return to capital by using the average private return to capital.[30]

By focusing on tax distortions exclusively, EPA fails to sufficiently discuss other reasons why the appropriate discount rate to use in regulatory analysis may diverge from private rates of return. The *Guidelines* thoroughly discuss the impact of taxation on the appropriate discount rate by explaining the difference between the consumption and capital rates (*see* Section 6.2 of the *Guidelines*). However, despite acknowledging additional reasons for private rates of return to differ from social rates of returns—such as imperfect capital markets and differences in private and social risk—the *Guidelines* fail to give such additional reasons adequate consideration. Moreover, the *Guidelines* ignore altogether how environmental externalities can drive a wedge between private and social returns on capital.[31] While

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[24] Policy Integrity, Supplemental Comments on the Safer Affordable Fuel-Efficient Vehicles Rule at 4 (Dec. 21, 2018), https://policyintegrity.org/documents/Policy_Integrity_Supplemental_Comments_NHTSA_2018.12.21.pdf.

[25] *Id.*

[26] *See* Cass Sunstein, *Rear Visibility and Some Unresolved Problems for Economic Analysis (with Notes on Experience Goods*) (2019); LA Paul & Cass Sunstein, *'As Judged by Themselves': Transformative Experiences and Endogenous Preferences* (2019).

[27] Policy Integrity, Supplemental Comments on the SAFE Rule, *supra*, at 4-5.

[28] Council of Econ. Advisers, *Discounting for Public Policy: Theory and Recent Evidence on the Merits of Updating the Discount Rate* at 1 (CEA Issue Brief, 2017).

[29] *Draft Guidelines* at 6-22 ("Private discount rates should not be used to estimate the NPV of the social net benefits of policies and projects because the intertemporal preferences of society as a whole (as measured by the social rate of time preference) are not likely to be equal to private market lending rates or individual or firm preferences.").

[30] *Compare id. with* CEA, *supra*, at 10-12.

[31] *See* CEA, *supra*, at 2: "There are no regular private forecasts of the economywide rate of return. In addition, even if we did have a precise measure or forecast of the economywide rate of return it could differ from the true value of the social opportunity cost of capital—the concept underlying benefit-cost analysis—because of unpriced externalities, market power that leads to supernormal returns, the incorporation of market risk, and taxation."

See also id. at 11: "Moreover, even to the degree it was measured and projected accurately the market return on capital such as that based on the NIPA calculations could differ from the social return for a variety of reasons. For example, some element of profit could reflect unpriced externalities (positive or negative). Dasgupta, Mäler, and Barrett (1999) give an example of a negative externality, in which the profit rate earned by polluting firms exceeds the social rate in the absence of an appropriate

taxation acts to increase the social return on capital relative to the private return, these other forces (imperfect capital markets, differences in risk, and externalities) move to decrease the social return on capital relative to the private return of capital.[32] Thus, these omissions act to overestimate the social opportunity cost of capital—an important issue that should be addressed in the *Guidelines*.

Similarly, the *Guidelines* fail to sufficiently discuss the underlying methods for estimating the capital discount rates and their corresponding shortcomings. In Section 6.2, EPA provides a range of estimates of the "social opportunity cost of capital" of 4.5% to 8%, with a central rate of 7% from OMB's *Circular A-4.*[33] Earlier in Section 6.2.3, EPA acknowledges that many of these underlying estimates represent the *average* return to "reproducible" capital (estimated using National Accounts data) instead of the lower *marginal* return to capital.[34] However, EPA fails to discuss the similar consequences of using the pre-tax market return on private investments that includes private risk premiums, monopoly markups, and economic rents.[35] By using the term "social opportunity cost of capital" instead of acknowledging that it is using a private approximation, the *Guidelines* potentially mislead the reader and obscure that these estimates in fact may be overestimates. Additionally, despite citing the Council of Economic Advisers' 2017 brief on *Discounting for Public Policy* (at page 6-16, n.156), the *Guidelines* fail to discuss the potential for mis-measuring the private return to capital using National Accounts data as applied by OMB and many of the cited studies.[36] These issues should be discussed to make clear that the current range of estimates provided by the *Guidelines* actually represent an upper bound.

Given these systemic upward biases, the current *Circular A-4* estimate of 7% based on National Accounts data overestimates the social opportunity cost of capital. As such, EPA should discuss this potential bias in a depth comparable to *Guidelines*' current focus on the taxation bias. This upward bias also provides yet another reason to favor the consumption discount rate—in addition to other reasons to favor the

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pollution tax. If some firms exercise market power, setting prices above marginal cost, then market rates of return include some monopoly rents and thus exceed the true market rate of return to capital, at least in cases where those rents are not related to fixed costs such as for innovation. Harberger and Jenkins (2015) note that the divergence from competitive rates of return due to monopoly rents should be considered in choosing the social discount rate. . . . However, CEA analysis finds that several indicators suggest that competition has declined in recent decades, and that rents may have increased. Third, market rates of return may also diverge from the SOC because private returns include both the pure time value of money and a risk premium, and some or all of that risk premium may not be relevant to government decisions."

[32] *See id.*

[33] While these estimates fail to account for private risk premiums, monopoly markups, and environmental rents in general, Harberger and Jenkins accounts for monopoly markups. *See* Harberger, Arnold C., and Glenn P. Jenkins. "Musings on the Social Discount Rate," 6 *Journal of Benefit-Cost Analysis* 6 (2015).

[34] *Draft Guidelines* at 6-13: "In practice, average returns that are likely to be higher than the marginal returns are typically observed, given that firms will make the most profitable investments first. In fact, it is not clear how to estimate marginal returns."

[35] "Improvements to land" are included in the national accounts, Harberger and Jenkins, *supra*, while "income from land" is removed from returns to capital when approximating the opportunity cost of capital. Technically, the environment is land in economic theory and, as such, pollution and environmental externalities (i.e., degradation of land) should be removed in the same way from the return to capital.

[36] CEA, *supra*, at 11: "A notable feature of figure 5 is that while the NIPA based calculation (in red) has been oscillating around 7 percent, the real rate of return on Treasuries has been falling, suggesting a growing divergence between the real safe return based on financial market data and the return based on the NIPA calculations. One possibility for this divergence is simply that the NIPA measures of the rate of return on capital are mis-measured. Many experts believe that equity premiums and other measures of the return to more risky investments in capital, while cyclical, have not systematically risen over time (Graham and Harvey 2016, Duarte and Rosa 2015). Then to the degree that the long term interest rate is well measured it is more plausible that at least part of the divergence between this and the estimated return to capital could reflect mismeasurement of the return to capital."

consumption discount rate, such as the small cost-share of EPA policies, an open-economy assumption,[37] and intergenerational concerns.[38]

The* Guidelines *Correctly Recognize That the Consumption Discount Rate Is More Appropriate in Many Cases, Though They Fails to Recognize Additional Evidence from the Literature: As the *Guidelines* note, there are many reasons to favor consumption discount rates over capital discount rates. As estimating the shadow price of capital is difficult, such that the amount of private investment is uncertain,[39] OMB *Circular A-4* recommends applying a consumption and a capital discount rate in cost-benefit analysis. However, the true discount rate may be somewhere between the consumption and capital rates. As the United States is likely to be better represented by an open-economy, and as the cost of EPA policies are small relative to the overall debt, it is unlikely that EPA regulations will significantly crowd out U.S. private investment instead crowding out foreign direct investment.[40] In intergeneration settings, the *Guidelines* (page 6-24) further support using the consumption discount rate—which is consistent with recommendation by the National Academies of Sciences 2017 report on the social cost of carbon.[41]

Due to the uncertainty over the magnitude of crowding out (i.e., whether capital investment or consumption is impacted by the policy) and over the magnitude of the shadow price of capital, recent work by Li and Pizer (2019) further support this preference for the consumption discount rate. Using *Circular A-4*'s "analytically preferred method,"[42] Li and Pizer (2019) demonstrate that the investment rate (i.e., the 7% rate) is inappropriate in long-horizon planning problems, including intergenerational problems like climate change.[43] *Circular A-4*'s recommendation of bounding the social discount rate for a government project using the consumption and capital discount rates is based on economics literature from the 1960s and 1970s, which had focused on the appropriate discount rate when "we are uncertain about whether costs and benefits [from government investment/projects] affect capital investment or household consumption (and, to a lesser extent, the appropriate shadow price to covert between the

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[37] In the 1980s, there was growing evidence that the United States was moving ever more towards an open economy, Richard N. Cooper, *The United States as an Open Economy* (1985), and this has continued with increased connectedness and trade from globalization and U.S. free trade agreements. *See Draft Guidelines* at 6-16: "The literature does not provide clear guidance on the likelihood of this displacement, but it has been suggested that if a policy is relatively small and capital markets fit an "open economy" model, there is probably little displaced investment. Changes in yearly U.S. government borrowing during the past several decades have been in the many billions of dollars. It may be reasonable to conclude that EPA programs and policies costing a fraction of these amounts are not likely to result in significant crowding out of U.S. private investments. Primarily for these reasons, some argue that for most environmental regulations it is sufficient to discount costs and benefits with an estimate of the consumption rate of interest with some sensitivity analysis."

[38] *Draft Guidelines* at 6-24: "If the policy has a long time horizon where net benefits vary substantially over time (e.g., most benefits accrue to one generation and most costs accrue to another), then the analysis should use the consumption rate of interest as well as additional approaches."

[39] *Id.* at 6-15: "The literature is not conclusive on the degree of crowding out."

[40] *Compare id.* at 6-16 *with* CEA, *supra*, at 10.

[41] National Academies of Sciences, Engineering, and Medicine. *Valuing climate damages: Updating estimation of the social cost of carbon dioxide* (2017).

[42] *Circular A-4* at 33 ("OMB's basic guidance on the discount rate is provided in OMB Circular A-94 (http://obamawhitehouse.archives.gov/omb/circulars/index.html). This Circular points out 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. This is sometimes called the "shadow price" approach to discounting because doing such calculations requires you to value benefits and costs using shadow prices, especially for capital goods, to correct for market distortions. These shadow prices are not well established for the United States. Furthermore, the distribution of impacts from regulations on capital and consumption are not always well known. Consequently, any agency that wishes to tackle this challenging analytical task should check with OMB before proceeding.")

[43] Li, Qingran, and William A. Pizer, *Discounting for Public Cost–Benefit Analysis*, (2019).

two)."[44] However, that older literature only proves that the social discount rate falls between these two rates under restrictive assumptions. Under general conditions (that nest the previous results), Li and Pizer (2019) demonstrate that the social discount rate collapses to the consumption rate over time, and that the rate of convergence is relatively quick (i.e., several decades) given their best estimate of the shadow price of capital. As the exact rate of convergence depends on the pattern of benefits from a project, they estimate that the appropriate discount rate range for the social cost of carbon is between 2.6% and 3.4% (based on consumption and capital discount rates of 3% and 7%, respectively). Thus, the logic that led OMB to recommend a range of social discount rates of 3% and 7% implies a much narrower range of 2.6% to 3.4% for inter-generational problems like climate change. Similarly, intra-generational projects covering several decades should also apply consumption rates, as "the social discount rate for benefits several decades in the future has already converged to roughly the consumer rate."[45]

Additional research on expert consensus shows a strong consensus among economists that it is theoretically correct to use consumption discount rates in the intergenerational setting, such as in the calculation of the social cost of carbon. Similarly, there is a strong consensus that a capital discount rate is inappropriate according to "good economics."[46] This consensus holds across panels of experts on the social cost of carbon;[47] surveys of experts on climate change and discount rates;[48] the three most commonly cited integrated assessment models employed in calculating the federal social cost of carbon; and the government's own analysis of the social cost of carbon from 2009 through 2016.[49] For more analysis of this issue, see the following section.

The* Guidelines *Do Not Discuss Empirical Estimates of Consumption Discount Rates in Sufficient Depth: The *Guidelines* present the demand-side and supply-side approach to discounting. With respect to the demand-side, they introduce and explain the concept of the simple Ramsey equation. In the context of intergenerational discounting, the *Guidelines* (Section 6.3.3.2) introduce the extended Ramsey rule (i.e., including the precautionary term) and the potential for a declining social discount rate over time. On the supply-side, the *Guidelines* introduce the shadow price of capital as a means of weighting the

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[44] *Id*. The cost to consumers and private investors is displaced consumption and investment, respectively.

[45] Li and Pizer, *supra*, at 4.

[46] The former co-chair of the National Academy of Sciences' Committee on Assessing Approaches to Updating the Social Cost of Carbon–Richard Newell–states that "[t]hough the addition of an estimate calculated using a 7 percent discount rate is consistent with past regulatory guidance under OMB Circular A-4, there are good reasons to think that such a high discount rate is inappropriate for use in estimating the SCC. . . . It is clearly inappropriate, therefore, to use such modeling results with OMB's 7 percent discount rate, which is intended to represent the historical before-tax return on private capital. . . . This is a case where unconsidered adherence to the letter of OMB's simplified discounting approach yields results that are inconsistent with and ungrounded from good economics." Richard Newell, *Unpacking the Administration's Revised Social Cost of Carbon* (Oct. 10, 2017), http://www.rff.org/blog/2017/unpacking-administration-s-revised-social-cost-carbon.

[47] *See generally* NAS *supra* note 41.

[48] *See* Martin L. Weitzman, *Gamma Discounting*, 91 AM. ECON. REV. 260, 270 (2001); Peter Howard & Derek Sylvan, *The Economic Climate: Establishing Expert Consensus on the Economics of Climate Change* (Inst. Policy Integrity Working Paper 2015/1); Drupp, Moritz A., et al. "Discounting disentangled." *American Economic Journal: Economic Policy* 10.4 (2018): 109-34; Pindyck, Robert S. "The social cost of carbon revisited." *Journal of Environmental Economics and Management* 94 (2019): 140-160.

[49] *See* Interagency Working Group on the Social Cost of Carbon, Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis (2010), https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf; Interagency Working Group on the Social Cost of Greenhouse Gases, *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis* (2016), https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc_tsd_final_clean_8_26_16.pdf.

consumption discount rate and the social opportunity cost of capital. In both cases, there is insufficient discussion of the empirical challenges and results.

With respect to the demand-side approach, the *Guidelines* fail to address the difficulty of estimating the elasticity of the marginal utility of consumption in the simple Ramsey equation. At page 6-11, EPA argues that this elasticity can be estimated (i.e., a positive approach), despite recognizing its normative interpretation in the intergenerational setting (*see* page 6-17). However, this normative interpretation of this parameter, which has strong support within the economics literature,[50] makes empirical estimation difficult. Additionally, this is compounded by the multiple interpretations of the elasticity parameter in the simple Ramsey framework. Specifically, in the simple Ramsey formula, the parameter "captures the intertemporal elasticity of substitution between consumption today and consumption in the future, the coefficient of relative risk aversion, and inequality aversion."[51] As empirical evidence does not support this equality,[52] and given that the superiority of positive or normative approaches is unclear,[53] the federal Interagency Working Group on the Social Cost of Carbon (2010) found a range of 0.5 to 3.0 for the elasticity of the marginal utility of consumption (though some estimates reach up to 4.0 even); Drupp et al. (2018) finds a similar range in a survey of experts. Thus, the *Guidelines* should extend their discussion of the elasticity of the marginal utility of consumption and make clear the difficulty in estimating this underlying preference parameter.

As isoelastic utility function asks too much of the elasticity parameter,[54] there has been movement towards adopting Epstein-Zin preferences that disentangle risk aversion and time preferences.[55] Recent research has shown that accurate estimation of decisions under uncertainty crucially depend on distinguishing between risk and time preferences.[56] For example, adopting this type of preferences

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[50] Moritz A. Drupp, et al. *Discounting disentangled*, 10 Am. Econ. J.: Econ. Pol'y 109 (2018); IWG, 2010 Technical Support Document, *supra*, at 20.

[51] Kenneth J. Arrow et al., *Should Governments Use a Declining Discount Rate in Project Analysis?*, 8 REV ENVIRON ECON POLICY 145, 148 (2014).

[52] Peter H. Howard, "The social cost of carbon: capturing the costs of future climate impacts in US policy." in *Managing Global Warming* (2019) ("The current welfare function is selected for empirical ease, despite known shortcomings of the isoelastic utility function. First, as currently applied in IAMs, the isoelastic utility function implies that the elasticity of intertemporal substitution (i.e., the determinant of intertemporal consumption smoothing) equals the inversion of relative risk aversion. As a consequence, society's preference for the intragenerational distribution of consumption, society's preference for the intergenerational distribution of consumption (see interpretation in the Ramsey equation), and risk aversion hold a fixed relationship. Modelers are asking too much from the η parameter in that they force these equalities despite evidence that they do not hold in the real world.").

[53] *See* Drupp et al., *supra*.

[54] Howard (2019), *supra*.

[55] *See* Arrow et al., *supra*, at 148; *see also* Cai, Y., Lenton, T. M., & Lontzek, T. S. (2016). Risk of multiple interacting tipping points should encourage rapid CO 2 emission reduction. *Nature Climate Change*, *6*(5), 520-525; Derek Lemoine & Ivan Rudik, *Managing Climate Change Under Uncertainty: Recursive Integrated Assessment at an Inflection Point*, 9 *Annual Review of Resource Economics* 18.1-18.26 (2017). The standard utility function adopted in IAMs with constant relative risk version implies that the elasticity of substitution equals the inversion of relative risk aversion. As a consequence, society's preferences for the intra-generational distribution of consumption, the intergenerational distribution of consumption, and risk aversion hold a fixed relationship. For purposes of stochastic dynamic programming, this is problematic because this assumption conflates intertemporal consumption smoothing and risk aversion. *See* WJ Wouter Botzen & Jeroen CJM van den Bergh, *Specifications of social welfare in economic studies of climate policy: overview of criteria and related policy insights*, 58 Environmental and Resource Economics 1-33 (2014). By adopting the Epstein-Zin utility function which separates these two parameters, modelers can calibrate them according to empirical evidence. For example, Cai et al. (2016), *supra*, replace the DICE risk aversion of 1.45 and elasticity parameter of 1/1.45 with values of 3.066 and 1.5, respectively.

[56] James Andreoni & Charles Sprenger, *Risk Preferences Are Not Time Preferences*, 102 AM.ECON.REV.3357–3376 (2012).

allows economists to solve the equity-premium puzzle underlying isoelastic preferences.[57] By conflating risk and time preferences, current models substantially understate the degree of risk aversion exhibited by most individuals.[58] Again, the adoption of more realistic preference structures and their implications for the discount rate parameter should be discussed in the *Guidelines*, particularly given the increased uncertainty faced in the intergenerational context.

Beyond discussing the difficulties in estimating the Ramsey approach, the *Guidelines* discussion at pages 6-15 to 6-16 fails to present a range of valid estimates for the consumption discount rate from the literature. Despite providing a range of social opportunity cost of capital estimates from 4.5% to 8%, the *Guidelines* only provides a single estimate of the consumption discount rate of 3.5% based on Ramsey specifications in Moore et al. (2013a) and Boardman et al. (2006). However, recent normative and prescriptive evidence points to a lower consumption discount rate than even the 3% currently recommended in *Circular A-4*. On the normative side, recent expert elicitations—a technique supported by both the *Guidelines* and *Circular A-4* for filling in gaps in knowledge –indicate that a growing consensus among experts in climate economics and discounting support a discount rate between 2% and 3%, particularly in inter-generational problems.[59] Using a voting procedure, as recommended by recent work by Millner and Heal in the normative context,[60] recent findings support a median rate of 2% for the consumption discount rate. On the prescriptive side, *Circular A-4* is out-of-date as long-term interest rates have fallen significantly; a more up-to-date estimate of the consumption rate of interest based on real ten-year Treasury yields "should be at most 2 percent."[61] The latest OMB updates to *Circular A-94*, the document on which *Circular A-4* based its discount rates,[62] also show that more up-to-date long-run discount rates are historically low. In the December 2019 update to *Circular A-94*'s discount rates, the OMB found that the real, 30-year discount rate is 0.4 percent,[63] the lowest rate since the OMB began tracking the number.[64] Notably, the OMB also shows that the current real interest rate is negative for maturities less than 10 years.[65]

Similarly, it is stated multiple times in the *Guidelines* that inter-generational discount rates are not observable in the market (e.g., at page 6-16).[66] This is generally true, though there are several papers on

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[57] Gollier, C., & Mahul, O. Term structure of discount rates: an international perspective, *Toulouse School of Economics*, at 3 (2017).

[58] Gollier and Mahul, *id.* at 11, assume a relative risk aversion parameter of 10 and a relative aversion to intertemporal inequality of 0.66. Cai et al., *supra,* at 523, assumes a relative risk aversion parameter of 10 and a relative aversion to intertemporal inequality of 1.5. Alternatively, Lemoine and Rudnick, *supra*, at S-2, apply a range: "The left panels keep relative risk aversion at its DICE value of 2 but increase the elasticity of intertemporal substitution to 2/3, and the right panels keep the elasticity of intertemporal substitution at its DICE value of 1/2 but increase relative risk aversion to 3. These changes are in the same direction as changes suggested by some recent asset pricing models."

[59] Howard and Sylvan, *supra*, at 33-34; Drupp, et al., *supra* (finding consensus on social discount rates between 1-3%). Pindyck, in a survey of 534 experts on climate change, finds a mean discount rate of 2.9% in the climate change context and this rate drops to 2.6% when he drops individuals that lack confidence in their knowledge. Pindyck, Robert S, *The social cost of carbon* revisited, Journal of Environmental Economics and Management 94 (2019). Unlike Howard and Sylvan (2015), Pindyck (2019) combines economists and natural scientists in his survey, though the mean constant discount rate drops to 2.7% when including only economists. Again, this further supports the finding that the appropriate discount rate is between 2% and 3%.

[60] Millner, Antony, and Geoffrey Heal, *Discounting by Committee*. 167 J. Public Econ. 91 (2018).

[61] CEA, *supra*, at 1.

[62] *Circular A-4* at 33

[63] OMB, *Circular A-94* Appendix C (2019), https://www.whitehouse.gov/wp-content/uploads/2019/12/Appendix-C.pdf

[64] https://www.whitehouse.gov/wp-content/uploads/2019/12/discount-history.pdf

[65] *Circular A-94* Appendix C, *supra*.

[66] "Intergenerational discounting is complicated by at least three factors: (1) the "investment horizon" is longer than what is reflected in observed market interest rates representative of intertemporal consumption tradeoffs made by the current generation; (2) intergenerational investment horizons involve greater uncertainty than intragenerational time horizons; and (3)

housing markets in the United Kingdom and Singapore that provide some revealed preference data for long-run market discount rates. Like recent work on consumption discount rates, this work supports long-run discount rates below 3% and declining discount rates.[67]

The* Guidelines *Mention Heterogeneity as a Reason for Declining Discount Rates, but Fail to Discuss the Underlying Literature: Under the normative framework, a significant literature on the selection of an efficient, time-consistent discount rate schedules under heterogeneity (i.e., uncertainty over ethical parameters with no true answer that is testable ex post[68]) goes relatively unmentioned. The *Guidelines* briefly mention heterogeneity as a potential reason for declining discount rates[69] and mention two key theoretical papers on this issue in footnotes: Gollier and Zeckhauser (2005) and Heal and Millner (2014). More recent work discusses the potential trade off of efficiency and time-consistency of preferences under heterogeneity and argues for the potential efficiency improvement from majority voting (i.e., selection of the median social discount rate / ethical parameters).[70] More recently, Millner (2020) demonstrates that under non-dogmatic preferences (i.e., preferences over which individuals recognize their willingness to change their current opinion in the future) that disagreements over the social discount rate decline over time and the rate converges in the long-run to a rate between 2% to 3%.[71]

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future generations without a voice in the current policy process are affected. These complications limit the utility of using observed market rates to evaluate long-term public investments." (EPA Guidelines, 6-16)

[67] Giglio, S., Maggiori, M., & Stroebel, J. (2015). Very long-run discount rates. *The Quarterly Journal of Economics*, *130*(1), 1-53; Fesselmeyer, E., Liu, H., & Salvo, A. (2019). Declining Discount Rates in Singapore's Market for Privately Developed Apartments. *Available at SSRN 2754429*.

[68] Mark C. Freeman, & Ben Groom, *How certain are we about the certainty-equivalent long term social discount rate?*, 79 J. ENVIRON. ECON. MANAGE. 152-168 (2016).

[69] *Draft Guidelines* at page 6-20 to 6-21: "Some modelers and government bodies have used fixed step functions for the discount rate term structure to approximate more rigorously derived declining discount rate schedules and to reflect non-constant economic growth, intergeneration equity concerns, and/or heterogeneity in future preferences."

[70] Specifically, Millner and Heal (2018a) corrects a misunderstanding in the literature demonstrating that non-dictatorial social preferences can be time-consistent (though, they must be time-consistent or time-invariant). Millner, Antony, and Geoffrey Heal. "Time consistency and time invariance in collective intertemporal choice." *Journal of Economic Theory* 176 (2018a): 158-169. Millner and Heal (2018b) focuses on discounting by committee with dogmatic preferences, i.e., committee members do not expect their beliefs about correct discounting practices to change. Millner, Antony, and Geoffrey Heal, *Discounting by Committee*. 167 J. Public Econ. 91 (2018b). However, committee members in each period recognize that future committees' pure rate of time preference may differ (though, all committee members over time have the identical elasticity of marginal utility of consumption). Millner and Heal (2018b), following the work on time-inconsistency in Millner and Heal (2018a), demonstrates that a utilitarian approach to aggregating preferences is often time-inconsistent, unless the committee in each period rationally treats their problem like a dynamic game. However, in doing so, the utilitarian approach is not efficient and does not maximize total welfare. An alternative approach whereby committee members vote is both time consistent, self-reinforcing (i.e., preferred by a major of committee members), and can welfare dominate the utilitarian approach. For the parameter space observed in Drupp et al. (2018), the voter approach dominates the utilitarian approach (see Figure 3). In fact, Millner and Heal (2018b) state that "our conclusion is that the voting on the PRSTP is likely to have advantages over utility aggregate in practice. Our simple empirical analysis suggests that a consensus value of $\delta \approx 0.5\%$/yr could emerge from such a vote."

[71] Millner (2020) focuses on the convergence of preferences over time under non-dogmatic preferences. Millner, Antony. *Non-dogmatic Social Discounting*, 110 Am. Econ. Rev. 760 (2020). Unlike Gollier and Zeckhauser (2005), Heal and Millner (2014) and Millner and Heal (2018b), this paper does not describe "the recommendations of 'experts' on social discounting." Instead, it demonstrates that, if all individuals were non-dogmatic such that they accepted that they may change their view on discounting in the future, they would agree on the same long-run discount rate (in contrast, earlier papers focus on dogmatic preferences and/or making decisions within committees whose composition changes over time). Convergence can happen more quickly depending on the *assumed* annual probability that an individual expert maintains their current discount theory. Thus, this methodology does not produce a discount rate schedule, but instead produces a 95th percentile for individual social discount rates over time, which can be narrow or wide depending on the unknown probability of an individual changing their belief on the appropriate theory. According to the authors, the choice of non-dogmatic preferences is also a normative choice.

Given the importance of the normative framework to discounting, particularly in intergenerational settings, the *Guidelines* should include some more in depth discussion of these issues.

Similarly, the *Guidelines* mention on several occasional Weitzman 2001's paper as support for declining discount rates. In Weitzman (2001), the author calibrates a declining gamma discount rate schedule using his own survey of respondents on the appropriate discount rate. However, Freeman and Groom (2016)[72] note that respondents may have interpreted the Weitzman (2001) survey as eliciting a positive discount rate, such that they actually provided their individual expectation of the average social discount rate, instead of the implicit normative interpretation imposed by Weitzman. Because responses are then appropriately interpreted as forecasts, the central limit theorem applies under reasonable assumptions such that the certainty equivalent discount rate declines much slower over time than gamma discounting. However, as discussed earlier, Drupp et al. (2018) finds a strong use of mixed normative-positive perspectives in a similar survey undermining the Freeman and Groom (2016) interpretation. However, Appendix E of Freeman and Groom (2016), demonstrates that a mixed positive/normative interpretation of elicited discount rates, such as in Drupp et al. (2018), implies a flattened discount rate schedule compared to the gamma discount rate schedule estimated in Weitzman (2001) (though not as flat as in a purely positive interpretation). Again, this discussion should be added to any discussion of Weitzman (2001) to provide a more nuanced and complete interpretation of normative discounting.

The* Guidelines *Should More Explicitly Recommend a Declining Discount Rate, as a Significant Consensus Exists that They Are Justified Under Uncertainty: A strong consensus has developed in economics that the appropriate way to discount intergenerational benefits is through a declining discount rate.[73] Not only are declining discount rates theoretically correct, they are actionable (i.e., doable given our current knowledge) and consistent with OMB's *Circular A-4*. Perhaps the best reason to adopt a declining discount rate is the simple fact that there is considerable uncertainty around which discount rate to use. The uncertainty in the rate points directly to the need to use a declining rate, as the impact of the uncertainty grows exponentially over time such that the correct discount rate is not an arithmetic average of possible discount rates.[74] Uncertainty about future discount rates could stem from a number of sources particularly salient in the intergenerational context, such as climate change, including uncertainty about future economic growth, consumption, the consumption rate of interest,

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[72] Mark C. Freeman, & Ben Groom, *How certain are we about the certainty-equivalent long term social discount rate?,* 79 J. ENVIRON. ECON. MANAGE. 152-168 (2016).

[73] Kenneth J. Arrow et al., *Determining Benefits and Costs for Future Generations*, 341 SCIENCE 349 (2013); Kenneth J. Arrow et al., *Should Governments Use a Declining Discount Rate in Project Analysis?*, REV ENVIRON ECON POLICY 8 (2014); Maureen L. Cropper et al., *Declining Discount Rates*, AMERICAN ECONOMIC REVIEW: PAPERS AND PROCEEDINGS (2014); Christian Gollier & Martin L. Weitzman, *How Should the Distant Future Be Discounted When Discount Rates Are Uncertain?* 107 ECONOMICS LETTERS 3 (2010). Arrow et al. (2014) at 160-161 states that "We have argued that theory provides compelling arguments for using a declining certainty-equivalent discount rate," and concludes the paper by stating "Establishing a procedure for estimating a [declining discount rate] for project analysis would be an improvement over the OMB's current practice of recommending fixed discount rates that are rarely updated."

[74] Larry Karp, *Global warming and hyperbolic discounting*, 89 Journal of Public Economics 261-282 (2005) (The mathematical "intuition for this result is that as [time] increases, smaller values of r in the support of the distribution are relatively more important in determining the expectation of e−rt" where r is the constant discount rate.") Or as Cameron Hepburn, *Hyperbolic Discounting And Resource Collapse*, 103 *Royal Economic Society Annual Conference 2004* (2004) puts it: "The intuition behind this idea is that scenarios with a higher discount rate are given less weight as time passes, precisely because their discount factor is falling more rapidly" over time.

and preferences. Additionally, economic theory shows that if there is debate or disagreement over which discount rate to use, this can lead to the use of a declining discount rate.[75]

There is a consensus that declining discount rates are appropriate for intergenerational discounting: Over the last decade, a large and growing majority of leading economists[76] have come out in favor of using a declining discount rate to reflect long-term uncertainty in interest rates. This consensus view is held whether economists favor descriptive (i.e., market) or prescriptive (i.e., normative) approaches to discounting.[77] Several key papers[78] outline this consensus and present the arguments that strongly support the use of declining discount rates for long-term benefit-cost analysis in both the normative and positive contexts. Finally, in a recent survey of experts on the economics of climate change, Howard and Sylvan (2015),[79] found that experts support using a declining discount rate relative to a constant discount rate at a ratio of approximately 2 to 1.

Economists have recently highlighted two main motivations for using a declining discount rate. First, if the discount rate for a project is fixed but uncertain, then the certainty-equivalent discount rate will decline over time, meaning that benefits should be discounted using a declining rate.[80] Second, uncertainty about the growth rate of consumption or output also implies that a declining discount rate should be used, so long as shocks to consumption are positively correlated over time.[81] In addition to these two arguments, other motivations for declining discount rates have long been recognized: if the growth rate of consumption declines over time, the Ramsey rule[82] for discounting will lead to a declining discount rate;[83] and normative uncertainty (i.e., heterogeneity) over the pure rate of time preference

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[75] Martin L Weitzman, Gamma discounting, 91 AM. ECON. REV. 260-271 (2001). Geoffrey M. Heal, & Antony Millner, Agreeing to disagree on climate policy, 111 PROC. NATL. ACAD. SCI. 3695-3698 (2014)

[76] *See generally* Arrow et al. (2013), *supra*.

[77] Mark C. Freeman, Ben Groom, Ekaterini Panopoulou, & Theologos Pantelidis, Declining discount rates and the Fisher Effect: Inflated past, discounted future?, 73 J. ENVIRON. ECON. MANAGE. 32-49 (2015).

[78] *See generally* Arrow et al., 2013; Arrow et al., 2014; Cropper et al., 2014, *supra* note 73; *see also* Christian Gollier, & James K. Hammitt, The long-run discount rate controversy, 6 ANNU. REV. RESOUR. ECON. 273-295 (2014).

[79] Peter Howard & Derek Sylvan, *The Economic Climate: Establishing Expert Consensus on the Economics of Climate Change,* INST. POLICY INTEGRITY WORKING PAPER (2015).

[80] This argument was first developed in Martin L Weitzman, Why the Far-Distant Future Should Be Discounted at Its Lowest Possible Rate, 36 J. ENVIRON. ECON. MANAGE. 201–208 (1998), and in Martin L Weitzman, Gamma discounting, 91 AM. ECON. REV. 260-271 (2001).

[81] *See* Christian Gollier, Should we discount the far-distant future at its lowest possible rate?, 3 *Economics: The Open-Access, Open-Assessment E-Journal* 1-14 (2009).

[82] The Ramsey discount rate equation for the social discount rate is $r = \delta + \eta * g$ where r is the social discount rate, δ is the pure rate of time preference, η is the aversion to inter-generational inequality, and *g* is the growth rate of per capita consumption. For the original development, *see*, Frank Plumpton Ramsey, *A mathematical theory of saving*, 38 The Economic Journal 543-559 (1928).

[83] Higher growth rates lead to higher discounting of the future in the Ramsey model because growth will make future generations wealthier. If marginal utility of consumption declines in consumption, then, one should more heavily discount consumption gains by wealthier generations. Thus, if growth rates decline over time, then the rate at which the future is discounted should also decline. *See*, *e.g.,* Arrow et al. (2014), *supra* note 73, at 148. It is standard in IAMs to assume that the growth rate of consumption will fall over time. *See*, *e.g.,* William D. Nordhaus, *Revisiting the social cost of carbon*, 114 PROC. NATL. ACAD. SCI. 1518-1523 (2017) at 1519 ("Growth in global per capita output over the 1980–2015 period was 2.2% per year. Growth in global per capita output from 2015 to 2050 is projected at 2.1% per year, whereas that to 2100 is projected at 1.9% per year.") Similarly, Chris Hope*, The social cost of CO2 from the PAGE09 model*, Economics The Open-Access, Open-Assessment E-Journal Discussion Paper No. 2011-39 (2011) at 22, assumes that growth will decline. For instance, in the U.S., growth is 1.9% per year in 2008 and declines to 1.7% per year by 2040. Using data provided by Dr. David Anthoff (one of the founders of FUND), FUND assumes that the global growth rate was 1.8% per year from 1980–2015 period, 1.4% per year from 2015 to 2050 and 2015 to 2100, and then dropping to 1.0% from 2100 to 2200 and then 0.7% from 2200 to 2300. *See* David Anthoff, & Richard SJ Tol, *The Climate Framework for Uncertainty, Negotiation and Distribution (FUND): Technical description, Version 3.8.*, Discussion paper, http://www.fund-model.org.

(δ)—a measure of impatience— in the simple Ramsey rule can also leads to a declining social discount rate.[84] More recently, research demonstrates that (very) long-run leases in Singapore employ declining discount rate schedules.[85]

In the descriptive setting,[86] economists have demonstrated that calculating the expected net present value of a project is equivalent to discounting at a declining certainty-equivalent discount rate when (1) discount rates are uncertain, and (2) discount rates are positively correlated.[87] Real consumption interest rates are uncertain given that there are no multi-generation assets to reflect long-term discount rates and the real returns to all assets—including government bonds—are risky due to inflation and default risk (though as noted above, the limited evidence of observable long-run discount rates in the UK and Singapore real estate market also exhibit declining rates)[88] Furthermore, recent empirical work analyzing U.S. government bonds demonstrates that they are positively correlated over time; this empirical work has estimated several declining discount rate schedules usable by practitioners within EPA.[89]

In representative agent context, economists have demonstrated that an extended Ramsey rule[90] implies a declining discount rate when (1) the growth rate of per capita consumption is stochastic,[91] and (2) consumption shocks are positively correlated over time (or their mean or variances are uncertain).[92]

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[84] Christian Gollier, & Richard Zeckhauser, Aggregation of heterogeneous time preferences, 113 J. POL. 878-896 (2005); Geoffrey M. Heal, & Antony Millner, Agreeing to disagree on climate policy, 111 PROC. NATL. ACAD. SCI. 3695-3698 (2014).

[85] Christian Gollier, & James K. Hammitt, The long-run discount rate controversy, 6 ANNU. REV. RESOUR. ECON. 273-295 (2014); Fesselmeyer, E., Liu, H., & Salvo, A. (2019). Declining Discount Rates in Singapore's Market for Privately Developed Apartments. *Available at SSRN 2754429*.

[86] *See* Interagency Working Group, 2010 Technical Support Document, *supra*.

[87] *See* Arrow et al. (2014) *supra* note 73, at 157.

[88] *See generally* Gollier and Hammitt 2014, *supra*.

[89] *See generally* Arrow et al., 2013; Arrow et al., 2014; Cropper et al., 2014, *supra* note 73. *See also* Mark C. Freeman, Ben Groom, Ekaterini Panopoulou, & Theologos Pantelidis, Declining discount rates and the Fisher Effect: Inflated past, discounted future?, 73 J. ENVIRON. ECON. MANAGE. 32-49 (2015). Finally, see Elyès Jouini, & Clotilde Napp, *How to aggregate experts' discount rates: An equilibrium approach*, 36 ECON. MODELLING 235-243 (2014).

[90] If the future growth of consumption is uncertainty with mean μ and variance σ^2, an extended Ramsey equation $r = \delta + \eta * \mu - 0.5\eta^2\sigma^2$ applies where r is the social discount rate, δ is the pure rate of time preference, η is the aversion to inter-generational inequality, and g is the growth rate of per capita consumption. Gollier (2012) shows that we can rewrite the extended discount rate as $r = \delta + \eta * g - 0.5\eta(\eta + 1)\sigma^2$ where g is the growth rate of expected consumption and $\eta + 1$ is prudence. Christian Gollier, Pricing the Planet's Future: The Economics of Discounting in an Uncertain World, Princeton University Press (2012) at Chapter 3.

[91] The IWG assumption of five possible socio-economic scenarios implies an uncertain growth path.

[92] *See generally* Arrow et al., 2013; Arrow et al., 2014; Gollier & Hammitt, 2014; Cropper et al., 2014, *supra* note 73. The intuition of this result requires us to recognize that the social planner is prudent in these models (i.e., saves more when faces riskier income). When there is a positive correlation between growth rates in per capita consumption, the representative agent faces more cumulative risk over time with respect to the "duration of the time spent in the bad state." Christian Gollier, Discounting with fat-tailed economic growth, 37*Journal of Risk and Uncertainty* 171-186 (2008). In other words, "the existence of a positive correlation in the changes in consumption tends to magnify the long-term risk compared to short-term risks. This induces the prudent representative agent to purchase more zero-coupon bonds with a long maturity, thereby reducing the equilibrium long-term rate." Christian Gollier, The consumption-based determinants of the term structure of discount rates, 1 *Mathematics and Financial Economics* 81-101 (2007). Mathematically, the intuition is that under prudence, the third term in the extended Ramsey equation (*see* footnote 323) is negative, and a "positive [first-degree stochastic] correlation in changes in consumption raises the riskiness of consumption at date T, without changing its expected value. Under prudence, this reduces the interest rate associated to maturity T" (Gollier et al., 2007) by "increasing the strength of the precautionary effect" in the extended Ramsey equation (Arrow et al., 2014; Cropper et al., 2014 *supra* note 73).

While a constant adjustment downwards (known as the precautionary effect[93]) can be theoretically correct when growth rates are independent and identically distributed,[94] empirical evidence supports the two above assumptions for the United States, thus implying a declining discount rate.[95]

Several papers have estimated declining discount rate schedules for specific values of the pure rate of time preference and elasticity of marginal utility of consumption[96], though recent work demonstrates that the precautionary effect increases and discount rates decrease further when catastrophic economic risks (such as the Great Depression and the 2008 housing crisis) are modeled.[97] It should be noted that this decline in discount rates due to uncertainty in the global growth path is in addition to that resulting from a declining central growth path over time.[98]

Additionally, a related literature has developed over the last decade demonstrating that normative uncertainty (i.e., heterogeneity) over the pure rate of time preference (δ)—a measure of impatience—also leads to a declining social discount rate.[99] Despite individuals differing in their pure rate of time preference,[100] an equilibrium (consumption) discount exists in the economy. In the context of integrated assessment models, modelers aggregate social preferences (often measured using surveyed experts) by calibrating the preferences of a representative agent to this equilibrium.[101] The literature generally finds a declining social discount rate due to a declining collective pure rate of time preference.[102] The heterogeneity of preferences and the uncertainty surrounding economic growth hold simultaneously,[103] leading to potentially two sources of declining discount rates in the normative context.

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[93] The precautionary effect measures aversion to future "wiggles" in consumption (i.e., preference for consumption smoothing); see Christian P Traeger, *On option values in environmental and resource economics*, 37 *Resource and Energy Economics* 242-252 (2014).

[94] *See* Cropper et al 2014 *supra* note 73.

[95] Arrow et al., 2014; Cropper et al., *Declining Discount Rates*, American Economic Review: Papers and Proceedings (2014); Intergovernmental Panel on Climate Change, *Climate Change 2014–Impacts, Adaptation and Vulnerability: Regional Aspects*, Cambridge University Press, 2014. Essentially, the precautionary effect increases over time when shocks to the growth rate are positively correlated, implying that future societies require higher returns to face the additional uncertainty.

[96] For example, Arrow et al. (2014) *supra* note 73.

[97] *See* Gollier and Hammitt 2014 *supra;* Arrow et al. (2014) *supra* note 73.

[98] A common assumption in IAMs is that global growth will slow over time, leading to a declining discount rate schedule over time. Uncertainty over future consumption growth and heterogeneous preferences would lead to a more rapid decline in the social discount rate. *See also* Alex L.Marten, Elizabeth A. Kopits, Charles W. Griffiths, Stephen C. Newbold, & Ann Wolverton, Incremental CH4 and N2O mitigation benefits consistent with the US Government's SC-CO2 estimates, 15 CLIMATE POL'Y 272-298 (2015); William D. Nordhaus, *Estimates of the Social Cost of Carbon: Concepts and Results from the DICE-2013R Model and Alternative Approaches*, 1 J. Assoc. Environ. Resour. Econ. 1 (2014).

[99] See Arrow et al 2014 and Cropper et al 2014 *supra* note 73. See also Mark C. Freeman, & Ben Groom, How certain are we about the certainty-equivalent long term social discount rate?, 79 J. Environ. Econ. Manage. 152-168 (2016).

[100] *See* Christian Gollier, & Richard Zeckhauser, Aggregation of heterogeneous time preferences, 113 J. Pol. 878-896 (2005).

[101] See Antony Millner & Geoffrey Heal, *Collective intertemporal choice: time consistency vs. time invariance,* Grantham Research Institute on Climate Change and the Environment No. 220 (2015). See also Freeman and Groom 2016 *supra* 346.

[102] See Elyès Jouini, & Clotilde Napp, *How to aggregate experts' discount rates: An equilibrium approach*, 36 Econ. Modelling 235-243 (2014); Freeman and Groom (2016) *supra*; and Gollier & Zeckhauser (2005) *supra*. *See also* Elyès Jouini, Jean-Michel Marin, & Clotilde Napp, Discounting and divergence of opinion, 145 J. Econ. Theory 830-859 (2010). The intuition for declining discount rates due to heterogeneous pure rates of time preference is laid out in Gollier and Zeckhauser (2005). In equilibrium, the least patient individuals trade future consumption to the most patient individuals for current consumption, subject to the relative value of their tolerance for consumption fluctuations. Thus, while public policies in the near term mostly impact the most impatient individuals (i.e., the individuals with the most consumption in the near term), long-run public policies in the distant future are mostly going to impact the most patient individuals (i.e., the individuals with the most consumption in the long-run).

[103] *See* Jouini and Napp (2014) *supra* note 102; Jouini et al. (2010) *supra* note 102.

Declining Rates are Actionable and Time-Consistent: There are multiple declining discount rate schedules from which the EPA *Guidelines* can choose: several options are provided in Arrow et al. (2014) and Cropper et al. (2014).[104] One possible declining interest rate schedule for consideration by the *Guidelines* is the one proposed by Weitzman (2001).[105] It is derived from a broad survey of top economists in context of climate change, and explicitly incorporates arguments around interest rate uncertainty.[106] Other declining discount rate schedule include Newell and Pizer (2003); Groom et al. (2007); Freeman et al. (2015).[107] Many leading economists support the United States government adopting a declining discount rate schedule.[108] Moreover, the United States would not be alone in using a declining discount rate. It is standard practice for the United Kingdom and French governments, among others.[109] The U.K. schedule explicitly subtracts out an estimated time preference.[110] France's schedule is roughly similar to the United Kingdom's. Importantly, all of these discount rate schedules yield lower present values than the constant 2.5% discount rate employed by federal Interagency Working Group (IWG) in 2010 as a proxy for the average certainty-equivalent rate using the mean-reverting and random walk approaches to reflect that interest rates are highly uncertain over time (2010),[111] suggesting that even the lowest discount rate evaluated by the IWG is too high.[112] The consensus of leading economists is that a declining discount rate schedule should be used, harmonious with the approach of other countries like the United Kingdom.

A declining discount rate motived by discount rate- or growth rate-uncertainty avoids the time inconsistency problem that can arise if a declining pure rate of time preference (δ) is used. *Circular A-4* cautions that "[u]sing the same discount rate across generations has the advantage of preventing time-inconsistency problems."[113] A time-inconsistent decision is one where a decision maker changes plans over time solely because time has passed. For instance, consider a decision maker choosing whether to make an investment that involves an up-front payment followed by future benefits. A time-consistent

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[104] *See* Arrow et al 2014 and Cropper et al 2014 *supra* note 73.

[105] Weitzman (2001)'s schedule is as follows: 4% for 1-5 years; 3% for 6-25 years; 2% for 26-75 years; 1% for 76-300 years; and 0% for 300+ years. Martin L Weitzman, Gamma discounting, 91 AM. ECON. REV. 260-271 (2001).

[106] Freeman and Groom (2016) demonstrate that this schedule only holds if the heterogeneous responses to the survey were due to differing ethical interpretations of the corresponding discount rate question; *see* Mark C Freeman, & Ben Groom, *Positively gamma discounting: combining the opinions of experts on the social discount rate*, 125 ECON. J. 1015-1024 (2015). A recent survey by Drupp et al. (2015)—which includes Freeman and Groom as co-authors—supports the Weitzman (2001) assumption; see Moritz A. Drupp, Mark Freeman, Ben Groom, & Frikk Nesje, *Discounting disentangled, Memorandum*, Department of Economics, University of Oslo, No. 20/2015 (2015).

[107] *See* Richard G. Newell & William A. Pizer, *Discounting the distant future: how much do uncertain rates increase valuations?*, 46 J. ENVIRON. ECON. MANAGE. 52-71 (2003). *See also* Ben Groom, Phoebe Koundouri, Ekaterini Panopoulou, &Theologos Pantelidis, *Discounting the distant future: how much does model selection affect the certainty equivalent rate?*, 22 J. APPL. ECONOMETRICS 641-656 (2007). Finally, *see* Mark C. Freeman, Ben Groom, Ekaterini Panopoulou, & Theologos Pantelidis, Declining discount rates and the Fisher Effect: Inflated past, discounted future?, 73 J. ENVIRON. ECON. MANAGE. 32-49 (2015).

[108] *See* Arrow et al 2014 and Cropper et al 2014 *supra* note 73.

[109] *See* Gollier and Hammitt 2014 *supra*; and Cropper et al 2014 *supra* note 73.

[110] The U.K. declining discount rate schedule that subtracts out a time preference value is as follows: 3.00% for 0-30 years; 2.57% for 31-75 years; 2.14% for 76-125 years; 1.71% for 126- 200 years; 1.29% for 201- 300 years; and 0.86% for 301+ years. Joseph Lowe, Intergenerational wealth transfers and social discounting: Supplementary Green Book guidance, HM Treasury (2008).

[111] *See* IWG, 2010 Technical Support Document.

[112] Using the IWG's 2010 SCC model, Johnson and Hope (2012) find that the U.K. and Weitzman schedules yield SCCs of $55 and $175 per ton of CO_2, respectively, compared to $35 at a 2.5% discount rate. Laurie T. Johnson, & Chris Hope, The social cost of carbon in US regulatory impact analyses: an introduction and critique, 3 J. ENVTL. STUD. & SCI 205-221 (2012). Because the 2.5% discount rate was included by the IWG (2010) to proxy for a declining discount rate, this result indicates that constant discount rate equivalents may be insufficient to address declining discount rates. *See* IWG 2010 Technical Support Document.

[113] *Circular A-4* at 35.

decision maker would invest in the project if it had a positive net-present value, and that decision would be the same whether it was made 10 years before investment or 1 year before investment. A time-inconsistent decision maker might change their mind as the date of the investment arrived, despite no new information becoming available. Consider a decision maker who has a declining pure rate of time preference (δ) trying to decide whether to invest in a project that has large up-front costs followed by future benefits. Ten years prior to the date of investment, the decision maker will believe that this project is a relatively unattractive investment because both the benefits and costs would be discounted at a low rate. Closer to the date of investment, however, the costs would be relatively highly discounted, possibly leading to a reversal of the individual's decision. Again, the discount rate schedule is time consistent as long as δ is constant.

The arguments provided here for using a declining consumption discount rate are not subject to this time-inconsistency critique. First, time inconsistency occurs if the decision maker has a declining pure rate of time preference, not due to a decreasing discount rate term structure.[114] Second, uncertainty about growth or the discount rate avoids time inconsistency because uncertainty is only resolved in the future, after investment decisions have already been made. As the NAS (2017) notes, "One objection frequently made to the use of a declining discount rate is that it may lead to problems of time inconsistency. . . . This apparent inconsistency is not in fact inconsistent. . . . At present, no one knows what the distribution of future growth rates . . . will be; it may be different or the same as the distribution in 2015. Even if it turns out to be the same as the distribution in 2015, that realization is new information that was not available in 2015."[115]

Time-inconsistency is not a reason to ignore heterogeneity (i.e., normative uncertainty) over the pure rate of time preference (δ). If the efficient declining discount rate schedule is time-inconsistent, the appropriate solution is to select the best time-consistent policy. Millner and Heal (2018b)[116] do just this by demonstrating that a voting procedure—whereby the median voter determines the collective preference—is: (1) time consistent, (2) welfare enhancing relative to the non-commitment, time-inconsistent approach, and (3) preferred by a majority of agents relative to all other time-consistent plans. Due to the right-skewed distribution of the pure rate of time preference and the social discount rate as shown in all previous surveys,[117] the median is less than the mean social discount rate (and pure rate of time preference); the mean social discount rate is what holds in the very short-run under various aggregation methods, such as Weitzman (2001) and Freeman and Groom (2016).[118] Combining an uncertain growth rate and heterogeneous preference together implies a declining discount rate starting at a lower value in the short-run.

The Guidelines *Should Make Clear that a Decreasing Discount Rate Schedule Is Actionable and Can Be Time-Consistent if Designed Correctly:* As noted in the previous sub-section, a declining discount rate schedule is actionable, as several countries have already adopted declining discount rate schedules and evidence indicates that long-run leases in U.K. and Singapore already apply them implicitly. Despite concerns over time-consistency, the above discussion demonstrates that a well-designed schedule can be time-consistent. However, the current discussion of time-consistency in Sections 6.3.3 and Box 6.6 of

[114] Gollier (2012) ("It is often suggested in the literature that economic agents are time inconsistent if the term structure of the discount rate is decreasing. This is not the case. What is crucial for time consistency is the constancy of the rate of impatience, which is a cornerstone of the classic analysis presented in this book. We have seen that this assumption is compatible with a declining monetary discount rate.").

[115] National Academies of Sciences, Engineering, and Medicine, *Valuing climate damages: Updating estimation of the social cost of carbon dioxide* at 53 (2017).

[116] Millner, Antony, and Geoffrey Heal. "Discounting by committee." *Journal of Public Economics* 167 (2018b): 91-104.

[117] See Weitzman (2001); Howard and Sylvan (2015); Drupp et al (2015) *supra*.

[118] See Weitzman (2001); Freeman et al. (2015) *supra*.

the *Guidelines* do not make this actionability clear. To avoid any confusion over the appropriateness of declining discount rates, the *Guidelines* should make clear when declining discount rate schedules are and are not time-consistent and fully summarize the literature on declining discount rates under normative and positive uncertainty. Most importantly, the *Guidelines* should provide a peer-reviewed schedule of discount rates that are declining and time-consistent for practitioners to use, and EPA should update these schedules in subsequent revisions to the *Guidelines*.

As currently written, the *Guidelines* in Sections 6.3.3.3 and 6.3.3.4 make clear that time-inconsistency is possible and emphasizes the potential subsequent challenges of calibrating a declining discount rate schedule despite the consensus in the literature. However, while the *Guidelines* cite Arrow et al. (2014) to note that changes to discount rate resulting from new information is not time-inconsistent (similar to receiving new information over benefits and costs in a cost-benefit analysis), the *Guidelines* currently ignore discussion of sufficient and necessary conditions in Arrow et al. (2014, pp. 159-160).[119] By failing to discuss these conditions, the section incorrectly reads as if the field is not yet capable of constructing time-consistent declining discount rate schedules. Similarly, textbox 6-6 is misleading as it applies a numerical example of time-inconsistency but does not provide a numerical example of time-consistency. Instead, the *Guidelines* should review existing declining schedules used by nations and proposed in the literature based on normative and positive frameworks. If EPA clarifies its intention to update these schedules in subsequent revisions to the *Guidelines*, this would avoid the problem of time-consistency arising from new information.

If EPA determines that specific declining discount rate schedules cannot be provided, the *Guidelines* should propose alternatives to declining discount rate schedules. In the descriptive case, the *Guidelines* at page 6-21 currently propose that a "possible response to such challenges is to select a constant but slightly lower discount rate when discounting costs and benefits that are expected to occur far out in the time horizon, reflecting a certainty equivalent discount rate." In the descriptive context, this is a sensible adjustment as it has both theoretical support (i.e., the precautionary effect is constant when the growth rate of consumption is not positively correlated over time (Arrow et al., 2014, p. 149)) and there is historical precedent in federal regulatory analyses. Specifically, the IWG (2010; 2013; 2016) adjusted downwards a consumption discount rate of 3% to 2.5% to account for long-run uncertainty. In the normative case (i.e., heterogeneity), Millner and Heal (2018b) demonstrate that selecting the median preference parameters / discount rates is time consistent. Following this approach, the median social discount rate in recent surveys of discount rate and climate economic experts is 2%. Based on these two adjustments, constant approximations of between 2% and 2.5% are justifiable in the intergenerational context.

Discount Rate Issues Come Up Beyond the Climate Context: As a final reminder to the SAB panel, important discount rate issues come up in many EPA regulations, not just in the context of climate change. For example, EPA's recent analysis of its water quality standards for lead and copper, which had monetized net benefits exceeding costs at a 3% discount rate but not at a 7% discount rate, also

[119] Arrow et al. 2014, pp. 159-160: "However, it is also well known (Gollier et al. 2008) that a policy chosen by a decision maker who maximizes a time-separable expected utility function will be time consistent if expected utility is discounted at a constant exponential rate. this means that if a social planner discounts the utility of future generations at a constant exponential rate, the DDR that results from utility maximization will not lead to time-inconsistent decisions…Constant exponential discounting is a sufficient but not necessary condition for time consistency. See Heal (2005) for other conditions that will yield time-consistent decisions. However, it is necessary for an optimal policy to be both time consistent and stationary."

highlighted the need for more agency guidance on discount rates, including on clarifying the use of private versus social discount rates.[120]

Comments on Chapter 7

Many Valuation Methods Depend on Assumptions about Rationality: At page 7-4, lines 5-6, the *Guidelines* offer as an example that, instead of monetizing individual health endpoints, a hedonic property method could be used to estimate the total value to residents of, for instance, a change in the presence of hazardous waste sites. While subsequently reminding analysts to consider whether any benefit endpoints are not reflected in such a reduced form valuation estimate (page 7-5 at line 1), the *Guidelines* fail to make clear at this point on page 7-4 that forgoing a monetization of individual health endpoints in favor a hedonic property method is only appropriate if analysts can reasonably assume that residents have accurate information about health endpoints; otherwise, the property value will not reflect all health effects.

On page 7-10, at line 4, the *Guidelines* emphasize the "principle of consumer sovereignty, in which values used for benefit-cost analysis respect the preferences individuals have for these goods and services." Though that principle is an appropriate starting point, there are many exceptions that must be considered. If consumers are systematically irrational about their preferences, perhaps due to loss aversion or some behavioral market failure; if consumers systematically lack important information in ways that changes their valuations or preferences; if consumers are not able to express their actual preferences in the market due to a supply-side market failure like market power, or due to a market failure caused by the positionality of goods; if consumers preferences can shift due to a regulation, as in the case of experiential goods, regulatory disclosures, or certain regulations affecting certain positional or bandwagon goods; or due to a host of other potential market failures or deviations from assumptions about rationality, consumers' preferences as measured by various valuation techniques may not be accurate or may not be stable.[121]

As *Circular A-4* says, market prices are only a good source of willingness-to-pay data if the goods and services "are traded in a well-functioning competitive market."[122] Revealed preference valuation methods only work "If the market participant is well informed and confronted with a real choice," if the market is competitive, if there is not a significant information gap or asymmetric information problem, and if the market does not exhibit an externality.[123] Stated preference valuation methods similarly depend on a clear, complete, and objective explanation of the thing being valued, and a variety of other assumptions and conditions.[124] Though the *Guidelines* do acknowledge such caveats in various places (such as at page 7-21), such caveats should also be mentioned earlier and throughout chapter 7, including in the statement about consumer sovereignty. A footnote should be added on page 7-10, at line 6, following the word "policy maker": footnote: Respecting the preferences of individuals also requires considering how market failures, information gaps, and the potential for regulatory action to shift preferences may necessitate an appropriate adjustment from the valuations of goods and services suggested by various revealed preference or stated preference valuation methods.

Similarly, on page 7-10, line 15 should be adjusted as follows: Economic theory suggests that when goods and services are bought and sold in competitive markets that are free of externalities and other

[120] *See* Policy Integrity, Comments on National Primary Drinking Water Regulations: Lead and Copper Rule Revisions (Feb. 12, 2020), https://policyintegrity.org/documents/EPA_Lead_Copper_Rule_Comments_2020.02.11.pdf.

[121] *See supra* notes 24-27 and accompanying text.

[122] *Circular A-4* at 19.

[123] *Id.* at 20.

[124] *Id.* at 23.

market failures, optimizing and well-informed consumers maximize their level of utility subject to constraints on their budget….

And again on page 7-21, line 2 should be adjusted: For goods bought and sold in undistorted markets by well-informed and rational consumers, the market price indicates the marginal social value of an extra unit of the good.

Dread May Be an Important Health Outcome: On page 7-16, in discussing the cost-of-illness (COI) approach to valuation, the *Guidelines* recognize that "dread" can be an important consideration, and a consideration that COI approaches typically ignore. For a longer discussion of dread, see Revesz and Livermore's *Retaking Rationality* at 96, 103-106 (2008). Unfortunately, the *Guidelines* fail to consistently recognize dread. On page 7-12, at line 21, in the discussion "the effects of latency," the *Guidelines* should add at the end of that line: including any welfare losses from dread during the period of latency. Similarly, on page 7-14, at line 25, the *Guidelines* should add: The second step should consider any quantifiable welfare losses from dread during any period of latency.

Replacement Costs: The example given in the text box on replacement costs (page 7-16) requires some caveats. The *Guidelines* suggest that the replacement costs of restocking a pond after pollution has killed all the fish may not be a good estimate of the value of those fish, because a cheaper substitute may be available, in the form of monetary payments to allow fishers to purchase other market goods. However, such monetary payments would only compensate for the lost fish if there were no ecosystem services, aesthetic values, or any other benefits associated with having a healthy pond stocked with a population of healthy fish. If there were such ecosystem services, aesthetic values, or other lost benefits, then it is possible that the costs of dredging and restocking the pond may provide some reasonable point estimate of the lost benefits—especially if there is no other suitable valuation method available. If the options are either assigning lost ecosystem services and other benefits no monetized value—when EPA knows the value is "certainly not zero"[125]—or else using a reasonable replacement cost estimate to approximate the lost value, case law and best economic practices would both favor a reasonable estimate over treating ecosystem service benefits as if they were worthless.

Carbon Offset Markets: On page 7-21, footnote 194 explains why markets for environmental permits, like the acid rain market, do not necessarily provide data on the actual valuation of the underlying environmental good, since the market value is instead determined by the regulation-induced scarcity of the permits. The footnote may also want to distinguish markets for greenhouse gas offsets, which may reflect the cost of abatement or compliance, but do not necessarily reflect the full social cost of greenhouse gases.

Cost of Time: The *Guidelines* include recommendations on valuing the opportunity cost of time that may be both internally inconsistent and inconsistent with other agencies' practices.

On page 7-25, lines 39-40, EPA recommends that, when using a travel cost approach to valuing environmental benefits, "analysts should generally rely on the standard one third of the wage rate opportunity cost assumption when estimating recreation travel."[126] This recommendation comes immediately after noting that the Department of Transportation's 2016 guidance instead recommends valuing recreation travel at 50% of hourly median household income for local travel and 70% for intercity travel. The *Guidelines* do not explain what justifies the deviation from the Department of

[125] *Center for Biological Diversity v. NHTSA*, 538 F. 1172, 1200 (9th Cir. 2008).

[126] Note that on page 7-35, at lines 18-21, the *Guidelines* indicate generally that costs to lost home productivity and the value of leisure should be included in a cost-of-illness valuation approach, but does not make any recommendation on how to value such costs.

Transportation's methodology. Nor do the *Guidelines* mention that the Department of Health and Human Service's 2016 guidelines on regulatory impact analysis recommend a default assumption "that the opportunity cost of unpaid time can be best approximated by post-tax wages."[127]

However, later on page 8-16, when discussing how to value time in calculating regulatory costs, the *Guidelines* take the same position as the HHS guidelines, that "[a]s a proxy for the opportunity cost of nonwork time, analysts should add the value of voluntary fringe benefits to the the [sic] wage net of any taxes paid by workers to federal, state, and local governments on earned income" (lines 8-9).

The *Guidelines* do not explain why the full post-tax wage is an appropriate proxy for the opportunity cost of nonwork time when calculating regulatory costs, but to calculate environmental benefits the default opportunity cost of nonwork time is only one-third the wage rate. It is possible that some explanation is contained in EPA's 2020 document on *Valuing Time Use Changes Induced by Regulatory Requirements and Other EPA Actions*, but despite the request made in Policy Integrity's prior comments on these *Guidelines*, that document still does not seem to be available anywhere online.

There is also some inconsistency in the treatment of children's time. On page 7-26, the *Guidelines* seem to leave to each individual analyst's "professional judgment" whether opportunity cost of time estimates "are assumed to accrue to adults and children or only to adults" (lines 9-11). The *Guidelines* do not explain why all adults, regardless of their employment status, are automatically included, while individual analysts can decide whether and which minors to value. This position seems inconsistent with the statement on page 7-36, lines 26-27, that "students' time in school [will] directly or indirectly contribute to the productivity of society." Notably, HHS's guidelines apply its post-tax wage figure to children's time costs as well as seniors and other adults who may not be employed.[128]

The SAB should ask EPA to explain the internal inconsistencies and inconsistencies with other agencies' approaches on the valuation of time. If the inconsistent positions on the cost of time cannot be explained, EPA should revise the *Guidelines* to adopt a consistent position on valuing the opportunity cost of nonwork time.

Weighing Studies by Their Merits Is Preferred to Outright Removal from Benefit Transfers: On page 7-46, at line 18, the *Guidelines* recommend that "[s]tudies based on inappropriate methods or reporting obsolete results should be removed from consideration" in a benefit-transfer approach. The terms "inappropriate methods" and "obsolete results" are not defined. While some reasonable selection criteria may be required in a benefit-transfer methodology, allowing the outright removal of studies from meta-analysis or other benefit-transfer approaches for vague reasons, left entirely to individual analysts, risks inviting bias into the methodology and may not be recommended when studies can otherwise be weighted by their merits. The *Guidelines* should offer more details on these points.

As *Circular A-4* explains, "there is no mechanical formula that can be used to determine whether a particular study is of sufficient quality to justify use in regulatory analysis."[129] Instead, evidence should be weighed on its merits, and analysts should use all studies that include potentially valuable information to inform the calculation of costs or benefits.[130] It may be appropriate to conclude that different studies have different evidentiary weight, and some studies may have features that make them

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[127] HHS, *Guidelines for Regulatory Impact Analysis* at 27-28 (2016), https://aspe.hhs.gov/system/files/pdf/242926/HHS_RIAGuidance.pdf; *see also id.* at 30.

[128] HHS, *Guidelines*, *supra*, at 30 n.70.

[129] *Circular A-4* at 23.

[130] *See* L.J. Savage, *The Foundations of Statistics* (2d ed., 1972); Larry Hedges & Ingram Olkin, *Statistical Methods for Meta-Analysis*, ch.14 (1985).

less useful than other studies. But as explained by the editors-in-chief of five leading scientific journals, "[i]t does not strengthen policies based on scientific evidence to limit the scientific evidence that can inform them."[131] As a leading textbook on meta-analysis explains, improperly excluding studies can result in bias; consequently, to avoid such bias, all research that meets the study selection criteria should be include in the analysis.[132] Furthermore, any criteria or rules on whether to include and how to weight various studies should be determined *a priori*.[133]

Rather than exclude studies outright, analysts can instead place different weight on each study in proportion to that study's evidentiary value.[134] EPA has historically taken that approach, for example in its 2015 economic analysis of the Clean Water Rule; more recently, in the rollback and replacement of the Clean Water Rule, EPA (together with the Army Corps of Engineers) made questionable decisions to exclude certain studies from its benefit-transfer analyses, without adequate justification and in contravention of best economic practices.[135] The SAB should advise EPA to provide more details in the *Guidelines* on the appropriate inclusion, weighting, or exclusion of studies from benefit-transfer approaches, to prevent EPA from repeating the mistakes made in the unit transfer analysis and meta-analysis of the recent repeal and replacement of the Clean Water Rule.[136]

Respectfully,

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[131] Berg, J., Campbell, P., Kiermer, V., Raikhel, N., & Sweet, D., Joint statement on EPA proposed rule and public availability of data, 360 Science 6388 (2018), http://science.sciencemag.org/content/360/6388/eaau0116.

[132] Michael Borenstein et al., *Introduction to Meta-Analysis* 280 (2009).

[133] *See* Peter H. Howard & Thomas Sterner, *Few and not So Far Between: A Meta-Analysis of Climate Damage Estimates*, 68, Envtl. & Res. Econ. 197 (2017).

[134] For example, a study that has been successfully replicated could be assigned a higher evidentiary value.

[135] *See* Peter Howard & Jeffrey Shrader, *Expert Report: An Evaluation of the Revised Definition of "Waters of the United States"* at 2-7 (2019), https://policyintegrity.org/documents/Shrader_Howard_Expert_Report_FINAL.pdf.

[136] *See id.*