Appendix B
Workshop on Intergenerational Discounting
Background and Charge Questions

Background

The purpose of this workshop is to seek advice on how the benefits and costs of regulations should be discounted for projects with long horizons—that is, for projects that affect future generations. For intragenerational projects the Office of Management and Budget (OMB, Circular A-4) indicates that the preferred approach to “handling temporal differences between benefits and costs is to adjust [them] 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.” However, Circular A-4 points out that analysts would need to use shadow prices of capital to implement this approach and these are not well established for the United States.

As an alternative, OMB states that agencies “should provide estimates of net benefits using both 3 percent and 7 percent” discount rates. A discount rate of 7 percent is “an estimate of the average pre-tax rate of return on private capital in the U.S. economy” and is meant to capture the opportunity cost of capital when “the main effect of the regulation is to displace or alter the use of capital in the private sector.” OMB acknowledges that “the effects of regulation do not always fall exclusively or primarily on the allocation of capital. When regulation primarily and directly affects private consumption . . . a lower discount rate is appropriate.” A discount rate of 3 percent is meant to represent this possibility and is approximated by the real rate of return on long-term government debt. OMB indicates that this rate is sometimes referred to as the “social rate of time preference” and “simply means the rate at which ‘society’ discounts future consumption flows to their present value.”

For regulations with important intergenerational benefits or costs, OMB advises that the analyst “might consider a further sensitivity analysis using a lower but positive discount rate in addition to calculating net benefits using discount rates of 3 and 7 percent” (OMB 2003). Although some believe that it is ethically impermissible to discount the utility of future generations, rates greater than 0 percent are still advised for intergenerational analysis, based on the fact that future generations will be wealthier and thus will value a marginal dollar of benefits or costs by less than those alive today. Consumption discount rates of 1–3 percent are suggested, based on information from the 1990s. Discounting the benefits and costs accruing to future generations at a lower rate is meant to account for “increased uncertainty about the appropriate value of the discount rate, the longer the horizon for the analysis.”

The U.S. Environmental Protection Agency’s (EPA) Guidelines for Preparing Economic Analyses (2010) elaborate on OMB’s suggestions for intergenerational discounting. For projects with long time horizons (for example, 50 years or more), the agency recommends discounting
future benefits and costs using the consumption rate of interest (3 percent) as well as additional approaches to account for discount rate uncertainty and variability over time. One example of an additional approach is a schedule of declining discount rates such as those in the UK’s Green Book.\(^1\) Another approach would be to estimate the expected present value of net benefits using an “estimated time-declining schedule of discount factors (for example, Newell and Pizer 2003; Groom et al. 2007; Hepburn et al. 2009).”

In February of 2010 an interagency working group produced estimates of the social cost of carbon (SCC) for use in regulatory impact analyses.\(^2\) The damages associated with a ton of carbon were estimated using aggregate damage functions from three integrated assessment models (DICE, FUND and PAGE). These were combined with assumptions about future paths of emissions, GDP and population obtained from other sources (The Stanford Energy Modeling Forum 22\(^{ND}\) Meeting (EMF-22)) and simplified assumptions about the carbon cycle, including a probability distribution over climate sensitivity. Given the impacts of carbon dioxide (CO2) emissions expected to be experienced over decades to hundreds of years, damages were discounted to the present using discount rates that varied from those prescribed by OMB for intragenerational net benefits.

Acknowledging that the intergenerational context implied lower effective discount rates over time, the interagency working group used constant discount rates of 2.5, 3, and 5 percent. The central value, 3 percent, is meant to roughly correspond to the after-tax riskless interest rate. The upper value of 5 percent “is included to represent the possibility that climate damages are positively correlated with market returns. Additionally, this discount rate may be justified by the high interest rates that many consumers use to smooth consumption across periods. The low value, 2.5 percent, is included to incorporate the concern that interest rates are highly uncertain over time. It represents the average of the certainty-equivalent rates from the mean-reverting and random walk approaches from Newell and Pizer (2003) starting at a discount rate of 3 percent. Further, a rate below the riskless rate would be justified if climate investments are negatively correlated with the overall market rate of return.” The Interagency Working Group noted this lower value is also consistent with more normative or prescriptive views in the literature (e.g. Stern et al. 2006; Stern 2008; Sterner and Persson 2008; Heal 2009).

**Charge to the Committee**

Social discounting in the context of policies with very long time horizons involving multiple generations, such as those addressing climate change, is complicated by at least three factors: (1)

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\(^1\) The Green Book (H.M. Treasury 2008) applies a discount rate of 3.5 percent to the first 30 years; 3 percent for years 31 -75; 2.5 percent for years 76 -125; 2 percent for years 126 -200; 1.5 percent for years 201 -300; and 1 percent after 300 years.

\(^2\) The final 2010 interagency report on Social Cost of Carbon is available at: http://go.usa.gov/3fH.
the “investment horizon” is significantly longer than what is reflected in observed interest rates
that are used to guide private discounting decisions; (2) future generations without a voice in the
current policy process are affected; and (3) compared to shorter time horizons, intergenerational
investments involve greater uncertainty. Understanding these issues and developing
methodologies to address them is of great importance given the potentially large impact they
have on estimates of the total benefits of policies that impact multiple generations.

The over-arching question that the committee is asked to address is: What principles should
be used to determine the rates at which to discount the costs and benefits of regulatory
programs when costs and benefits extend over very long horizons?

To focus the discussion, this overarching question is decomposed into a series of specific
questions about the different approaches that have been suggested in the OMB and EPA
guidance documents, and in the literature. The committee’s goal is to determine which
approaches are appropriate and how they should be implemented.

When thinking about the charge questions it is useful to keep in mind two examples of
regulations whose benefits extend to future generations. In both cases, the costs of regulation are
expected to occur largely in the present or near future, while at least some of the benefits occur
in the far future. The first example is a regulation that would prevent the release of toxic
pollutants into aquifers. Pollutants such as chlorinated solvents, once released into aquifers, will
persist for hundreds of years and are difficult to remediate. Preventing their release will protect
the water supplies of current and future generations. The second example is a regulation that
would control domestic greenhouse gas emissions. While there may be non-climate benefits
associated with this rule, the direct benefits from greenhouse gas reductions accrue over multiple
generations.

**Applying the Ramsey Discounting Framework in an Intergenerational Context**

The Ramsey model is often used as an organizing framework for discussing long-term discount
rates. Along an optimal growth path the consumption rate of discount equals \( \rho + \eta \cdot g \), where \( \rho \) is
the pure rate of time preference, \( \eta \) is the elasticity of the marginal utility of consumption and \( g \) is
the growth rate of per-capita consumption. Much has been written about the selection of the
parameters \( \rho \) and \( \eta \), with some arguing that they should be chosen to reflect actual market
behavior (the “descriptive” approach) and others arguing that they should reflect ethical values
(the “prescriptive” approach) (Arrow et al. 1996). This question asks under what circumstances it
is appropriate to use the Ramsey equation to generate discount rates for benefit–cost analyses
under long horizons and how, exactly, it should be used.

**Question 1:** Is it appropriate to use the Ramsey equation in either a prescriptive or descriptive
fashion to generate discount rates for benefits and costs over long horizons?
Question 1a. Assuming that the parameters $\eta$ and $\rho$ could be determined, how, exactly, would the Ramsey framework be used in a discounting context?

Is the appropriate approach to embed these parameters in a structural model (such as an IAM) so that discount rates can be determined endogenously? How would the Ramsey equation be used to discount streams of benefits and costs generated outside of the context of a growth model (as in the groundwater example)?

Question 1b. What criteria should be used to determine the parameters $\eta$ and $\rho$ of the Ramsey formula? Should they reflect ethical considerations or attempt to reproduce observable behavior in markets?

Question 1c. How should uncertainty be handled in a Ramsey framework? Is it appropriate to define probability distributions over $\eta$ and $\rho$, or should sensitivity analysis be used? How should uncertainty about $g$ be handled?

Directly Estimating Discount Rates over Long Time Horizons

There is a literature dating back to Weitzman (1998, 2001) that suggests that due to uncertainty about the discount rate, discount rates should decline over long horizons. In Weitzman (2001) the source of this uncertainty is subjective uncertainty (disagreement among experts) about what constant exponential discount rate to use. A probability distribution over the discount rate under constant exponential discounting produces declining certainty-equivalent discount rates. Subsequent literature has discussed other sources of uncertainty about the discount rate, including uncertainty about the rate of economic growth (Weitzman 2004, Gollier 2002a, 2002b). Other literature has used a reduced-form approach to estimating certainty equivalent discount rates based on historical time series (for example, Newell and Pizer 2003; Groom et al. 2007; Hepburn et al. 2009).

Weitzman (1998, 2001) showed theoretically, and Newell and Pizer (2003) and Groom et al. (2006) confirmed empirically, that discount rate uncertainty can have a large effect on net present values. A key result from these studies is that if there is a persistent element to the uncertainty in the discount rate (e.g., the interest rate follows a random walk), then it will result in an effective (or certainty-equivalent) discount rate that declines over time. This is due to the fact that lower discount rates will dominate over the very long term (see Weitzman 1998, 1999, 2001; Newell and Pizer 2003; Groom et al. 2006; Gollier 2008; Summers and Zeckhauser 2008; and Gollier and Weitzman 2009).
Question 2. How should the results of the declining discount rate (DDR) literature be reflected in benefit–cost analyses? Should a schedule of discount rates be derived from theoretical principles and/or simulation models? Should discount rates be estimated empirically or should both approaches be used?

Question 2a. If an empirical approach is taken, what should it be? What datasets should be used, for what countries, and which empirical models should be used? What difficulties do you foresee in implementing this approach practically?

Question 2b: Will the use of time-declining discount rates lead to time inconsistent decisions? How much of a concern is this?

Question 2c: If future benefits in a regulatory impact analysis represent expected values (rather than certainty equivalents), the appropriate discount rate will not equal the risk-free rate. How should the appropriate discount rate be determined, allowing for correlation between benefits and market returns?

Assessing Intra- and Intergenerational Benefits and Costs within a Rulemaking

Question 3: Are the approaches to discounting over long horizons suggested above consistent with current approaches to intragenerational discounting?

Question 3a: If some costs and benefits associated with a regulation apply intragenerationally and are evaluated as specified by Circular A-4, can they be added to the present value of intergenerational costs and/or benefits that apply different discount rates?

Wrap-Up

At the end of the workshop, we expect to have a discussion about the relative merits of various approaches to discounting costs and benefits over long horizons in order to determine key recommendations that can be made to EPA.