Applying the Ramsey Discounting Framework in an Intergenerational Context

In benefit–cost analysis, the net benefits of a project in year t (in consumption units) are to be discounted to the present at the rate at which society would trade consumption in year t for consumption in the present. OMB suggests in its guidance that the net benefits of projects be evaluated by converting them into consumption units and discounting future net benefits at the consumption rate of discount.In the standard Ramsey model the consumption rate at which one should discount today a sure benefit at date equals $\rho + \eta \cdot g_t$, where ρ is the pure rate of time preference, η is the elasticity of the marginal utility of consumption and g_t is the growth rate of per-capita consumptionbetween now and time t. As was emphasized during the workshop, it is important to distinguish between the Ramsey formula for the consumption rate of discount and the optimality conditions in the Ramsey model, which say that the consumption rate of discount will equal the marginal rate of return of capital along an optimal growth path.[1]

1. The panelists believe that the Ramsey model provides a useful framework for examining intergenerational discounting issues.The key question is whether, and if so how, it can be used to generate a path of discount rates for use in a benefit–cost analysis. A related issue is that the Ramsey model is a highly simplifiedrepresentation of the real world. So one must take care in moving from the theory of the Ramsey model to empiricalpractice.

2. The consumption rate of discount could be estimated from the Ramsey formula $\rho + \eta \cdot g_t$, treating the parameters η and ρ as representing social preferences. One way of eliciting these preferences would be to use choice experiments or conjoint analysis to elicit the η and ρ implied by consumption tradeoffs made from a social perspective by members of the public. Another way would be to investigate the preferences revealed by investment decisions by private individuals and public bodies (in democracies). There are problems with either approach, as previous estimates have shown a wide range of results.

3. Several panelists emphasized the need to check on the reasonableness of the discount rates obtained from the Ramsey formula by comparing them to the return on risk-free capital. Although the rate of return to risk-freecapital may not equal the consumption rate of discount in the real world, market rates of return are observable (at least for some period) and provide a check on whether results obtained by estimating $\rho + \eta \cdot g_t$ directly make sense.

4. Another approach to estimating η and ρwould be to look at behavior in financial markets (for example, to estimate η using estimates of relative risk aversion). One drawback to this is that behavior in financial markets is likely to reflect short-term rather than

[1] That is, $f'(k_t) = \rho + \eta \cdot g_t$ where k is the (per capita) capital stock.

intergenerational preferences. Another drawback is that financial markets reflect the preferences of people facing no borrowing constraint.

5. Practical considerations argue for using the rate of return to capital to measure the discount rate, even though this may not equal the consumption rate of discount. It may, for example, be easier to forecast r than g. There are, however, problems in applying this approach: marketed securities should, in theory, have risk-adjusted rates of return equal to the rate of return on capital in industry; but, in fact, they yield very different rates.

6. The standard Ramsey formula for the consumption rate of discount can be extended to handle uncertainty about the rate of growth in consumption by adding a third term to the Ramsey formula. If growth is subject to independently and identically distributed shocks, this is unlikely to significantly alter the consumption rate of discount. If however, shocks to growth are correlated over time, this can lead to a declining term structure of discount rates (Gollier workshop presentation).

7. The Ramsey formula can also be extended to evaluate policies that would reduce catastrophic risks to the economy. In this case, the impact of possible catastrophes could also have a significant impact on the discount rate (Pindyck workshop presentation).

Uncertainty andDiscount 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 approachtoestimating certainty-equivalent discount rates based on historical time series of interest rates (for example, Newell and Pizer 2003; Groom et al. 2007; Hepburn et al. 2009).

1. If there is persistence in the discount rates that will be applied in the future and if we can assign probabilities to these discount rates, this will result in a declining schedule of certainty-equivalent discount rates. One question is how such probabilities should be assigned.

2. If uncertainty about the discount rate reflects disagreement among individuals about ρ (i.e., disagreement about preferences rather than underlying uncertainty about the economy), it is not appropriate to use this disagreement to set probabilities.

3. If uncertainty about the discount rate reflects uncertainty about the state of the economy and if there are persistent shocks to growth, this will lead (ceteris paribus) to a declining discount rate schedule. There are two approaches that could be used to estimate discount rates in this case: an approach based on the (modified) Ramsey formula, which would entail choosing η and ρ and modeling the process that generates g_t, and an approach that focuses on estimating reduced-form models of market interest rates (i.e., that focuses on the left-hand side of the Ramsey equation).(See points3. and 5. above for caveats regarding the former andlatter approaches.)

4. The literature has focused on the latter approach—estimating reduced form models using time series data to estimate the stochastic process generating market interest rates.

5. Some panelists suggested that expert elicitation methods could be used to obtain forecasts of future market interest rates, from experts knowledgeable about the future state of the economy.

6. Should EPA wish to follow either of these approaches, the agency should have the Science Advisory Board (SAB) establish criteria for model selection and for combining the results of the literature.

7. The use of time-declining discount rates need not lead to time inconsistent decisions. In a Ramsey model in which ρ is constant, decisions are time consistent. It is the requirement that an optimal policy be both stationary and time consistent requires constant exponential discounting of utility. In the context of expected net present value models, if new information becomes available and decisions can be revised in light of new information, time consistency is not likely to be a major concern.

8. The preferred practice (which accords with OMB's guidance) is to express net benefits as certainty equivalents, rather than adjusting the discount rate for a project's beta. Certainty equivalents should take into account the correlation between net benefits and consumption per capita. It is also preferable to adjust net benefits for changes in relative prices, rather than altering the discount rate.

Assessing Intra- and Intergenerational Benefits and Costs within a Rulemaking

In recent regulatory impact analyses for Corporate Average Fuel Economy (CAFE) standards,the benefits of reduced carbon emissions were discounted at constant exponential rates of 2.5, 3, and 5 percent, while the benefits of reduced fuel consumption were discounted at rates of 3 and 7 percent. The use of a 2.5 percent discount rate for intergenerational benefits and a rate of 3 percent for intragenerational benefits implies that (sure or certainty-equivalent) benefits occurring in the same year could be discounted to the present at different rates.

1. It is inappropriate to discount(sure or certainty-equivalent) benefits and/or costs occurring in the same yearto the present using different discount rates.

2. One solution to this is problem is to apply a declining discount rate schedule to all regulations. The use of such a schedule would result in consistency between intragenerational and intergenerational discounting practices.