



*How Should*

# **BENEFITS & COSTS**

*Be Discounted in an  
Intergenerational  
Context?*

*Twelve prominent economists convened at RFF to advise the US government on the vital challenge of evaluating the costs and benefits of environmental policies affecting generations to come. Moderator **Maureen Cropper** reports.*

Because the benefits of reduced greenhouse gas emissions last for centuries while many mitigation costs are borne today, climate change has presented a very difficult political economy challenge. But issues with very long horizons do not just raise political questions; they pose thorny analytical questions as well. After all, deciding how quickly and aggressively to respond depends on how much we think a

given amount spent on mitigation today will benefit future generations.

Converting future costs and benefits into today's currency requires the process of discounting, a calculation that accounts for the fact that people value present costs and benefits more than future costs and benefits. The US Environmental Protection Agency and Office of Management and Budget have clear-cut discounting guide-

lines when it comes to assessing the costs and benefits of environmental policies that have effects lasting a few decades, but those lines blur in the case of climate change, which will affect future generations. Yet in benefit–cost analysis, the rate at which future benefits and costs are discounted can have enormous implications for policy prescription. For example, the central issue separating the aggressive policy recommendations advocated in Nicholas Stern’s 2007 report on climate change from US agency estimates of the damages associated with climate change is Stern’s controversial decision to discount future damages at a much lower rate.

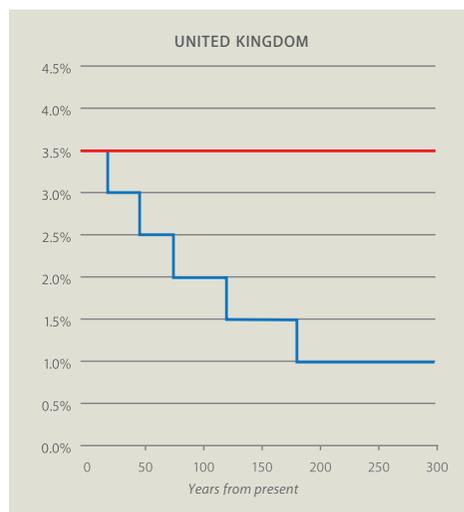
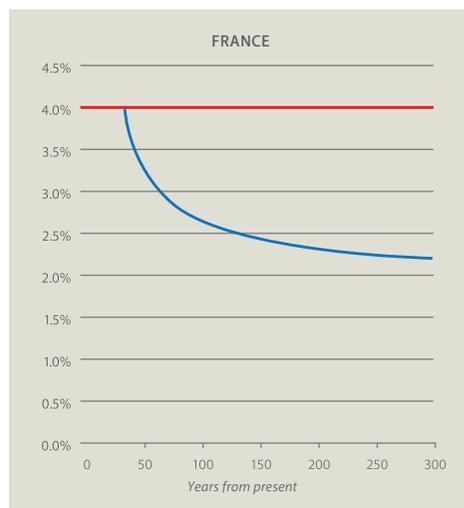
Besides the choice of how high or low to set the rate, there is also the question of whether and how it might change over time. In evaluating public projects, France and the United Kingdom use discount rate schedules in which the discount rate applied to benefits and costs in future years declines over time. As shown in Figure 1, the discount rate in year 200 is lower than the discount rate in year 100 in both countries. This is clearly more future-oriented than applying a constant discount rate (shown by the red line) to benefits in all years.

In the United States, the Office of Management and Budget recommends that project costs and benefits be discounted at a constant rate, although this rate may be lower for projects that affect future generations. This raises a familiar, but difficult, question: how should governments discount the costs and benefits of public projects, especially projects whose costs or benefits extend beyond the current generation?

Twelve prominent economists were asked to address this question at a workshop held at RFF in September 2011. Specifically, they were asked what prin-

ciples the US government should follow in estimating the discount rate to be applied in cost–benefit analyses involving future generations—and whether the discount rate should decline over time. Although panelists disagreed about the empirical approach that should be taken in estimating the discount rate, there was strong agreement about the rationale for using a discount rate that declines over time.

**Figure 1. Declining Discount Rates in France and the United Kingdom**



Source: Damon, Mohlin, and Sterner 2013.

### How, Empirically, Should the Discount Rate Be Determined?

There are two rationales for discounting future benefits—one based on consumption and the other on investment. The consumption rate of discount reflects the rate at which society is willing to trade consumption in the future for consumption today. Basically, we discount the consumption of future generations at a higher rate because we assume future generations will be wealthier than we are and that the utility people receive from consumption declines as their level of consumption increases. To illustrate, if per capita consumption grows at 1.3 percent per year, in 200 years it will be over 13 times higher than today. So it makes sense to discount an extra dollar of consumption received 200 years in the future.

The investment approach says that, as long as the rate of return to investment is positive, we need to invest less than a dollar today to obtain a dollar of benefits in the future. Under the investment approach, the discount rate is the rate of return on investment. If there were no distortions or inefficiencies in markets, the consumption rate of discount would equal the rate of

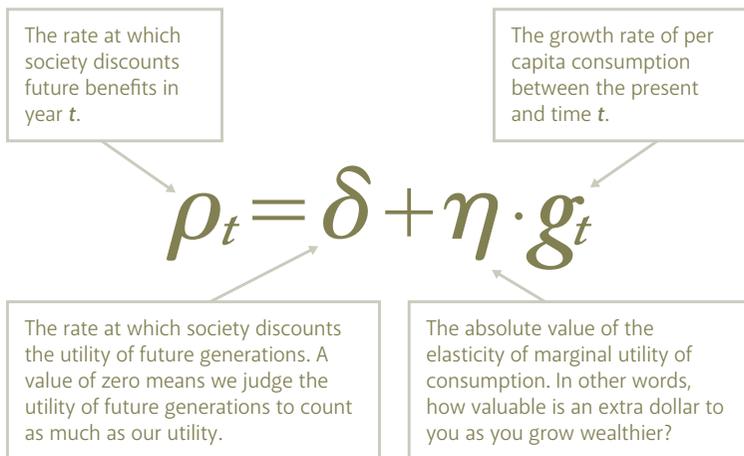
return on investment. There are, however, many reasons why the two may differ. This implies that using a consumption versus an investment approach will often lead to very different discount rates.

### The Consumption Approach to Discounting: The Ramsey Formula

The consumption-based, or “prescriptive,” approach to discounting can be traced back to Frank Ramsey (1903–1930), a mathematician at Cambridge University who made fundamental contributions to economics. What has become known as the “Ramsey formula” says that the rate at which one should discount an increase in consumption that occurs in the future depends on three key factors, elaborated upon below: our pure rate of time preference, our expectations about future growth rates, and our judgment about whether and how fast the marginal utility of consumption declines as we grow wealthier (see Figure 2).

» In an intergenerational context, a positive pure rate of time preference ( $\delta$ ) implies that we judge the contribution of future generations to social welfare to be less than ours. Ramsey believed, on ethical grounds, that  $\delta$  should be zero.

Figure 2. The Ramsey Formula



» The absolute value of the marginal utility of consumption ( $\eta$ ) determines how rapidly the marginal utility of consumption changes as consumption increases, and thus affects the discount rate. In an intragenerational context,  $\eta$  can be viewed as a measure of inequality aversion: higher values of  $\eta$  imply that wealthier people should be asked to forgo more income to make poorer people better off.

» The rate of per capita consumption growth is given by  $g$ .

Specifying values of the parameters  $\delta$  and  $\eta$  and forecasting the rate of growth in consumption are something of a challenge. For example, economists have inferred the value of  $\eta$  implied by income tax schedules in different countries and the percent of GDP donated in the form of foreign aid. It is also possible to elicit values of  $\eta$  and  $\delta$  using stated preference methods, for example, by asking members of the public to make trade-offs between consuming today and saving to make future generations better off.

Practical difficulties in measuring the parameters of the Ramsey formula led some panelists to suggest that the rate of return on investment—which is, in principle, observable—should be used as a check on the discount rate that emerges from the Ramsey formula. The investment, or “descriptive,” approach to discounting suggests that  $\eta$  and  $\delta$  should be estimated based on behavior in financial markets. One drawback is that behavior in financial markets is likely to reflect short-term rather than intergenerational preferences. And taxes on capital and frictions in financial markets may cause the rate of return on investment to deviate from the consumption rate of discount. The return on risk-free investments, however, is often used to approximate the consumption rate of discount due to difficulties in estimating the latter.

### Should the Discount Rate Decline over Time?

Our expectation about future growth rates ( $g$ ) does not depend on the same type of social and ethical judgments as the other two elements of the Ramsey formula but is equally difficult to predict. Future discount rates are inherently uncertain, due to uncertainty in the rate of growth in consumption (under the consumption-based approach) and the rate of return to investment (under the investment-based approach). But uncertainty about future growth translates into uncertainty about future discount rates. And this uncertainty may give rise to a declining discount rate schedule.

To illustrate this point, consider the simple case where we know that future discount rates will be constant, but we are uncertain about the correct rate to use. Table 1 contrasts the present value of \$1,000 received at various future dates using a constant discount rate of 4 percent versus a constant but uncertain discount rate that equals 1 percent and 7 percent with equal probability. When the discount rate is uncertain, governments should use the expected present value (the average of columns 3 and 4, shown in column 5). The present value computed using the mean discount rate of 4 percent is always smaller than when the discount rate is uncertain. This effect is magnified over time. When the discount rate is uncertain, a certainty-equivalent discount rate will yield the present values in column 5. As shown in column 6, this certainty-equivalent discount rate declines over time.

Using a declining discount rate schedule makes a considerable difference to estimates of the social cost of carbon, compared to using a constant discount rate. The range of estimates produced by some of the 12 panelists at the workshop provides a case in point. Using a constant rate of 4 percent and damage estimates

**Table 1. Present Value of \$1,000 Received after t Years**

(1)	(2)	(3)	(4)	(5)	(6)
<i>t</i>	Discount rate = 4%	Discount rate = 1%	Discount rate = 7%	Present value when discount rate is uncertain*	Certainty-equivalent discount rate
1	960.7894	990.0498	932.3938	961.2218	0.0394
10	670.3200	904.8374	496.5853	700.7114	0.0313
100	18.3156	367.8794	0.9119	184.3957	0.0102
200	0.3355	135.3353	0.0008	67.6681	0.0101

\* average of columns 3 and 4

from panelist Bill Nordhaus, the present discounted value of global damages from emitting a ton of carbon in 2000 is \$5.30 (1989 US\$). It is \$10.00 (1989 US\$) per ton using the declining discount rate schedule estimated by Richard Newell and Billy Pizer, and \$14.00 (1989 US\$) per ton of carbon using the model estimated by Ben Groom and colleagues.

### Conclusions

Among economists, the principles underlying intergenerational discounting are to a large degree uncontroversial. The 12 economists at RFF’s discounting workshop agree that there are compelling arguments for using a declining discount rate schedule in the face of uncertainty. Setting the schedule empirically is clearly a difficult task, but so is the task of setting constant discount rates for public projects.

The panelists also agree that the Ramsey formula provides a useful framework for thinking about intergenerational discounting—but they disagree as to how the parameters of the Ramsey formula might be determined empirically. In many ways, the discussion about how to parameterize the formula revisits a long-standing debate about the “descriptive” versus “prescriptive” approach to discounting—the former approach arguing that discount rates should reflect observed behavior in markets, and the latter that ethical and policy considerations should be used to set the discount rate.

Recent research by RFF University Fellow Larry Goulder and RFF Senior Fellow Rob Williams offers fresh perspective on this debate. They have argued that the consumption rate of discount should be used to evaluate public projects for the following reason: when the consumption rate deviates from the return on investment, this indicates opportunities for increasing social welfare by adjusting the savings rate. For example, if the rate of return on investment is greater than the consumption rate of discount, more should be saved. ●

This article draws from the Intergenerational Discounting Workshop held at RFF September 22–23, 2011. The participants were Kenneth J. Arrow, Christian Gollier, Ben Groom, Geoffrey M. Heal, Richard G. Newell, William D. Nordhaus, Robert S. Pindyck, William A. Pizer, Paul R. Portney, Thomas Sterner, Richard S.J. Tol, and Martin L. Weitzman. The workshop was chaired by RFF Senior Fellow Maureen L. Cropper and sponsored by the US Environmental Protection Agency. Workshop presentations are available at [www.rff.org](http://www.rff.org)/discounting.

### FURTHER READING

- Arrow, Kenneth, et al. 2012. How Should Benefits and Costs Be Discounted in an Intergenerational Context? The Views of an Expert Panel. Discussion paper 12-53. Washington, DC: Resources for the Future.
- Damon, Maria, Kristina Mohlin, and Thomas Sterner. 2013. Putting a Price on the Future of Our Children and Grandchildren. In *The Globalization of Cost-Benefit Analysis in Environmental Policymaking*, edited by Michael A. Livermore and Richard L. Revesz. New York: Oxford University Press.
- Goulder, Lawrence H., and Roberton C. Williams III. 2012. The Choice of Discount Rate for Climate Change Policy Evaluation. Discussion paper 12-43. Washington, DC: Resources for the Future.