RESOURCES *for the* FUTURE

Discounting for Public Benefit-Cost Analysis

Issue Brief 21-05 by **Qingran Li** and **William A. Pizer** — June 2021

To determine the overall value of a policy to society, the US government calculates costs and benefits both now and over time. To compare costs and benefits that occur at different times, future impacts must be reduced in value, or discounted, since future costs and benefits are less significant than those same costs and benefits today. Higher discount rates mean that future effects are considered increasingly less significant; a low discount rate means that they are close to equally significant.

For nearly 20 years, the Office of Management and Budget (OMB) has advised federal agencies to use two discount rates in policy analyses: 7 percent and 3 percent. The 7 percent rate captures the return paid by private capital, reflecting effects on investment and business, and the 3 percent rate the return received by consumers, with the difference due largely to taxes. When applied to government policies that have costs today but benefits extending far into the future, the two rates can have strikingly different outcomes. Recent estimates of social cost of carbon (SCC)[1] are six to nine times higher using 3 percent rather than 7 percent, and this discrepancy can have significant, cascading effects on the benefit-cost analysis of policies.[2]

In contrast, economic theory suggests converting the dollar effects on investment and business to their consumption equivalents. That way, costs and benefits (measured entirely as effects on consumers) can be discounted at the consumption rate across the board. This idea has not caught on, however, because the "shadow price" to convert capital goods into consumption equivalents and the distribution of costs and benefits (across investment versus consumption) are not always certain.

In this issue brief, we show that a shadow price is no more difficult to identify than discount rates of 7 or 3 percent. Nor is it difficult to establish bounds based on whether costs and benefits accrue to capital or consumption, valuing them differently and appropriately. This approach provides more consistency than the current use of alternative 3 and 7 percent discount rates, particularly for valuing benefits far into the future.

Background on Discount Rates

A **benefit-cost analysis** (BCA) is central to designing and evaluating policy: it compares the total economic benefits of a proposed policy with its total economic costs. The US government first issued guidance to agencies on how to conduct BCA in 1969, and BCA has been required for major federal regulations since 1981.

Discounting is fundamental to BCA. The traditional approach for choosing the discount rate has been to look for observed market rates of return to see how people make trade-offs over time. However, these market rates vary based on whether we are observing a typical return paid by private capital or the return received by consumers.

In 1969, the government's discount rate for BCA was 10 percent. In 1992, the rate was revised to 7 percent. In 2003, the after-tax rate of 3 percent was added.

1 The social cost of carbon refers to the monetized benefits (avoided climate damages) from reducing one ton of carbon dioxide.

2 The Obama administration adopted a range of SCC estimates centered on a 3 percent discount rate. Several years later, the EPA under the Trump administration adopted SCC estimates based on both 7 and 3 discount rates with equal emphasis.

Since then, government agencies conducting BCA have generally presented both 3 and 7 percent as alternative cases, with 3 percent representing the rate at which consumers trade off consumption over time, and 7 percent representing the rate of return to productive investments by business.

Because climate change could have far-reaching and lasting consequences for society, using the correct discount rate to assess the future benefits and costs of policies to reduce greenhouse gas emissions is particularly important.

Investment Rates vs. Consumption Rates

For brevity, we refer to the 7 and 3 percent discount rates as the "investment rate" and "consumption rate," respectively.

- The **investment rate** for discounting future effects is based on the before-tax profitability of investment in a mix of corporate and noncorporate assets. The 7 percent rate is based on the observation that US stocks have earned around 7 percent over long periods of time.
- The **consumption rate** for discounting future effects is based on households' after-tax earnings on their investments. Since taxes account for roughly half the 7 percent return created by businesses, the consumption rate is only 3 percent.

In a competitive capital market without taxes, a household's return on savings and the return on capital investment would be the same. Taxes on the income from capital drive the wedge between these two rates. So which is a correct basis for BCA, the observed behavior of households or that of firms?

Economists generally look to households as the ultimate authority on "welfare value"—the value used in BCA to represent the well-being of society. Societal welfare is an aggregation of individuals' preferences, which should be revealed by the prices they are willing to pay or receive in the market. The relevant question, then, is the rate of interest available for household savings: what kind of return does a household face when it makes trade-offs in consumption over time? Put another way, it seems unlikely that households would prefer a government policy with a lower rate of return than they could seek in the market.

This idea builds off the work of economist David Bradford. In 1975, Bradford published "Constraints on Government Investment Opportunities and the Choice of Discount Rate," which argued that when conducting a societal BCA—when determining the welfare value—households and consumers should be front and center. If consumers trade off consumption over time by valuing each future year 3 percent less than the preceding year, then 3 percent is the discount rate to use. But meanwhile, productive capital is earning 7 percent. To address this discrepancy, we need a **shadow price** of capital to value effects on the capital stock in BCA.

"Shadow price" refers to society's valuation of some good or service when market prices are either lacking or distorted by taxes, regulation, or market failures. In the case of capital, a large part of capital income is being taxed away by the government and then used to benefit society. When a household thinks about saving for the future, however, it typically does not consider the societal value of tax revenue. For BCA, we need to value that revenue.

Calculating the Shadow Price of Capital

To calculate the shadow price of capital, assume that capital (let's use $1) is earning 7 percent (7 cents) per year, of which 4 cents is going to the government and 3 cents is going to households, forever. We presume that the government is spending its 4 cents on activities and infrastructure that benefit society as a whole. In essence, then, the full 7 percent return benefits households as a group. But as individuals, consumers don't recognize this flowback. When consumers think about the future value $1 of capital invested today, they think about the 3 cents they receive each year, forever.

With a return to society of 7 cents per year and a value recognized by consumers of 3 cents per year, the shadow price of capital is 7 divided by 3, or 2.33 times higher than the market price. Put another way, when $1 of capital with a 7 percent return is evaluated at the consumer's discount rate of 3 percent, it is worth much more than a dollar: it's worth $2.33. Taxes on investment returns create a gap between society's value of $1 of capital and $1 of ordinary consumption. Thus $2.33 is our shadow price of capital.

This example assumes that investments pay 7 percent a year forever. It seems more reasonable to imagine that some increase (or decrease) in capital will not last forever. In that case, we can show (through an elaborate model) that the shadow price will always be less than $2.33, which is otherwise an upper bound. In our paper last year, we described a best guess shadow price of around $1.5, still using the OMB rates as guideposts. In a more recent comment on the federal SCC, Pizer (2021) suggests a shadow price of $1.2 based consumption rates of 2–3 percent and investment rates of 3–5 percent.

Identifying Cost and Benefit Effects

At this point, it may seem we have replaced one problem—dramatically inconsistent results from using different discount rates for BCA over long time horizons—with another: the need to identify whether costs and benefits accrue to capital or consumption and therefore whether they get multiplied by the shadow price of capital.

The easiest way to approach this is a sensitivity analysis to determine the effects of different variations. In particular, the highest net benefit value will occur when *benefits* accrue to capital and are multiplied by the shadow price. The lowest net benefit will occur when *costs* accrue to capital and are multiplied by the shadow price. But in both cases, costs and benefits are discounted at the consumption rate.

Moreover, 7 percent (or an investment rate more generally) is never a suitable discount rate for government BCA. The possibility that regulation or other policy displaces capital is an important consideration. But it is better captured by scaling up costs based on the shadow price of capital than by crudely messing with the discount rate. The correct adjustment to the discount rate will differ across applications and particularly with the time horizon.

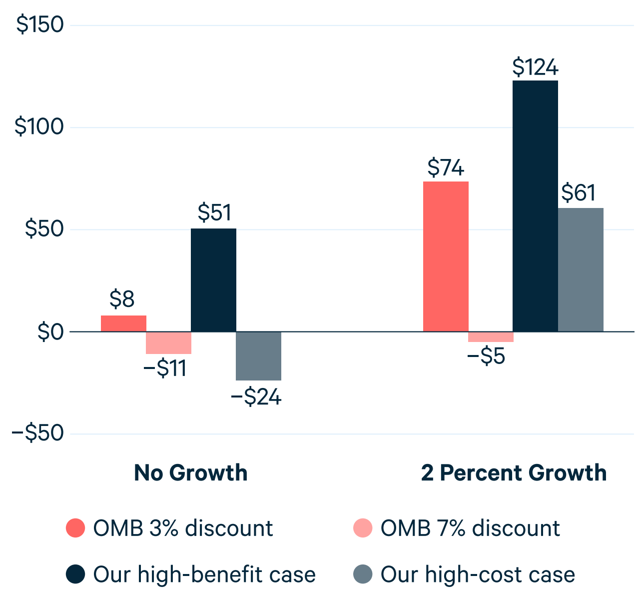
All of which leads to our suggestion that BCA focus solely on consumption rates, taking account of capital effects through sensitivity analyses that scale costs and benefits by the shadow price of capital.

The Two Approaches Compared, in Practice

Suppose for simplicity that a project reduces one ton of carbon dioxide at a cost of $25 today. That reduced ton of carbon dioxide yields $1 of environmental benefits every year forever. The OMB BCA approach would make two net benefit estimates, one based on 3 percent and one based on 7 percent. The $1 stream of benefits, discounted at 3 percent, would yield a $33 SCC, for a net benefit of +$8, but only a $14 SCC if discounted at 7 percent, for a net loss of −$11 (Figure 1).

With the approach we propose, we begin with the above 3 percent consumption rate and net benefits of $8 as a central case. The high-benefits case multiplies the $33 SCC estimate by a shadow price of capital, at most

Figure 1. Net Benefit Calculations: $25 cost today and $1 benefit per year forever (at 0 and 2 percent growth rates)



2.3, yielding a net benefit of +$51. The high-costs case multiplies the $25 cost estimate by 2.3 yielding a net benefit of –$24.

Our high-costs –$24 estimate exactly equals 2.3 times the OMB 7 percent –$11 estimate. The 7 percent estimate captures the idea that costs accruing to capital require higher benefits to break even (and in this case do not). But it fails to capture the idea that the costs themselves are higher. The fact that the two approaches are the same up to a multiple of 2.3 relates to the simplifying assumption that benefits extend in perpetuity.

The OMB approach does not consider the possibility that benefits, rather than costs, could accrue to capital. That is, we can relate our central estimate to OMB's 3 percent approach, and our high-costs estimate to OMB's 7 percent approach. There is no comparable estimate in OMB's approach to our high-benefits estimate of $51. In OMB parlance, the results suggest a discount rate lower than 3 percent. Put another way, there should be a corresponding third OMB estimate, based on something lower than the consumption rate to match this high-benefits case.

A more realistic climate benefit model would assume that benefits grow at some rate, say 2 percent, corresponding to economic growth. In that case, OMB's 3 percent SCC estimate would be $99 and its 7 percent estimate $20, leading to a net benefit range of –$5 to +$74. Our approach, focusing on 3 percent estimates and applying our preferred 1.5x shadow price alternately to costs and benefits, yields a $61-124 range—roughly centered on the 3% estimate and two-thirds as wide.[3]

Summary

Two discount rates, 7 and 3 percent, have been used to evaluate policies largely because of divergent views about whether a before-tax investment rate or an after-tax consumption rate is preferable. This, in turn, relates to whether a policy affects capital or consumption, particularly in terms of its costs. The choice has consequences for BCA over long horizons: the magnitude of the SCC falls by a factor of six to nine when 7 percent is used instead of 3 percent.

These divergent estimates are not, however, a correct application of basic economics. Instead of thinking about different discount rates to capture the possibility of capital or consumption effects, BCA needs a shadow price for capital and a focus on the consumption rate. It should also consider the possibility that benefits, as well as costs, may accrue to capital. Intuitively, benefits and/or costs should be scaled up if they affect capital, since market prices do not capture the social benefits from tax revenues generated from capital income.

Beyond a message to focus on consumption rates and the shadow price of capital, this is a strong caution against using the investment interest rate as a benchmark for discounting in BCA for projects with long horizons. Even when costs fall entirely on capital and benefits accrue to consumption, use of an investment rate will dramatically undervalue benefits relative to any plausible shadow price estimate applied to costs. In the extreme, benefits might fall by a factor of two, but not a factor of six to nine.

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3 In the paper underlying this issue brief, we estimate the social cost of carbon using our approach with a climate economy model (DICE). With our preferred shadow price of 1.5 for capital and a 3 percent consumption rate, we find the social cost of carbon ranges from $47 to $98. This would correspond to a range of discount rates from 2.7 to 3.4 percent in the OMB approach without the shadow price.

William Pizer is a senior fellow at RFF. Previously, he was the Susan B. King Professor at the Sanford School of Public Policy, Duke University. He is also a Research Associate at the National Bureau of Economic Research. His past and current research examines how we value the future benefits of climate change mitigation, how environmental regulation and climate policy can affect production costs and competitiveness, and how the design of market-based environmental policies can address the needs of different stakeholders.

This issue brief summarizes a study recently published in the *Journal of Environmental Economics and Management*:

Li, Qingran and William A. Pizer (2021). Use of the consumption discount rate for public policy over the distant future, *Journal of Environmental Economics and Management*, Volume 107.

An earlier version of the study is **available as an RFF working paper**.