Discounting the Distant Future:
A Critique of the EPA's Analysis of the Social Cost of Carbon

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Economic analyses of government policy must often combine policy effects that occur at different times into a single measure of social value. A payoff that occurs sooner generally carries greater weight than one that occurs later. The rate at which a payoff's social value declines with its distance from us in time is called the *social discount rate*.[1] This rate is a critical parameter of economic analyses. However, economists have long disagreed about its value, especially for analyses with long-term time horizons (Gollier and Hammitt 2014). These debates persist because economics alone does not offer any easy answers—the appropriate approach to social discounting depends on ethical judgments, such as how much value to place on people in future generations.

Social discount rates are crucial inputs to the decades-long literature in economics that attempts to estimate the social cost of carbon dioxide emissions ($SC\text{-}CO_2$)—i.e., the present value of future damages caused by emitting one additional ton of carbon dioxide now. US federal government agencies have used $SC\text{-}CO_2$ estimates in regulatory analysis since the late 2000s. Late last year, the Environmental Protection Agency (EPA) released its updated estimates of $SC\text{-}CO_2$. While the $SC\text{-}CO_2$ is often described as an "optimal carbon tax," the EPA designs its methodology for a different purpose—to enable an estimate of the benefits of emissions reductions in the (non-optimal) world in which we live. In principle, this $SC\text{-}CO_2$ helps policy makers to understand the social welfare impact of any policy that alters CO_2 emissions by a small amount. Since carbon dioxide emissions today will cause damages for centuries into the future, the EPA's approach to

discounting is a highly consequential input to its SC–CO$_2$ estimates and therefore its assessment of the climate benefits of federal regulations.

The EPA's SC–CO$_2$ analysis does not grapple with the complex, ethics-laden debate on social discounting; instead it takes a "descriptive" approach, which involves "inferring the discount rate from market rates of return." This commentary explains why the rationale for using market interest rates as social discount rates may not apply to policies with far-future effects. Indeed, most experts believe that a purely "descriptive" approach to discounting is insufficient to grapple with the inherent ethical issues raised by valuing costs and benefits far into the future (Drupp et al. 2018). The commentary also proposes an alternate approach that is consistent with US federal government guidance that regulatory analysis may recognize the "specific ethical considerations" involved in discounting far-future benefits and costs (White House 2023).

We sympathize with the EPA's predicament. It is one thing to say that ethical judgments should influence the choice of a social discount rate, but quite another to say exactly how this should occur. Federal agencies prefer to avoid the perception that their analyses are heavily influenced by ethical judgments, particularly when the analysis will be highly scrutinized and litigated. It is far easier to point to empirical data, even if those data do not speak directly to the question at hand. However, as the philosopher Michael Sandel cautions, "The deepest appeal of markets...is that they seem to spare us the need for messy, contentious debates about how to value goods. This is, in the end, a false promise. Banishing morally contested questions from public debate does not leave them undecided; it simply means that markets...will decide these questions for us" (Sandel 2022).

Rationale for the "Descriptive" Approach

For many private firms and economists, the default approach to discounting future payoffs is to use market rates of interest. Understanding the difficulties with this approach when applied to social decision-making at long time horizons requires understanding why interest rates are used as social discount rates at all.

The justification starts with imagining a hypothetical market economy where every "good" (i.e., product or some other item that satisfies a human want) is traded for delivery in every possible "state of the world" (i.e., scenario for how uncertain events could play out) and in every time period (Arrow 1964, Debreu 1959). Everyone gathers together to buy and sell everything they might ever need in any future time period. It is assumed that everyone takes the prices of goods as given, and chooses the best bundle of goods they can, given their preferences and budget. In such an idealized economy, consumers will buy and sell goods until relative prices of different goods emerge that reflect *all* consumers' willingness to exchange a unit of one good for a unit of another.

If prices reflect the relative value that people attach to different goods, that in principle can facilitate efforts to tally the benefits and costs of a public policy. The prices can be used to add up the value of the goods the policy uses (the "costs") and the value of the goods the project creates (the "benefits"), enabling a comparison of the costs and benefits.

Adding the dimension of time simply requires recognizing that a good delivered next year and the same good delivered today are effectively two different goods, with the former usually valued less than the latter. Interest rates reflect the difference between the price of the two goods.[2] This is the justification for using interest rates to adjust the value of otherwise equivalent costs and benefits for their occurrence at different dates, i.e., as social discount rates.

What's Wrong with the Descriptive Approach?

Objections to using market interest rates as discount rates in a long-term policy analysis fall into two categories: (1) claims that the assumptions in the model described above are oversimplified and unrealistic; and (2) claims that the approach is conceptually invalid.

The first category of objection accepts the premise that market prices are an appropriate basis for a social discount rate, but observes that the idealized economy described above—which assumes a market for every good in every time period and in every possible way the world could evolve—does not actually exist. In reality, active securities markets extend for at most a few decades, whereas climate change occurs over centuries. So, in many cases, the prices needed to deduce long-term discount rates using empirical data are not available.[3]

The EPA analysis attempts to sidestep this limitation by developing a model that links historical near-term "risk-free" interest rates (10-year Treasury bonds) with the preferences of a "representative" consumer. Technically, a simple model of consumers' preferences is "fit" to data on historical risk-free interest rates, and then the estimated relationship is extrapolated hundreds of years into the future, with the social discount rate evolving based on projections of economic growth over those centuries.

This approach has several problems, though. First, even if it were possible to estimate consumers' near-term preference parameters with data on longer-run market interest rates (which are not available), there is no guarantee they would be stable. Studies in behavioral economics suggest that people are more impatient about near-term events than about events in the distant future (Frederick et al. 2002), so estimating preference parameters based on comparatively short time horizons, and extrapolating these estimates to long maturities, may lead to overestimates of long-run discount rates.

A second problem is that when markets are incomplete (i.e., there is not a market for every good in every possible state of the world and at every future time), no one-to-one relationship exists between consumers' preferences and the observed prices of assets. On the contrary, there are *infinitely many* models of consumers' discounting behavior that are consistent with observed asset prices, and no empirical method can determine which would correctly price the securities that are not currently marketed (Cochrane 2009).

Finally, the descriptive approach, at least as it is currently operationalized by the EPA, fails to describe the prices of all observable asset classes. The EPA's analysis treats observations of risk-free interest rates as the only empirically relevant data for calibrating a model of consumers' preferences, while ignoring the many other risky asset classes that can be observed in the marketplace. A careful empirical analysis of the relationship between observed prices and consumers' preferences should not cherry-pick which asset classes are empirically relevant (i.e., 10-year Treasury bonds); rather, it should test the validity of its model of preferences for *all* assets. It is well known that the specific model of consumer preferences that the EPA uses performs poorly on this extended empirical task (Fama and French 2004, Hommol et al. 2023).

The second category of objections to the "descriptive" approach focuses on whether interest rates provide a conceptually valid metric for long-run social discounting. Even if the idealized economy described above existed, this would not be sufficient to establish that society as a whole should discount the future using market rates of interest. In fact, there are several reasons why a society might not wish to do so.

First, while market prices aggregate information about individuals' preferences and beliefs, they cannot aggregate the preferences of those who do not participate in exchange, i.e., people who are not yet alive. Future people would presumably be far more concerned about anticipated future outcomes than people living today, but the descriptive approach to discounting is biased toward the preferences of contemporary generations. From a certain narrow democratic perspective, it is possible to argue that this is as it should be: future generations, according to this view, are only relevant to the extent that current generations care about them. But governments arguably have a responsibility to adopt a more expansive view of their role as a steward of the well-being of *all* of their citizens, including those who are not yet with us.

Second, using market prices for far-future social discounting is only valid if policy makers are unconcerned with the differing effects of policies across different individuals, i.e., "distributional effects." If a small project has positive net benefits as computed using market interest rates to discount future payoffs, then it is theoretically possible for the "winners" from the project to compensate the "losers" and still have benefits left over. This criterion—known as the Kaldor-Hicks

"potential compensation test"—is frequently used to justify cost-benefit analysis that relies on market interest rates.[4] However, *potential* compensations that never transpire are not much use to those who suffer the negative consequences of a policy, and the idea that those most affected by far-future climate damages will actually be compensated strains credulity. In addition, it has been known since the 1970s that using the potential compensation test to rank social outcomes can give rise to unpalatable inconsistencies that arguably render this test intellectually incoherent (see Blackorby and Donaldson 1990 for a review).

Therefore, if policy makers are more concerned about a cost that falls on the poor than they are about an equivalent cost that falls on the rich, cost-benefit analysis must explicitly account for social concerns regarding inequalities, and these concerns are not factored into market prices (i.e., interest rates). Governments clearly do have these concerns; they are the basis for the progressive tax systems adopted the world over, including in the United States. Their omission from the descriptive approach arguably undermines the rationale for using market prices alone to value a policy's effects (Millner and Heal, forthcoming).[5]

Discounting with Explicit Ethical Judgements

The use of market interest rates is a convenient shortcut for social discounting because market data is widely available. However, as discussed above, there are several reasons to be skeptical of the claim that markets tell us what we need to know when discounting far-future effects. The alternative is to return to first principles and consider a benign "social planner" (i.e., a hypothetical decision maker for a society) whose preferences reflect the considered objectives of society, particularly with respect to time. Although this may seem a somewhat fanciful construct, the reality is that governments routinely make implicit or explicit judgments about the appropriate distribution of goods and services among people of different incomes, demographic characteristics, and of course ages. The purpose of the social planner framework is to provide a rigorous formal scaffolding for debating such judgements and examining their quantitative implications for social discount rates.

There are at least four core issues that must be addressed when specifying a model of social discounting with explicit ethical judgements: (1) social impatience, i.e., whether current generations should receive more weight than future generations; (2) aversion to consumption inequality, i.e., how much one dislikes differences in consumption between people alive at different times; (3) uncertainty, i.e., how much one is willing to sacrifice to reduce aggregate economic risks; and (4) population, i.e., whether and to what extent one is willing to sacrifice individuals' well-being to achieve a larger total population.

Each represents a complex issue requiring serious inquiry and ethical judgments, but for the

purposes of this commentary we focus on social impatience. This will be sufficient to illustrate the ethical disagreements that arise when choosing social discounting rates.

The parameter of a social planner's preferences that captures social impatience is called the Pure Rate of Social Time Preference (PRSTP). In the standard approach to measuring intergenerational social welfare, each generation is assigned a well-being value (which depends on the goods and services it consumes) and a weight that depends on their temporal distance from the present. These weighted well-being values are then summed across generations to produce a measure of total intergenerational well-being. The PRSTP is the rate at which the weight on future generations' well-being declines with their distance from us in time.[6] Any positive PRSTP value leads to substantial differences between the importance assigned to the well-being of current versus distant future generations.

Scholars who pursue the ethical approach to discounting frequently argue for a PRSTP that is either zero or near zero. For example, almost a century ago, Ramsey (1928) initiated this debate by arguing that "discounting future [well-beings] is ethically indefensible and arises purely from a weakness of the imagination." Nobel laureate Robert Solow (2000) agreed, saying: "there is no excuse for treating generations unequally." In other words, an ethical social planner, according to this view, should not place less value on the well-being of future generations simply based on their birth date.

Given the importance of valuing far-future effects to an analysis of climate damages, it should be no surprise that climate-focused scholars have arrived at similar conclusions. For example, Lord Nicolas Stern argued that straying from a near-zero PRSTP "is not a position which has much foundation in ethics and which many would find unacceptable" (Stern 2007).

Assuming a near-zero PRSTP leads to valuations of far-future effects that are vastly different than those arrived at through a descriptive approach to discounting. After all, in private decisions about their own consumption, which ultimately determine market interest rates, people do act impatiently. The descriptive approach arguably conflates private impatience related to one's path of lifetime well-being with social impatience related to the well-being of different generations.

Critiques of a Zero Pure Rate of Social Time Preference

While scholars who favor a zero PRSTP highlight the desire to give equal treatment to all generations, others have argued that the ethical obligation to help others depends in part on the closeness of relationships (Chatterjee 2003). In a temporal context, this argument suggests placing more value on the generation of one's children than that of one's grandchildren.

Perhaps even more common are arguments against a zero PRSTP that do not highlight the unequal treatment of different generations as a desirable assumption, but rather focus on the assumption's *implications* for an intergenerational economic analysis. With no social impatience and with the ability to grow resources by investing for tomorrow instead of consuming resources today, an analysis that simply maximizes wealth across generations may ask current generations to impoverish themselves so that future generations can be a bit wealthier. Moreover, this may be asked of every generation, i.e., each generation is ordered to impoverish itself for the future, with the result that none benefits from the beneficence of their ancestors. The Nobel Prize–winning economist Tjalling Koopmans referred to this phenomenon as the "paradox of the indefinitely postponed splurge" (Koopmans 1969). A related conundrum is that when the PRSTP is zero, the current generation is required to accept arbitrarily large reductions in its own well-being in exchange for an arbitrarily tiny increase in the well-being of all future generations.

Even Ramsey, though he argued forcefully for a zero PRSTP, acknowledges toward the end of his pathbreaking article that the "rate of saving which [a model with a zero pure rate of time preference] requires is greatly in excess of that which anyone would normally suggest" (Ramsey 1928).

These properties of social evaluations with zero PRSTP have struck many economists as intolerable. Another Nobel laureate, Kenneth Arrow, summarized the problem as follows: "the strong ethical requirement that all generations be treated alike, itself reasonable, contradicts a very strong intuition that it is not morally acceptable to demand excessively high savings rates of any one generation, or even of every generation" (Arrow 2013). Arrow concluded that current generations are justified in putting less weight on the well-being of future generations.

Disagreement among Economists

The discussion so far has suggested that while there may be valid justifications for the use of interest rates as a social discount rate in certain situations, these justifications likely fail for far-future effects such as climate damages. And when determining a social discount rate with explicit ethical judgments, two plausible ethical principles may be in conflict: that all generations should be given equal weight, and that no generation should be expected to make great sacrifices for others.[7] As Dasgupta (2008) noted, "intergenerational welfare economics raises more questions than it is able to answer."

Of course, reasonable minds may disagree about how to trade off reasonable principles. For this reason, there are seemingly irreconcilable differences in opinion about the appropriate values of social discount rates, even in a population as homogeneous as academic economists who have published papers on the topic.

In a survey of social discounting experts on their preferred values of the social discount rate and the PRSTP (Drupp et al. 2018), only a small minority (5 percent) of respondents believed that market data *alone* are sufficient for choosing a discount rate for *long-run* policy analysis. Most experts believe that a descriptive approach to discounting is insufficient to grapple with the inherent ethical issues raised by valuing costs and benefits far into the future. The vast majority of experts support using both descriptive data and ethical judgments to develop a discounting approach. As Millner and Heal (forthcoming) note, the variation in preferences reflected by the survey is extraordinary: individuals differ in their estimates of the value of a payoff 100 years from now by a factor of 500,000.

Survey results confirm what intuition and common sense might suggest: one cannot expect agreement on how to select social discount rates. The tradeoffs involved reflect personal ethical judgments, which, even if made in good faith, may lead different thinkers to different conclusions. This situation is not dissimilar to many other ethical judgments policy makers must make, such as the degree of progressivity of the tax system or the extent of the social safety net.

A Pathway to a Resolution?

If neither a descriptive approach based on market interest rates nor an approach that seeks to single out "best" values for ethical judgments is fully convincing, the debate should evolve from what the "right" discount rate is to how to cope with irreconcilable disagreements in a structured and methodical way.

This situation is precisely the one described by Arrow in his seminal 1951 book Social Choice and *Individual Values*, in which he considered a divided society that needs to make a decision and must find a way of combining differing individual values and perspectives into a social choice or outcome (Arrow 2012). Arrow's original findings are often seen as pessimistic: taken at face value, his "impossibility theorem" suggests that social decision rules cannot satisfy all of the seemingly reasonable properties one might require of them.[8]

Fortunately, we have 70 years of subsequent research that has built on, refined, and clarified Arrow's original contribution. For example, Millner and Heal (2018) showed that the combination of iterative voting with anticipation of the outcomes of future votes suggests the implementation of the median opinion about the PRSTP, which is 0.5% in the Drupp et al. survey.[9] In contrast, by adjusting a traditional evaluative metric (the "Pareto property") so that it reflects the preferences of *all* generations, Feng and Ke (2018) recommended a PRSTP that is strictly lower than that recommended by any individual ethical theory under consideration today. Indeed, the finding that aggregating across diverse ethical viewpoints leads to low long-run discount rates is common to most social

choice methods that have been proposed in the academic literature (Millner & Heal forthcoming).

The spirit of the social choice literature—of finding an acceptable process for aggregating a range of irreconcilable views—is in principle directly applicable to the problem at hand. In its recent study, the EPA presents nine different SC-CO$_2$ estimates for each year, including three different social discount rates. Instead of using a purely descriptive approach to specify these discount rates, the EPA could have used existing survey data on the ethical inputs to social discount rates, and a handful of select preference aggregation methods, to present a range of estimates. This approach would reflect the diversity of views on ethical matters, and also take a pragmatic approach to reconciling them into coherent policy evaluation frameworks.

Following the publication of the EPA's SC-CO$_2$ study, the White House released updated proposed guidance for economic analyses of US federal regulations. While similarly focused on a "descriptive" approach to social discounting, the new guidance recognizes that "special ethical considerations" arise when discounting far-future benefits, and that these considerations call into question the appropriateness of grounding discount rates on the preferences of current market participants alone. The EPA and other federal agencies can take advantage of this flexibility to move away from the purely descriptive approach to discounting (White House 2023).

Conclusion

We have argued that some important inputs to long-run discount rates are inherently ethical in nature—they cannot be elicited from the private attitudes of market participants toward their own consumption. Unfortunately, recognizing this also requires us to acknowledge that ethical questions tend to admit a variety of reasonable viewpoints. It is a difficult, but not insurmountable, problem to move from this plurality of opinions to the kind of quantitative framework that the EPA needs for its policy evaluations.

As argued above, the descriptive approach has numerous limitations that should make us cautious of policy conclusions that rely heavily on this method. Instead of forcing the inherent ethical issues associated with choosing long-run discount rates into the straightjacket of a rather simplistic empirical analysis, it may be better to acknowledge the true nature of the questions at hand and confront them head on. Doing so raises its own challenges, particularly in regard to coping with ethical disagreements, but the academic community has already supplied us with workable tools for dealing with these disagreements and moving beyond them. The EPA may have missed an opportunity to shift the debate toward these questions and provide leadership on them.

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Notes

1. A social discount rate is used to value future benefits and costs to society, whereas a private discount rate is used to value future benefits and costs to individuals. The social discount rate is therefore the appropriate concept for governments in benefit–cost analysis of public policies.

2. The prices in question here are "real" rather than "nominal," i.e., price differences are computed net of inflation. Inflation plays no role in discussions of social discounting because the analysis is concerned with the goods people can consume and not how much these goods cost in nominal dollars.

3. While clever empirical strategies can partially alleviate this difficulty (e.g., Giglio et al. 2015, 2021), they can at most deduce bounds on interest rates for certain risky asset classes (e.g., real estate); they cannot be used to deduce interest rates on assets in other risk classes or on "risk-free" assets, without (contestable) auxiliary assumptions. For example, as there is no liquid market in risk-free bonds with maturities beyond, say, 50 years, there is no way of knowing how the market would price risk-free payoffs at, say, 100 or 200 years in the future. These long time horizons are critical for the analysis of climate policy.

4. In addition to its reliance on market prices, the Kaldor-Hicks potential compensation criterion has the advantage of not requiring assumptions about how to make interpersonal comparisons of well-being.

5. An alternative to explicitly accounting for these distributional concerns in cost-benefit analysis is to value projects using the potential compensation test, but then use the income tax system to address any social inequalities that arise. This requires a careful accounting of the distributional consequences of government projects as well as integrating these consequences into a computation of individuals' net incomes when it comes time to decide on tax obligations. This is not a practical way to proceed in most cases, as project valuation exercises are most often done independently from tax collection agencies.

6. In the standard formulation, the social planner's preferences are represented as a weighted sum of a well-being measure for each generation, from now into the indefinite future. Usually, the weight on future generations in this sum is modeled as an exponentially declining function of their temporal distance from the present. The PRSTP is the rate at which the weight attached to the well-being of a generation that lives t years in the future declines with t. Somewhat confusingly, the PRSTP rate is also sometimes referred to as a "utility discount rate," to distinguish it from the consumption discount rate, i.e., the rate at which the social value of a unit of consumption declines over time. The PRSTP is just one input to the consumption discount rate,

which is ultimately what is used to compute social cost of carbon estimates. As mentioned above, a comprehensive overview would cover the other important inputs to consumption discount rates that rely on explicit ethical judgments, such as the relative value of a unit of consumption to a rich person compared to a poor person—i.e., the "diminishing marginal utility of consumption" (Milner and Heal, forthcoming).

7. Those familiar with the relevant economic literature should not be surprised by this finding. Diamond (1965) showed that, to simplify somewhat, it is impossible for a planner to give equal weight to all generations and satisfy the "Pareto principle," which states that society is better off if every generation is no worse off and at least one generation is better off. Diamond's results show that a benign planner will inevitably violate one of these reasonable criteria.

8. A central difficulty is that, under standard assumptions, desirable properties of social decision rules seem again to be in conflict (Jackson and Yariv, 2015). The properties in question in this case are the desire to make choices that are time consistent (i.e., the rankings of plans do not change merely because of the passage of time), the Pareto principle, and the requirement that no single individual be elevated to the status of a dictator.

9. In addition, expanding the Pareto principle to account for the opinions of all generations, not just those people who happen to be alive today, allows us to overcome time inconsistency problems (Feng and Ke, 2018). Finally, Millner (2020) showed that we need not even agree on a decision rule for aggregating individual opinions in order to get agreement on long-run social discount rates. All that is required is a little normative humility—ethical agents should admit the possibility of a change in their idiosyncratic normative views in the future, and give a little weight to the views of their possible "future selves" when forming their current views about how to evaluate social welfare. Millner showed that even if everyone does this completely idiosyncratically, normative humility will cause everyone to agree on long-run discount rates.

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