YALE LAW & POLICY REVIEW

Climate Change and Discounting the Future:
A Guide for the Perplexed

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INTRODUCTION

What should be done about climate change? The debate is notoriously complex, involving a mix of difficult and uncertain science, the potential restructuring of the energy, agricultural, and forestry sectors across the globe, as well as issues of national sovereignty, distributive justice, corrective justice, and development. Specialists intensely disagree about the central issues—the types of policies that are best, the level of resources to be devoted to the problem, and which nations should pay.[1] Many of these disagreements are beginning to play a role in domestic law,[2] and they may well arise in the context of judicial interpretation of many environmental statutes.

When readers pick up two of the most prominent recent books on these topics, one by Sir Nicholas Stern written for the UK government, and one by American economist William Nordhaus, they find dramatically different recommendations.[3] Stern argues for an immediate and dramatic response, with a very high carbon tax imposed immediately and increasing rapidly over time. The issue, according to Stern, is urgent. Nordhaus also favors an international agreement, but he recommends modest and slow changes. In his view, rapid changes impose costs that are far too large relative to the benefits, and he prefers a slow but steady change in the energy supply system. As a result, Nordhaus

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1.   A good overview can be found in JOHN HOUGHTON, GLOBAL WARMING: THE COMPLETE BRIEFING (3d ed. 2004).

2.   *See, e.g.*, Massachusetts v. EPA, 549 U.S. 497 (2007).

3.   WILLIAM NORDHAUS, A QUESTION OF BALANCE: WEIGHING THE OPTIONS ON GLOBAL WARMING POLICIES (2008); NICHOLAS STERN, THE ECONOMICS OF CLIMATE CHANGE: THE STERN REVIEW (2007). Partha Dasgupta offers a similar comparison of the Stern and Nordhaus contributions. Partha Dasgupta, *Discounting Climate Change*, 37 J. RISK & UNCERTAINTY 141, 143 (2008).

argues in favor of a relatively low carbon tax. What is the policy analyst to conclude? What accounts for these differences? These questions will ultimately bear on both domestic and international choices; they might also be litigated in federal court.[4]

Both authors, it turns out, make the same basic assumptions about the effects of climate change, about the structure of economic systems, and about most other parameters that might affect the debate.[5] The major difference is one that at first seems entirely technical: The proper computation of the discount rate, which, as we will discuss, is simply the rate one uses to match cash flows in different periods. Stern argues for a low discount rate, while Nordhaus argues for a high one. Both authors recognize this difference as the major reason for their radically disparate recommendations. The resulting debates about the proper method of discounting have been heated, with Stern finally accusing Nordhaus and others of plain ignorance.[6] It is clear that decisions about the proper response to climate change will turn, in significant part, on resolution of this debate.

In this Essay, we explore the issue of discounting in the context of climate change. The central problem is that if the world cuts emissions immediately, the beneficiaries of its action will be people living decades from now, not people living today. By contrast, the costs of emissions reductions will be paid mostly by current generations. At the core of the climate change problem, then, is an ethical debate involving the allocation of resources across generations. Defenders of

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4.   The appropriate discount rate has become an issue in several cases. For a slightly dated but helpful overview, see Edward R. Morrison, Comment, *Judicial Review of Discount Rates Used in Cost-Benefit Analysis*, 65 U. CHI. L. REV. 1333 (1998).

5.   The major difference between the two models, other than the discount rate, is Stern's greater attention to worst-case scenarios and risk. Nordhaus conducts sensitivity analyses in his model to obtain a sense of how changes in parameters affect the results, but he does not incorporate risk in any systematic way. Stern's model incorporates risk more robustly. Stern also applies discounting in a nonstandard (and impossible to justify) way; he discounts the costs of reducing emissions over the next fifty years but discounts the benefits over several hundred years. *See, e.g.*, John P. Weyant, *A Critique of the* Stern Review's *Mitigation Cost Analyses and Integrated Assessment*, 2 REV. ENVTL. ECON. & POL'Y 77 (2008) (discussing Stern's calculations of the costs of reducing emissions). We focus here on the disagreement over discount rates and ignore Stern's unusual application of discounting. A final important difference between Stern and Nordhaus is that Stern, at the end of the day, abandons economic analysis in favor of the intuition that concentrations of carbon dioxide over 550 parts per million impose an excessive risk on humanity. Nordhaus maintains a consistent economic analysis throughout his model.

6.   Nicholas Stern, *The Economics of Climate Change*, 98 AM. ECON. REV. 1, 12 (2008). Nordhaus and others have responded to Stern's claims in the academic literature. *See* William D. Nordhaus, *A Review of the* Stern Review on the Economics of Climate Change, 45 J. ECON. LITERATURE 686 (2007); Martin L. Weitzman, *A Review of* The Stern Review on the Economics of Climate Change, 45 J. ECON. LITERATURE 703 (2007).

discounting argue that it is necessary to ensure consistent comparisons of re-sources spent in different time periods. Critics of discounting begin with a prin-ciple of intergenerational neutrality. They insist that people in the current gen-eration should not be treated as more valuable than people in the next generation. In short, they object that discounting ensures that future genera-tions will receive less attention, and perhaps far less attention, than those now living.

Discounting has generated a massive literature with strong views on various sides of the issue.[7] Although there are many subtleties and complexities in these arguments, we break down the basic positions into two camps: the positivists

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7. For a small sampling, see THOMAS STERNER & U. MARTIN PERSSON, AN EVEN STERNER REVIEW: INTRODUCING RELATIVE PRICES INTO THE DISCOUNTING DE-BATE (2007); Kenneth J. Arrow, *Discounting, Morality, and Gaming, in* DISCOUNT-ING AND INTERGENERATIONAL EQUITY 13 (Paul R. Portney & John P. Weyant eds., 1999); Kenneth J. Arrow, *Discounting and Public Investment Criteria, in* WATER RESEARCH 13 (Allen V. Kneese & Stephen C. Smith eds., 1966) [hereinafter Arrow, *Discounting and Public Investment Criteria*]; K.J. Arrow et al., *Intertemporal Eq-uity, Discounting, and Economic Efficiency, in* CLIMATE CHANGE 1995: ECONOMIC AND SOCIAL DIMENSIONS OF CLIMATE CHANGE 125 (James P. Bruce et al. eds., 1996) [hereinafter Arrow, *Intertemporal Equity*]; John Broome, *Discounting the Future*, 23 PHIL. & PUB. AFF. 128 (1994); Partha Dasgupta et al., *Intergenerational Equity, Social Discount Rates, and Global Warming, in* DISCOUNTING AND INTER-GENERATIONAL EQUITY, *supra*, at 51; Geoffrey Heal, *Discounting: A Review of the Basic Economics*, 74 U. CHI. L. REV. 59 (2007) [hereinafter Heal, *Discounting*]; Geoffrey Heal, *Intertemporal Welfare Economics and the Environment, in* 3 THE HANDBOOK OF ENVIRONMENTAL ECONOMICS 1106 (Karl-Göran Maler & Jeffrey R. Vincent eds., 2005) [hereinafter Heal, *Intertemporal Welfare Economics and the Environment*]; Louis Kaplow, *Discounting Dollars, Discounting Lives: Intergenera-tional Distributive Justice and Efficiency*, 74 U. CHI. L. REV. 79 (2007); Robert C. Lind, *Analysis for Intergenerational Discounting, in* DISCOUNTING AND INTERGEN-ERATIONAL EQUITY, *supra*, at 173; Robert C. Lind, *Intergenerational Equity, Dis-counting, and the Role of Cost-Benefit Analysis in Evaluating Global Climate Policy*, 23 ENERGY POL'Y 379 (1995); Robert C. Lind, *A Primer on the Major Issues Relating to the Discount Rate for Evaluating National Energy Options, in* DISCOUNTING FOR TIME AND RISK IN ENERGY POLICY 21 (Robert C. Lind ed., 1982) [hereinafter Lind, *A Primer on the Major Issues*]; Nordhaus, *supra* note 6; Ari Rabl, *Discounting of Long-Term Costs: What Would Future Generations Prefer Us To Do?*, 17 ECOLOGI-CAL ECON. 137 (1996); Dexter Samida & David A. Weisbach, *Paretian Intergenera-tional Discounting*, 74 U. CHI. L. REV. 145 (2007); Thomas C. Schelling, *Intergen-erational and International Discounting*, 20 RISK ANALYSIS 833 (2000); Thomas C. Schelling, *Intergenerational Discounting*, 23 ENERGY POL'Y 395 (1995); Cass R. Sun-stein & Arden Rowell, *On Discounting Regulatory Benefits: Risk, Money, and Inter-generational Equity*, 74 U. CHI. L. REV. 171 (2007); Weitzman, *supra* note 6; Martin L. Weitzman, *Why the Far-Distant Future Should Be Discounted at Its Lowest Pos-sible Rate*, 36 J. ENVTL. ECON. & MGMT. 201 (1998) [hereinafter Weitzman, *Lowest Possible Rate*].

and the ethicists.[8] The positivists generally defend discounting at the market rate of return on the theory that only by evaluating projects at the market rate can we ensure the projects are worthwhile. If a project produces less than the market rate of return, there is a better return available by simply investing in the market. We should not, argue the positivists, invest in a project (such as reducing carbon emissions) unless the returns are as good as opportunities available elsewhere. The positivist argument is of course acceptable only if it can be justified in ethical terms; positivists argue that it can be so justified.

The ethicists respond that the positivist approach is morally indefensible and unjust, because it grossly undervalues the future in violation of a principle of intergenerational neutrality. In particular, it is easy to show that using any modest level of discounting, future generations count for essentially nothing. The destruction of Florida through sea level rise in 200 years, for example, turns out to matter very little in a cost-benefit analysis that relies on discounting. This cannot be correct and, at its most fundamental level, violates the principle of intergenerational neutrality by treating the welfare of people who live in the future as far less important than the welfare of people who live in the present.

Our more modest goal is to explain exactly what separates the two sides— to provide a kind of primer, or consumers' guide, for an unusually complex disagreement. Our more ambitious aim is to sort out the competing arguments. We argue that the two sides are addressing essentially different issues. The ethicists are concerned about the overall distribution of welfare and resources across generations. They are correct to insist that the consequences of climate change raise important distributional issues and that future generations are at serious risk in a way that might violate the ethical obligations of the current generation. Given present understandings of the likelihood of bad or even catastrophic effects from climate change,[9] those who are now living need to address whether they are imposing excessive risks on their descendents. We also agree, and will show, that cost-benefit analysis with discounting can produce outcomes that are not easy to defend.

We will argue, however, that this concern about intergenerational justice is separate from the issue addressed by the positivists.[10] Positivists are considering

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8.   To our knowledge, these terms are our own. A chapter of the 1996 Intergovernmental Panel on Climate Change (IPCC) report on climate change uses similar terms, referring to the basic positions as descriptive and prescriptive. Arrow, *Intertemporal Equity*, *supra* note 7, at 131-33; *see also* Sunstein & Rowell, *supra* note 7, at 177-78 (explaining descriptive and prescriptive approaches).

9.   *See, e.g.*, Martin L. Weitzman, *Structure Uncertainty and the Value of Statistical Life in the Economics of Catastrophic Climate Change* (AEI-Brookings Joint Ctr. for Regulatory Studies, Working Paper No. 07-11, 2007), *available at* http://www.aei-brookings.org/publications/abstract.php?pid=1196.

10.   We and others have defended this position in previously published articles. *See, e.g.*, Kaplow, *supra* note 7, at 79 ("[Q]uestions of intergenerational distributive justice and of intergenerational efficiency are substantially distinct in principle."); Samida & Weisbach, *supra* note 7, at 145 ("[D]iscounting future costs and benefits

the choice of projects for any given decision about how much each generation should get, but they do not address at all the amount each generation should receive. That is, the ethicists are concerned with distribution, and the positivists are concerned with efficiency. Because we can redistribute across generations not merely through emissions reductions, but in many other ways, (e.g., simply saving more) these two concerns can be separated. The best way for the current generation to help posterity might be through reducing emissions; however, it might be through other methods, including approaches that make posterity richer and better able to adapt.[11]

To illustrate, suppose that the ethicists convince us that the consequences of climate change are such that far more needs to be done for and left to the future. If we thought our legacy was appropriate before learning about the effects of climate change, an understanding of climate change means that we need to adjust that view. If we need to leave more to the future, however, the positivists are correct to point out that we should choose projects by evaluating them at the rate of return otherwise available: the market rate of return. Because we can always invest at the market rate rather than in the project being evaluated, any decision to save for the future by investing in a lower-return project wastes resources. To be sure, if we save more for the future, the market rate of return will decrease, so there is an interaction between the two effects. But as we begin the project of saving more for the future, each project needs to be evaluated at the market rate of return *at that time*.

Although we recommend discounting at the market rate of return when evaluating climate change policy, we accept the principle of intergenerational neutrality.[12] In particular, we agree that if cost-benefit analysis with discounting imposes serious harms on members of future generations, then there is indeed a serious ethical problem. The solution is not, however, to refuse to discount. It is to adjust overall savings and investment rates. As we shall also show, a refusal to discount can, under reasonable assumptions, harm rather than help members of future generations by depriving them of the benefits of current investments. Our conclusion, then, is that discounting is appropriate and ethically justified.

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of projects does not undervalue future generations."); Sunstein & Rowell, *supra* note 7, at 198 ("A refusal to discount, often justified as a way of assisting the future, is a singularly crude way of attempting to fulfill our obligations to future generations.") (footnote omitted). In this Essay, we aim to defend the position further and to address the concerns of various ethicists with whose arguments we have not previously dealt. *See, e.g.,* STERN, *supra* note 3, at 46-51; Heal, *Discounting, supra* note 7.

11.   We express no views here on the underlying merits of various policies, such as whether the return on investments in emissions reduction is higher or lower than the return on alternative investments. The discussion in the text is merely illustrative.

12.   *See* JOHN RAWLS, A THEORY OF JUSTICE (2d ed. 1999) (offering one understanding and defense of the principle of intergenerational neutrality); CASS R. SUNSTEIN, WORST-CASE SCENARIOS (2007) (presenting applications to risk regulation).

Moreover, when cost-benefit analysis with discounting produces indefensible results, the response should be, not to refuse to discount, but to take more direct steps to help members of future generations.

In short, the defenders and critics of discounting are simply talking past one another, and careful examination of their views show that their positions are not inconsistent. Instead, each emphasizes different aspects of the problem. One of our goals here is to show where, and when, those different aspects deserve attention.

Part I reviews the basic mathematics of discounting and explores why it makes sense in the normal context of a person making investment decisions. Part II considers the arguments for and against extending this logic to the intergenerational context presented by climate change. Part III discusses our proposed resolution of the problem. Part III also considers objections, including the argument that discounting entails valuing lives or the welfare of individuals living in the future differently. We show that this argument confuses the valuation of lives with the problem of discounting; we argue for discounting money, not lives.

I. WHY DISCOUNT?

In this Part, we outline the basic fundamentals of discounting as they might be applied to an individual's allocation decisions as well as generations making distributional choices over longer time horizons.

A. The Basic Problem

The basic problem addressed by discounting is that the costs and benefits of spending resources to reduce the effects of climate change occur at different times. To prevent significant harms, we must begin spending sizable resources in the near future. The benefits of these expenditures, however, will be enjoyed over the next several hundred years in the form of reduced effects from climate change. This is due to two factors.[13] The first is that carbon dioxide and other greenhouse gases have very long lives in the atmosphere.[14] Emissions today will increase concentrations of greenhouse gases long into the future. They cannot

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13.   For a helpful summary, see RICHARD A. POSNER, CATASTROPHE: RISK AND RESPONSE (2004).

14.   The lifetime of carbon dioxide in the atmosphere, unfortunately, is not well defined because it depends on the availability of land and ocean sinks. See INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS, CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 824-25 (2007). According to the IPCC, under current conditions, "more than half of the CO_2 emitted is currently removed from the atmosphere within a century." About 20%, though, "remains in the atmosphere for many millennia." Id. at 824. The rate of removal will slow as land and ocean sinks are depleted.

be undone with any currently available or foreseeable technology. The second is that the climate system has significant inertia. It takes a substantial period of time before the effects of emissions are felt. This means that, even if the world were to cease emitting greenhouse gases immediately, prior emissions would continue to have an effect on the climate in the future. Similarly, current and future emissions will have effects over long periods of time. In short, emissions of greenhouse gases today hurt future people. Correspondingly, reductions in emissions today help future generations through reduced fluctuations in the climate. Different people, living hundreds of years apart, will pay the costs and receive the benefits of reducing greenhouse gas emissions.

For short-term projects where the costs and benefits occur in different but relatively proximate periods, it is standard to discount the costs and benefits to a single period. Suppose that one has $100 and is presented with a $100 investment that will produce $110 in two years. She can choose to spend the $100 today or make the investment and spend $110 in two years. The individual should not simply choose $110 on the ground that $110 is larger than $100. Instead, she should use discounting to compare the two choices.

To see why, suppose that the individual has an alternative choice: putting the money in a bank account, which will pay interest at 6%. If she places the $100 in the bank instead of making the investment, she would have $112.36 after two years. Therefore, she should not make the investment. Doing so would leave her worse off than the alternative. An equivalent procedure for making this comparison is to discount the investment returns by the interest rate. If the *discounted* flow is more than $100, the investment makes sense and if not, it does not. To discount, simply divide each cash flow by $(1 + r)^n$ where r is the interest rate and n is the number of years. Here, the present value of $110 when the interest rate is 6% is about $98 ($110/1.06^2 = $97.90), which is less than $100.

Discounting is best seen as a way of taking opportunity costs into account. The opportunity cost of making the investment in this example was the alternative return available by putting the money in the bank. Using our numbers, the opportunity cost was higher than the return on the investment. If the bank paid interest at 4%, however, the opportunity cost would be lower, and, in this case, the investment would make sense ($110/1.04^2 = $101.70).

Central to this analysis is the fact that alternative means of shifting resources across time existed—in our example, a bank account. With the bank account, the individual could choose $100 today or $112.12 in two years, but in no event should she choose $110 in two years. If she were Robinson Crusoe and had no other investment choice, that is, no way of shifting resources across time periods by borrowing or saving, the opportunity cost of the investment would be zero, and the decision would be between $110 in two years and $100 today. She might still prefer $100 today because she has to eat, but she would no longer look to the opportunity cost to decide. We will return to this point at the end of the Essay. The ethicists are, in a sense, claiming that the world is like Robinson Crusoe's with respect to climate change: We have to decide how much to have in each period without reference to opportunity costs. The positivists claim that

we have the option of the market, so we must take opportunity costs into account.

B. Future Generations and the Arc of Time

One key question is whether this same logic can be applied over very long time periods (perhaps 200 years or more), especially when the costs and benefits are spread across generations rather than a single individual. Discounting, then, is no longer simply about an individual spreading consumption over her lifetime. Instead, it is about comparing the welfare of different individuals. Does the same logic apply?

It is clear that discounting can have profound effects on policy choices that have long time horizons. For example, suppose that as a result of climate change, we face losing $1 trillion in 100 years. If the discount rate is 7%, we would be willing to spend only a little over $1 billion—one one-thousandth of the damages—to prevent that harm! If the time horizon were 200 years—a span well within climate change policy considerations—at a 7% discount rate, we would be willing to spend only about $1.3 million, or 0.00013% of the future cost, to prevent it. Using these numbers, it is easy to construct examples where it is not desirable to spend a small amount of money today to save some valuable asset or large number of people in the future. On ethical grounds, many people are skeptical about the conclusions seemingly required by discounting the future benefits of reductions in climate change.

We have noted that, because of the potentially profound effect of discount rates, these figures are central to major disagreements over climate change policy. As we have also noted, almost the entire difference between the influential recommendations of Stern and Nordhaus is driven by the discount rate assumptions used by the authors.[15] Stern discounted future costs and benefits at 1.4%,[16] while Nordhaus discounted them at 5.5%.[17] A 1.4% discount rate would value a cost in 100 years almost 53 times as highly as would a 5.5% discount rate. If the harm occurs in 200 years, the Stern approach would value it almost 2,800 times as much as the Nordhaus approach. If most of the costs of climate change occur in the distant future, the discounting assumption would lead Stern to view climate change as a far more critical problem than Nordhaus does. To confirm that this was the primary difference in the two approaches, Nordhaus ran his computer model using Stern's discount rate. The results with this change echoed Stern's recommendations. To an approximation, discount rates were all that separated the authors' positions.[18]

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15. See supra notes 5-6 and accompanying text.

16. NORDHAUS, supra note 3, at 178.

17. Id. at 61.

18. See id. at 165-91; see also Chris Hope, The Marginal Impact of CO_2 from PAGE2002: An Integrated Assessment Model Incorporating the IPCC's Five Reasons for Concern, 6 INTEGRATED ASSESSMENT 19 (2006).

While we highlight these two recent books as examples, analysts have long recognized that discount rates are among the central parameters in evaluating the effects of climate change and that the decision about the appropriate response depends on resolving the debate. The Intergovernmental Panel on Climate Change (IPCC), for example, estimates that discount rates are the second most important factor in evaluating the effects of climate change. The IPCC rates the effect of climate sensitivity (the average global temperature change due to a doubling of the concentration of CO_2 in the atmosphere) as the most important factor. If this factor is scaled at 100, discounting would have a value of 66, while estimates of the valuation of the economic impact from a 2.5 degree increase in temperature are valued at 32.[19]

The debate on discounting began long before climate change was an issue. In 1928, Frank Ramsey famously argued that "it is assumed that we do not discount later enjoyments in comparison with earlier ones, a practice which is ethically indefensible and arises merely from the weakness of the imagination."[20] Roy Harrod argued that discounting is "a polite expression for rapacity and the conquest of reason by passion."[21] Nobel laureate Tjalling Koopmans argued, however, that a failure to discount effectively means that the current generation must starve itself to benefit the future.[22] Suppose that, in ethical terms, we must act to maximize total welfare and that a dollar invested grows at a positive rate for the indefinite future. If we do not discount, the future gains from the investment dollar will also be worth infinitely more than the present loss. Therefore, not discounting means that we must save every dollar, an indefensible conclusion. Numerous other authors have studied the issue over the years.[23]

II. ETHICISTS AND POSITIVISTS

There are two major positions with respect to the proper discount rate, which we described earlier as the ethicists' and the positivists' approaches.[24] The ethicists attempt to reason from first principles about what the discount rate should be. The positivists attempt to observe what the market-determined discount rate actually is. If the market rate does not coincide with what the ethicists think it should be, the two positions will conflict. We begin by describing

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19. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY, WORKING GROUP II CONTRIBUTION TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 823 (2007).

20. Frank P. Ramsey, A Mathematical Theory of Saving, 38 ECON. J. 543 (1928).

21. ROY F. HARROD, TOWARDS A DYNAMIC ECONOMICS 40 (1948).

22. Tjalling C. Koopmans, On the Concept of Optimal Economic Growth, 28 PONTIFICIAE ACADEMIAE SCIENTIARUM SCRIPTA VARIA 225, 252-53 (1965).

23. See supra note 7.

24. See supra note 8 and accompanying text.

the approach of the positivists and then turn to the ethicists'. In the end, of course, the positivists' approach is worth nothing unless it can be defended on ethical grounds.

We ultimately suggest that the two approaches focus on largely separable issues. The ethicists' approach should not be used to choose projects with a lower-than-market rate of return, and the positivists' approach should not be used to abdicate obligations to the future. We suspect that the intuitions behind the ethicists' arguments turn on a conflation of discounting welfare with discounting money. The ethicists are correct to say that the welfare of a person born in 2050 does not matter less than the welfare of a person born in 2010. But as we shall see, they are wrong to suggest that this claim makes it unacceptable to discount money.

A.   The Positivist Position

The positivists approach the issue as a simple problem of opportunity costs, even for the long term.[25] Suppose that we were going to invest $100 billion to reduce carbon emissions, producing a benefit of $400 billion in 100 years. This represents a rate of return of 1.4%, the discount rate used in the Stern Review. The positivists reason that if the market rate of return over that time period is 5.5% (the Nordhaus rate), the same $100 billion could be invested to produce over $21 *trillion* in 100 years, almost 53 times as much. Equivalently, we could provide future generations with $400 billion dollars by investing about $2 billion at the market rate, keeping the remaining $98 billion to spend on riotous living now. It does not make any sense, argue the positivists, to invest the $100 billion to reduce the effects of climate change under this hypothetical set of facts. To do so would be to throw away vast resources: either $98 billion today or more than $20 trillion in 100 years.

The conclusion, following this logic, is that it is not sensible to invest in any project unless it yields a return at least equal to the return available elsewhere. The problem is exactly parallel to that of the individual who compared the return on an investment project to the return available elsewhere (the bank). The long time horizon does not change the method of analysis; it only makes the issue more important. We should, therefore, discount projects at the otherwise available return: the market rate of return. Only projects that pass discounted cost-benefit analysis should be undertaken. Any other choice wastes resources, which harms future generations. In our example, instead of investing the $100 billion in the project with a 1.4% return, we could invest, say, $5 billion in the market and give future generations about $1 trillion. Everyone would be better

25.   *See, e.g.,* Arrow, *Discounting and Public Investment Criteria, supra* note 7; Kenneth J. Arrow & Robert C. Lind, *Uncertainty and the Evaluation of Public Investment Decisions,* 60 AM. ECON. REV. 364 (1970); David Bradford, *Constraints on Government Investment Opportunities and the Choice of the Discount Rate,* 65 AM. ECON. REV. 887 (1975); Robert Lind, *A Primer on the Major Issues, supra* note 7; Stephen A. Marglin, *The Opportunity Costs of Public Investment,* 77 Q.J. ECON. 274 (1963).

off; the current generation would have $95 billion more than otherwise, and the future ones would have $600 billion more than otherwise.

Note that the positivists are discounting money and argue that they are treating lives at different times equally. For example, suppose that a statistical life today has a value of $5 million.[26] This is the amount we would be willing to spend to save a life immediately. The positivists argue that if a life in 200 years is worth the same amount ($5 million in constant dollars), we should be willing to put aside only the present value of that amount to save that life. They are not discounting the lives—both are worth $5 million—but they discount the dollars, because a dollar set aside today grows with the discount rate. Therefore, the positivists believe their position firmly respects the principle of intergenerational neutrality and thus is defensible on ethical grounds. The claim is that future generations are helped, not hurt, by discounting, because it ensures that resources will be invested to yield the highest possible return.

B. Complications and Difficulties

This simple analysis runs into several complications.

1. Private and Social Rates of Return

A number of technical issues must be addressed when computing the opportunity cost. One important issue focuses on how to adjust for taxes and similar items that drive a wedge between the rates of return investors realize (the after-tax rate of return) and the rate of return that benefits society (the full, pre-tax rate of return that includes investors' gains and the government's tax revenue). Another problem is that there are many market rates of interest. Treasuries pay a different rate from corporate securities; short-term bonds pay a different rate from long-term bonds; and stocks and bonds have different returns. While important, these issues are largely technical and need not detain us here.[27]

2. Uncertainty

A seemingly technical issue, very much worthy of attention, involves the effect of uncertainty on discount rates. Suppose that we are considering a project that produces a return of $1 million in 50 years. In addition, suppose that the discount rate is uncertain and can take one of two values: 10% or 2% with equal probability. What is the expected discount rate we should use in evaluat-

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26. This number is close to current approximations. *See* Cass R. Sunstein, *Valuing Life: A Plea for Disaggregation*, 54 DUKE L.J. 385, 387 (2004) (noting a figure of $6.1 million for the statistical value of a human life).

27. This is not to say that the issues are not important. Because small changes in the discount rate can have large effects on project valuation, it is very important to get these issues right. They are, however, not central to our discussion.

ing this return? It turns out not to be the simple average of 10% and 2%, i.e., 6%. Instead, the number is far lower—in this case, around 3.4%. The reason is that, in order to determine the expected discount rate, we first need to take the discounted value of the $1 million in each of the two scenarios and *then* average these results. If the discount rate is 10%, the present value is about $8500 ($1,000,000/1.10^{50}). If the discount rate is only 2%, the present value is approximately $372,000 ($1,000,000/1.02^{50}). The average of these two values is about $190,000. This average is the proper number we should use for our estimate of the present value of the project. The implied discount rate, i.e., the discount rate that yields a present value of $190,000 from $1 million as $190,000, is roughly 3.4%. As uncertainty increases and as the length of time increases, the effect is magnified.

This point has serious implications for the problem of climate change, which is the paradigmatic case of a long-term problem with uncertain effects.[28] This means that the discount rate used by the positivists should be *near the very lowest expected rate of return over the long run*. If an agency uses a high rate, or averages the high and the low values, its action should be legally vulnerable on the grounds that it has acted arbitrarily. For example, even if we fully expect growth rates over the next 100 years to be three or four (or more) percent, there will be a possibility that growth rates turn out to be very low. We should discount at the low rates because the bad states of the world—where growth is very low—will dominate the averaging process. Therefore, we should not mistake the high observed rate of return on investments for implying that the positivists' logic recommends a high discount rate. Indeed, given that climate change itself might lower the rate of return on investments dramatically, the discount rate recommended by the positivists might be extremely low. This would be true even if very negative climate consequences are unlikely, because the averaging effect just illustrated means that adverse outcomes, even if unlikely, dominate the analysis.

3.   The Richer Future

Positivists also have to ensure that they attach the correct values to future goods.[29] For example, if future people are richer than those alive today, they may value the environment more than people do today. (It is a well-known fact that people value the environment more as they get richer.) Moreover, if climate change damages the environment (as expected), the benefits the environment provides will be scarcer, and its relative value increased. Estimating correct values for the environment in the far distant future will not be easy. But unless we are careful to take into account these sorts of considerations, we risk using the wrong valuations and calculating the costs and benefits of climate change abatement incorrectly.

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28.   *See, e.g.*, Weitzman, *Lowest Possible Rate, supra* note 7.

29.   *See* STERNER & PERSSON, *supra* note 7, at 6-8.

C. The Ethicists' Position

The ethicists argue that the only way to determine the correct discount rate is to return to first principles of ethical reasoning.[30] Their central argument is that cost-benefit analysis with discounting can result in clearly unethical choices. Climate change provides the most vivid example. Climate change exposes the future to the risks of terrible harm. Because of the high discount rates required by the positivists' approach, however, we may be willing to spend only a very small amount today to prevent these serious harms in the future. If we respect a principle of intergenerational neutrality and believe that we have an ethical obligation to take the interests of members of future generations seriously, this position is unjustifiable. Discounting cannot validate refusing to spend small amounts to prevent causing the risk of terrible harm to others.

To be more concrete, suppose that sea level rise will destroy Florida in 200 years. Suppose further that these effects will be extremely difficult to counteract: Reducing emissions may be extraordinarily expensive, and mitigating the resulting harm not feasible. The rate of return on climate change projects under these assumptions is low, and cost-benefit analysis using the market return as a discount rate might recommend that very little be done. This, however, says nothing about whether we are behaving justly toward our descendants. We may, under a variety of ethical theories, owe them prevention of or compensation for this harm. Under a deontological approach with a Rawlsian foundation, for example, the generation in which one finds oneself is irrelevant from the moral point of view; the current generation therefore violates its moral obligations if it enriches itself while subjecting future generations to catastrophic harm.[31] Under a welfarist approach, the question is whether the actions of the current generation increase or decrease overall welfare; it is easily imaginable that a failure to take certain actions to prevent climate change could cause a far greater welfare loss (to all generations taken as a whole) than would those actions themselves. The positivists' theory of discounting has nothing to say about the obligations of the current generations. In short, choosing projects solely through cost-benefit analysis with discounting can result in serious injustice and may violate our ethical obligations to the future.

By examining the details of discounting, the ethicists show why it produces what seem to be obviously unethical results. They offer three central reasons.

1. Private Versus Social Rates of Return

The ethicists argue that the rate of return on an investment realized by individuals—the so-called private rate of return—is not the same as the benefit society derives from that investment—the social rate of return. There could be

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30. *See, e.g.,* STERN, *supra* note 3; Dasgupta et al., *supra* note 7; Heal, *Discounting, supra* note 7.

31. For a discussion of the just savings principle, see RAWLS, *supra* note 12, at 251-58.

many reasons for this difference. But unless markets are perfectly competitive, a condition that is unlikely to hold, the two rates will not be equal. Observed interest rates reflect only private rates of return and, therefore, they are not good guides to whether the total, social benefits from an investment are worth the costs.

To illustrate using the discount rates discussed above, individuals may demand a 5.5% rate of return on investments, but they see only their private benefits. The social benefits of an investment may be much greater. If individuals receive, for example, a 1.4% benefit, then the additional benefits to society from an investment may make it worthwhile. Looking only to the market rate (5.5%) would mean that we reject projects that are overall worthwhile. Absent very stringent conditions, such as the economist's imaginary perfect market, the private and social benefits will not be equal, so we cannot look to the private returns available in the market as a guide for social policy.

2. Individuals Neglecting Posterity

Second (and closely related to the first argument), individuals determine today's interest rate by deciding how much to save for the future. In making this decision, individuals consider their lifetime consumption—how much to consume today compared to their retirement—and possibly the consumption of their children and grandchildren. Climate change, however, is a problem that will last many hundreds of years, spanning multiple generations. Individuals, the ethicists claim, are simply not thinking about the distant future when making savings decisions. This means that observed interest rates are not a good benchmark for decisions over very long time periods. Individuals, in setting the market rate of return, are simply not considering the relevant question.

3. Changing Rates of Return

Finally, climate change abatement will involve large adjustments to the economy. If we make these adjustments, rates of return are likely to change. That is, the rate of return to investments is endogenous to the problem, not something that is external to it. The rate of return is a variable we choose rather than a variable we observe. To make this choice, we have to be explicit about the reasons; we have to go back to ethics.

Starting from scratch to determine the appropriate discount rate, the ethicists conduct a social thought experiment. Here the relevant claims become somewhat technical, and to understand them we have to introduce a little math. Imagine that we are considering investing an additional dollar today that will produce returns in the future. How much must that return in the future be to compensate for the reduction of consumption today? The difference—how much the future must get if the present loses a dollar—is based on our ethical judgments about how much each generation deserves. The "social discount rate" captures this net increase in consumption. Thus, if we must sacrifice one

unit today, and society would demand $1 + \rho$ in the future to offset this loss, ρ is the discount rate.

The ethicists assume that society determines the answer to this question by maximizing the sum of the welfare of each generation, possibly discounting for time. That is, in symbols, society wants to find:

$$Max\ [\ W(C_o) + W(C_1)\ /\ (1 + \delta) + W(C_2)\ /\ (1 + \delta)^2 \dots]$$

where δ is the rate at which we discount the welfare of future generations, if at all, and $W(C_i)$ is a measure of the welfare of a given generation, C_i being the consumption of that generation.

The ethicists then make one additional special assumption. They assume that the welfare of each generation is determined by a very particular form: As consumption goes up, the marginal benefit of additional consumption (in percentage terms) goes down at a constant rate, η. In particular, the welfare of a given generation (W) is set equal to $C^{(1 - \eta)}\ /\ (1 - \eta)$. This form is chosen largely for mathematical convenience rather than its basis in any empirical or ethical support.[32]

With these two very specialized assumptions—that society uses a particular function to choose how to distribute wealth across generations and that it weighs each generation using a specialized functional form which happens to be simple to use for calculations—and some simple math, the ethicists derive the following as an expression for the social discount rate:

$$\rho = \eta \dot{c} + \delta$$

The explanation of this formula is straightforward. As discussed, ρ is the social discount rate—the rate we use to evaluate projects such as climate change abatement. The term $\dot{c}$ is the rate of growth of the economy. It tells us what consumption levels are in each period, i.e., the C_is in the formula. The variable η reflects how much we care about inequality. That is, suppose that growth rates are high, so that the future is significantly richer than today. The value of η tells us that incremental consumption in the future matters less because future generations are richer. The higher η is, the more we demand the future receives to give up a unit of consumption today. We can think of it as an inequality parameter.

The second term δ is the rate at which we discount future generations. The ethicists call it the "pure rate of time preference." It reflects a lower evaluation of future generations simply because they are distant from us. Most of the aca-

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32. This simplification is simply astonishing. Stern, for example, severely criticizes the positivists for requiring all kinds of specialized assumptions for the private rate of return to equal the social rate of return but then imposes specialized functional forms in his analysis. STERN, *supra* note 3, at 49-61. Although the use of this functional form has a long history in public economics, it remains a specialized assumption. *See, e.g.*, Anthony B. Atkinson, *On the Measurement of Inequality*, 2 J. ECON. THEORY 244, 251 (1970).

demic discussion has focused on δ. The ethicists almost uniformly take the position that it is unethical to allow positive values of δ, because this would mean giving less weight to a future person simply because she lives in the future.[33] If all people count equally, δ must be zero.

The variable η is also important. It reflects views about inequality, both across generations and within any given generation; higher ηs are more egalitarian. In the climate change context, the more egalitarian we are, the higher the discount rate and the less we should be willing to invest in abatement. If we use the same values for redistribution within the current generation as we do across time, the more we want to redistribute now, i.e., we are more egalitarian, and the higher the discount rate should be (we should want to engage in climate change abatement less because it redistributes toward the richer future). This seeming paradox, that strong egalitarians should care less about the future, arises because the future is expected (one hopes) to be richer than today.

The terminology in the debate, at this point, becomes a little confusing. Setting δ equal to zero is often described as not discounting. In a sense this is correct: Future generations' welfare is not discounted merely because they are in the future. The pure rate of time preference is zero. The social rate of discount, ρ, however, will be positive. But this, the ethicists say, is not because we are discounting. It is because we have distributive preferences; to the extent that future generations are richer, we should not want to increase their consumption as much. If ρ is positive, however, there will be a mathematical procedure used in evaluating climate change that is identical to discounting. The procedure, however, is about adjusting for distributive preferences, not time. It resembles discounting only by coincidence.

Once we have had our ethical debates about the parameters (and made good technical estimates of the growth rate, $\dot{c}$), we can determine the social discount rate. Stern, in his initial report, set $\delta = 0.1$, $\eta = 1$, and estimated the growth rate as 1.3%. Therefore, he used a social discount rate of 1.4%.[34] Note that this is well below the rate of return available for investments in the economy. He has recently modified his views, adjusting η up to 2, so that the discount rate would be 2.7%, which is closer to, but still below, the rate of return on other investments, although he has not recomputed the resulting policy recommenda-

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33. *See generally* JOHN BROOME, COUNTING THE COST OF GLOBAL WARMING (1992); HARROD, *supra* note 21; DEREK PARFIT, REASONS AND PERSONS (1984); A.C. PIGOU, THE ECONOMICS OF WELFARE (4th ed. 1938); STERNER & PERSSON, *supra* note 7; Broome, *supra* note 7; Tyler Cowen & Derek Parfit, *Against the Social Discount Rate, in* JUSTICE BETWEEN AGE GROUPS AND GENERATIONS 144 (Peter Laslett & James S. Fishkin eds., 1992); Dasgupta, *supra* note 3; Heal, *Intertemporal Welfare Economics and the Environment, supra* note 7; Ramsey, *supra* note 20; Richard L. Revesz, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 COLUM. L. REV. 941 (1999).

34. STERN, *supra* note 3, at 49-61.

tions.[35] Nordhaus would set $\delta = 1.5$, $\eta = 2$, and include a growth rate of 2% to derive a discount rate equal to 5.5%.[36] The difference in conclusions from using these different discount rates is, as noted, dramatic, shifting the policy recommendation from among the most conservative to the most aggressive.

III. THE ETHICS OF DISCOUNTING

In this Part, we attempt to defend three conclusions: (1) the ethicists are correct to insist that choosing projects solely through cost-benefit analysis with discounting can result in serious injustice to the future and that we must respect the principle of intergenerational neutrality; (2) the positivists are correct that choosing any project that has a lower rate of return than the market rate wastes resources; and (3) notwithstanding the long debate between these two positions, they are not fundamentally inconsistent. The ethicists' insistence on intergenerational neutrality does not justify rejecting discounting at the market rate of return (properly taking uncertainty into account). As we shall soon see, choosing our overall legacy to the future—how much each generation receives—is to a large extent unrelated to the choice of particular projects.

In particular, the ethicists' concern over the effects of climate change suggests that we need to do more for the future but says nothing about what in particular that action should be. The positivists' use of the market rate of discount to choose projects says nothing about whether we are fulfilling our obligations to the future.

A. Our Central Claim

To illustrate how the two issues can be separated, imagine that the current generation is leaving a given legacy for the future, a legacy that for now we imagine to be the ethically justified amount. In monetary equivalents, let it be $100.[37] Suppose also that a new project is being considered that costs the current generation $10 and produces $20 for the future. If we engage in this project, we can reduce our legacy elsewhere, still leaving $100 for the future, thereby maintaining distributional neutrality. The only question in this case is whether spending the $10 on this project produces a higher return than spending the $10 elsewhere. The correct procedure for deciding whether to engage in this project

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35. Stern, *supra* note 6, at 23.

36. NORDHAUS, *supra* note 3, at 61.

37. Imagine putting as many zeroes at the end as needed, and we recognize that some consider the goods at stake to be incommensurable, a point to which we shall return.

is to measure the opportunity costs, which, as we showed above, is equivalent to discounting.[38]

Now suppose that we discover our legacy to the future is inadequate because of newfound environmental harms from our actions. Imagine, for example, we discover that the legacy is only $70 instead of $100. We must now reevaluate whether we are leaving enough for later generations. If we believe that, given this information, the correct amount to leave to the future is $95, we must increase our legacy.[39] We should do so in a way that costs us least, which means considering the opportunity costs of alternative projects. If we can find a project that costs us only $10 and leaves $25 for the future, we should not engage in projects that cost more.[40] The market rate of return measures the returns from currently available projects, so as an initial matter, the market rate is a measure of the opportunity costs of this choice. Once again, therefore, we should discount at the market rate to choose projects. Project choice and ethical obligations to the future are, to a large extent, separate.

Viewed this way, the ethicists' criticism of the positivists' opportunity cost argument is simply irrelevant. It does not matter whether the current market rates of interest are ethically correct, because they still represent the opportunity costs of investment. Recall the numbers used above. If we could invest $100 billion to produce $400 billion of benefits in 100 years when the market rate is 5.5%, we could equivalently invest only $2 billion to produce those same benefits.

The ethicists argue that the 1.4% rate of return on the $100 billion (to produce $400 billion) is good enough once we consider the ethical arguments. That is, ethical considerations show that society should make investments not only with a 5.5% rate of return but also with a 1.4% rate of return. But given that there are hundreds or thousands of investment choices, if we are going to make investments at less than the 5.5% rate, we should start with those with the highest return. That is, at least initially, the opportunity cost is 5.5%. If we make enough investments to exhaust the opportunities at this rate of return, we can begin moving down the scale, but in no case should we pursue investments with very low rates of return as a first option.

Another way to describe the problem with the ethicists' approach is that if the correct social discount rate is 1.4%, we should be saving vastly more than we do today to leave the ethically appropriate legacy for the future. The exact

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38. *See supra* Section I.A. If it turns out that the project is desirable, i.e., that current projects have lower rates of return, there is an issue about how to divide the surplus (although any division makes both generations better off).

39. We use $95 rather than $100 because the newly discovered environmental harm means that we (all generations together) are not as well off as we previously thought. It is as if we lost money, and all generations likely will need to share in this loss. The number is only illustrative, and we take no position on whether it should be more or less than $100 because of the damages from climate change.

40. This is a simplification of the idea of distribution-neutral investment choice. *See, e.g.*, Kaplow, *supra* note 7, at 82; Samida & Weisbach, *supra* note 7, at 146.

implied savings rate is contested, because the calculation involves estimates of technological change and other factors. But the ethicists seem to demand behavior from individuals that is far outside anything ever observed. As a first-order matter, therefore, the ethicists should not be arguing about discount rates for climate change. They should be arguing that overall savings and investment rates must dramatically increase. Given the dramatically increased savings and investment rates, we could decide whether investments in climate change abatement make sense.

This point is central: The ethicists' argument is that we are leaving an insufficient amount for the future given current policies. On certain assumptions about the effects of current decisions on the future, these arguments are correct. But regardless of whether they are, *this point says nothing about the particular choice of projects or policies*. If we are going to increase the amount we leave for the future, it is incumbent on us not to do so in a way that wastes resources. Therefore, even if the ethicists' argument is entirely correct, we still must carefully consider the opportunity costs of projects and pick those with the highest return.[41]

The positivists, however, also make a mistake. As we noted, using a market discount rate (properly adjusted for uncertainty) is not a reason for failing to discharge our obligations to the future. The underlying intuition behind the ethicists' argument is that current policies threaten to impoverish the future or to reduce its welfare greatly (as climate change threatens to do). If this is true, discounting is not a reason to permit this occurrence. It is simply a method for choosing projects that *fulfill* our obligations to prevent this from happening. A recommendation for modest climate change abatement, such as that made by Nordhaus, may also require other projects that ensure the proper intergenerational distribution of welfare. That is, the ethicists may very well be correct that we need to adjust the amounts we are leaving for the future in light of our new understanding of the effects of climate change, while the positivists are correct that in doing so, we must be sure to pick those projects with the highest rates of return. Climate change abatement, beyond that suggested by Nordhaus, would be justified if *and only if* it counts as such a project.

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41.   An alternative, slightly more controversial way to make this point is that the ethicists observe that the private rate of return is not equal to the social rate of return and suggest that the government can fill this gap. For example, if the private market rejects a project if the rate of return is only, say, 5% when it demands a 5.5% return, the government should engage in the project if the social rate of return is lower, such as the 1.4% figure used by Stern. Given large differences in the private and social rates of return, the government would be engaging in a vastly greater number of projects than any democratic government currently does. There are likely to be good reasons for restricting the scope of government projects, however. Therefore, the ethicists' arguments for a very low social discount rate are incomplete. Recommendations about government projects using a low social discount rate need to be combined with these reasons for restricting the scope of government projects. The models run by the ethicists and their resulting recommendations, however, never include these exogenous restrictions.

B. Objections

We consider here three objections to our claim that the positions of the ethicists and positivists address separate issues.

1. The Link Between the Market Rate of Return and Overall Savings Rates

The ethicists might object that our claimed separation between the market rate of return and our ethical obligations to the future is misguided. The reason is that, if we were to save more, market rates would decrease. When we finally are saving the right amount, the market rate will be the rate prescribed by their ethical arguments. Therefore, we might as well choose projects with that rate of return.[42]

While we agree that there is a likely connection between overall savings rates and the market rate of return, the ethicists' conclusion does not follow. If the market rate of return is, say, 5.5%, and the ethicists argue that at the correct savings rate the rate of return should be 1.4%, we should not immediately un-dertake projects with such low rates of return because eventually, if we increase savings enough, market rates of return might become this low. Large adjust-ments to our legacy to the future are difficult, and their success unclear. We should begin by choosing high-return projects, not low-return projects.

Moreover, it is probably wrong to suggest that if we sufficiently increase our savings, the interest rate will equal the one determined by the ethicists' in-tuitions. The basic macroeconomic model used by the ethicists to derive their equilibrium market rate of return is the Ramsey model, an almost 100-year-old conception that has been supplanted by vastly more sophisticated models.[43] Even the most rigorous, modern models cannot compute equilibrium interest rates when there are large-scale changes to the economy, such as a vast increase in savings. It does not seem wise to make decisions by relying on an outdated model to argue for committing potentially trillions of dollars to a project on the theory that, in the eventual equilibrium predicted by that model, the project choice will seem sensible.

A better approach is to consider more directly the nature of our ethical ob-ligations to the future. If the obligations are to leave more than we previously thought (say, because of newly discovered risks from climate change), we need

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42. A more subtle (and less powerful) objection is that even if overall savings rates stay the same, interest rates may fluctuate with a change in projects. For example, if we keep our legacy to the future at $100 but change the mix of projects that make up this value, market rates of return may change. This concern seems sec-ond-order, as interest rates could move in either direction. *See* Kaplow, *supra* note 7, at 111-12.

43. *See, e.g.*, ROBERT J. BARRO & XAVIER SALA-I-MARTIN, ECONOMIC GROWTH 59-90 (1995).

to decide how to do that. The first choice of projects as we begin this adjust-ment should be those with the highest rates of return. This means discounting at the market rate. As market returns adjust (by falling if the model used by the ethicists is correct), the opportunity cost of new projects goes down.

2. Feasibility

While in theory the ethicists' and positivists' positions can be reconciled, the most difficult problems for both are potentially ones of feasibility. We start with the feasibility problems of the ethicists' position and then turn to the prob-lems with the positivists' position.

The ethicists derive a discount rate to be used by a social planner independ-ent of the rates demanded by individuals. That is, they begin with the basic premise that social and private rates of return are different and that the gov-ernment should choose projects using the social rate of return. The problem with framing the question in this way is that individuals, not the government, control most of the wealth in society. This means that whatever their prefer-ences about savings, even if wrong, individuals can offset whatever the govern-ment does. Suppose, for example, that individuals (taken collectively) wish to leave $100 for the future and are doing so now. On the basis of the ethicists' recommendation, the government invests in a new project that leaves $40 for the future. Individuals observing this project can simply reduce their legacy to $60 and keep the total at $100, frustrating the government's attempt to correct the market. If individuals can make these adjustments, the question the ethicists start with is simply the wrong question, because the government is not actually making the hypothesized choice. Instead, the government merely chooses which projects will be included in the total amount left for the future.

This type of behavior is known in the economics literature as Ricardian equivalence. The extent to which individuals behave this way is highly con-tested, and no one side is likely to be completely correct.[44] Individuals may, using our numbers, reduce their legacy to only $70, or $80, or even $90. Never-theless, there is a basic futility problem with the ethicists' approach. The ques-tion they pose, by imagining that the government makes the basic choices about total investment, ignores the basic (and well-founded) constraints on govern-ment activity.

The positivists also encounter feasibility problems. Specifically, it may not be possible to transfer resources across centuries to compensate the future vic-tims of climate change. We are, when it comes to climate change, like Robinson Crusoe—the choices are simply about distribution because there is no "bank." There is no other way of shifting resources across these long periods of time.

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44. For a review of this debate, see Kent Smetters, *Ricardian Equivalence: Long-Run Leviathan*, 73 J. PUB. ECON. 395 (1999).

This argument has been made most convincingly by Robert Lind.[45] He argues that we simply do not have direct methods of shifting resources across long periods of time, so indirect methods—for example, the choice of projects including climate change abatement—have unavoidable distributional consequences. He discusses a hypothetical proposal to transfer resources to the distant future through an investment with a 0% rate of return at a time when money or other projects earn a 10% return:

> The preferred decision may well be to make that investment and transfer the resources to the future generation even though it earns a zero rate of return. At this point an eager graduate student jumps up, sensing an economic slam dunk, and says "That was a really dumb decision. You could have invested that money at 10% and made those people a lot better off." Wrong! We don't know how to set aside investment funds and to commit intervening generations to investing and reinvesting those funds for eventual delivery as consumer goods to the generation 200 years from now.[46]

The extent to which this is correct is an empirical and institutional question rather than a purely ethical one. We cannot rule out the possibility that projects with very low rates of return are the best way of shifting resources across time, but it seems unlikely. If, for example, the market rate of return were really 10%, and the project under consideration had a 0% rate of return, it is hard to imagine that no other projects existed that, while perhaps not yielding the full 10%, had some positive rate of return.

As in the quotation above, the claim that we cannot set aside funds for the future is often based on the problem of intervening generations. Suppose that a project, such as climate change abatement, will pay off in the long-distant future, say, 100 to 200 years. If we try to set aside funds for those same future individuals on the theory that the conserved funds will have a greater future value than funds invested in reducing emissions, those resources would have to pass through many generations before the target population receives them. Any of those intervening generations could prevent transfers to the future, making it impossible to guarantee that the funds will be used as intended.

Note, however, that the same problem arises with climate change abatement. Even if we spend vast resources reducing carbon emissions, future generations can always revert to burning fossil fuels. It is hard, without much more institutional detail, to understand why various projects would differentially implicate the problem of intervening generations, which is what is needed for the claim to have force. We cannot rule out this possibility, but it seems to us to be extremely unlikely.

At the end of the day, which way do the feasibility issues cut? We do not think that feasibility concerns seriously undermine the case for choosing the

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45. *See* Lind, *Analysis for Intergenerational Discounting, supra* note 7; Lind, *A Primer on the Major Issues, supra* note 7.

46. Lind, *Analysis for Intergenerational Discounting, supra* note 7, at 176.

best projects, which means using market discount rates. On the other hand, it seems clear that the very high savings rates suggested by the ethicists' approach are unrealistic. At the same time, as we learn more about climate change, it is becoming apparent that our legacy to the future may fall short of expectations. New understandings about climate change increase our need and responsibility to save, whether through investments in abatement or alternative projects. The ethicists' imperative is becoming more important. The best approach, however, is to help the public gain an understanding that our legacy is likely to be lower than we might have hoped unless we let the market aggregate preferences to the future with this new information incorporated.

3. Incommensurable Goods: Lives Versus Money

A final argument that we cannot separate our ethical obligations from project choice is that climate change produces particular future harms that cannot be offset by projects that benefit the future in other ways. This argument may take a variety of forms. One version is that the deaths caused by climate change cannot be counterbalanced by simply saving more. Dean Richard Revesz makes such an argument.[47] He contends that the primary reason for discounting monetary benefits does not apply to risks to life and health. Money is discounted because it can be invested. But human lives cannot be invested, and a life lost twenty or two hundred years in the future cannot be "recovered" by investing some sum in the present.

Revesz is correct to state that lives cannot be invested, but the problem with his argument is that what is being discounted is money, not lives. Under the standard analysis, any discount rate applies to willingness to pay to reduce statistical risks, which is a monetary measure.[48] The issues raised by the monetary valuation of lives are no different when used for standard cost-benefit analysis within a single time period than when used over differing time periods. Once lives (or more properly, statistical risks of mortality) are converted to monetary equivalents, all of the arguments discussed above concerning discounting apply. If a life today and a life in 200 years are both "worth" the same amount in terms of money, we should discount the dollars allocated to the future life, because money set aside for the future grows. For example, if a life today and a life in 200 years are both worth $5 million, we should only allocate the present value of $5 million to the future life. Anything more than $5 million values the future life more than the present one. To be sure, translating lives into money is not easy and raises a host of thorny questions,[49] but it is not an issue for discounting in particular; objections to the methodologies for valuing lives are orthogonal to the discounting debate.

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47. Revesz, *supra* note 33, at 974.

48. *See, e.g.,* W. KIP VISCUSI, FATAL TRADEOFFS (1994).

49. For further discussion, see Sunstein, *supra* note 26, at 386-94.

An alternative version of the incommensurability argument, associated with Derek Parfit, is that, even if discounting combined with changes in overall savings rates produces the correct allocation of resources across generations taken as a whole, harms to particular individuals cannot be offset by this procedure.[50] Parfit imagines activities today that increase the risk of genetic deformities in a small number of individuals in the future. Overall changes to the allocation of resources across generations do not compensate those individuals.

In a sense Parfit is right, but just as with the problem of valuing lives, his argument is not really about discounting. A project that takes place entirely within a single time period may still impose risks on individuals. Before the project begins, all individuals may be subject to the same risk and, taken as a whole, the project may seem sensible. Particular individuals, however, will suffer harms ex post, and those who gain from the project may not be able to compensate those who lose. The arguments surrounding this problem have been debated vigorously.[51] They present nothing new when the project occurs over more than one time period.

CONCLUSION

In one sense, the debate over climate change is over. A consensus has emerged not only on the existence of global warming,[52] but also on the proposition that the world would benefit, on balance, from a suitably designed agreement to control emissions.[53] As yet, there is no consensus on what the agreement should require. One of the most significant arguments involves the aggressiveness of emissions cuts. That dispute turns, in large part, on the appropriate discount rate.[54]

Our minimal goal here has been to illuminate the debate—to show exactly what is dividing the two sides. Because of the problem of uncertainty, we have argued for a low interest rate. But we also have contended that, on the most fundamental question, the positivists are largely correct. Projects, including those involving climate change, should be evaluated by discounting the costs and benefits at the market rate of return, properly adjusted for uncertainty and for the inherent value of the environment. Any other approach risks choosing projects with low rates of return, which leaves resources on the table, as it were.

Discounting, however, should be seen only as a method for choosing projects, *not as a method for determining our ethical obligations to the future*. We have endorsed a principle of intergenerational neutrality, and if, because of cli-

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50. *See* PARFIT, *supra* note 33, at 483.

51. *See, e.g.,* VISCUSI, *supra* note 48; Sunstein, *supra* note 26.

52. *See, e.g.,* HOUGHTON, *supra* note 1, at xxvii.

53. *See, e.g.,* NORDHAUS, *supra* note 3.

54. Another important issue involves the weight accorded to catastrophic outcomes. *See* Weitzman, *supra* note 9.

mate change, the legacy to our descendents is far lower than we imagined, we have a moral obligation to adjust. The proper response is to leave them more, not to choose projects by refusing to discount.